3nd OPEN-AIR CITIES INTERNATIONAL CONFERENCE "LOCAL AND REGIONAL SUSTAINABLE DEVELOPMENT AND URBAN RECONSTRUCTION"

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WELCOME INTRODUCTION

Dear Invited guests, Colleagues and Students,

On behalf of the Scientific and Organizing Committee, we welcome you to the 3rd OPEN-AIR CITIES International Conference, organized by Open-Air Cities, HAROKOPIO UNIVERSITY of Athens - Postgraduate Programme "Sustainable Development" and SYROS INSTITUTE.

The conference aims to present and disseminate research results related to the Sustainable Development of cities and regions at a global level.

The main subject is the presentation of relevant research in the field of Sustainable Development.

The conference is organized and structured on the four main pillars of Sustainable Development, which in fact are also the main pillars of Urban and Regional Development: Environment, Economy, Society and Culture. Each of these pillars includes its subcategories, which are detailed through the thematic sections related to the 17 Global Goals of Sustainable Development.

The conference brings together many distinguished researchers of Local and Regional Sustainable Development and Urban Reconstruction from many countries all over the world. Participants have the opportunity to present new research, exchange information, and discuss current issues.

The papers that will be presented at the conference have the possibility to be included in the conference proceedings and to be published in the international journal *Sustainable Development, Culture, Traditions Journal* (www.sdct-journal.com) (ISSN: 2241-4010), after their final submission to the journal.

I would like to extend particular thanks to the conference Keynote speakers: Moraitis Konstantinos, Salvati Luca, Plotnic Olesea, Kremlis George, GiacomoDi Foggia, KaldiStavroula, DimelliDespina, AngelidisMinas, RodiAlcestis, GospodiniAspa.

Also, I would like to thank all the participants, as well as all the colleagues who have prepared the very interesting sessions you will attend at the conference.

I wholeheartedly hope that all participants gain valuable scientific knowledge and find the 3rdOPEN-AIR CITIES International Conference an enjoyable and fulfilling experience.

Chair of the Organizing & Scientific Committees
Roido Mitoula
Dean, School of Environment, Geography and Applied Economics, HAROKOPIO UNIVERSITY OF ATHENS
Professor, "Local and Regional Development - Urban Reconstruction"
Head of Postgraduate Programme "Sustainable Development"
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TABLE OF CONTENTS

SCIENTIFIC COMMITTEE 15
OFFICER OF PUBLICATIONS & COMMUNICATION 16
ORGANIZING COMMITTEE 16
CONCISE CONFERENCE PROGRAMME 21
KEYNOTE SPEAKERS 23
CONFERENCE SCHEDULE 27
CONFERENCE PAPERS 40
CITATION GUIDELINES 801

KEYNOTE SPEACHES 40

URBAN SUSTAINABILITY: NOTES AND PARADIGMES ON THE ENVIRONMENTAL, CULTURAL AND POLITICAL IMPROVEMENT OF PLACE (L02144) 41
Moraitis Konstantinos

MULTIDISCIPLINARY PARADIGMS BETWEEN SCIENCE AND POLICY. POSITIVE AND NORMATIVE APPROACHES FOR THE ANALYSIS OF COMPLEX ECONOMIC AND ENVIRONMENTAL SYSTEMS (L02136) 53
Salvati Luca

INNOVATIVE ENTREPRENEURSHIP AS A CATALYST FOR SUSTAINABLE PROSPERITY AND COMPETITIVENESS IN EUROPEAN CITIES AND REGIONS (L02241) 54
Plotnic Olesea

ACHIEVING CLIMATE NEUTRALITY: STRATEGIES AND CHALLENGES IN THE ENERGY TRANSITION (L02230) 55
Kremlis George

SCALING UP THROUGH COOPERATION: HOW VOLUNTARY AGGREGATION IN LOCAL ENVIRONMENTAL SERVICES SUPPORTS CIRCULAR ECONOMY GOALS (L02248) 56
Giacomo Di Foggia

EDUCATION FOR SUSTAINABLE DEVELOPMENT: THE EXAMPLE OF THE "GREENCOMP SCHOOL" CURRICULA AND LEARNING (L02132) 57
Kaldi Stavroula

HISTORIC URBAN LANDSCAPES AND URBAN RESILIENCE: RETHINKING CULTURAL HERITAGE IN GREEK CITIES (L02129) 58
Dimelli Despina

OVERTOURISM AND BEYOND: TOURISM AND SUSTAINABILITY IN CITIES AND TERRITORIES (L02161) 74
Angelidis Minas

FROM FORMA URBIS TO FORMA HORTO: BLUE-GREEN ROOFS AS THE NEW URBAN GROUND (L02249) 96
Rodi Alcestis

HOUSING CRISIS IN POST-CRISIS ATHENS; INEFFECTIVE STATE POLICIES & THE POTENTIAL OF URBAN RENEWAL SCHEMES OF ABANDONED INDUSTRIAL SITES (L02243) 97
Gospodini Aspa

Session: 98
"Local and Regional Development – Economy -Entrepreneurship"
Chaired by **Prof Olesea Plotnic** and **Angelos Papavasileiou**

THE ADAPTATION INVESTMENT CYCLE: THE MISSING LINK FOR BRIDGING THE REGIONAL ADAPTATION GAP IN EUROPE (L02135) 99
Dellis Konstantinos, Chourdaki Maria

THE ROLE OF INTRAPRENEURSHIP IN THE ENTREPRENEURIAL ORIENTATION OF UNIVERSITIES (L02149) **100**
Troshani Ines, Nuka Dardane, Cabiri Mijo Ketrina
THE ROLE OF COACHING IN SHAPING LEADERS FOR A SUSTAINABLE WORLD (L02150) **101**
Dologlou Maria, Mitoula Roido
COSMETOLOGY PRODUCTS AND SUSTAINABILITY: GREEK CONSUMER'S SOCIAL AND ENVIRONMENTAL ATTITUDES AND PERCEPTIONS (L02166) **109**
Lezou Vasiliki, Karametou Panagiota, Economou Agisilaos, Mitoula Roido
THE GIG ECONOMY AND EMPLOYMENT CREATION IN THE DIGITAL ERA: EXPLORING THE OPPORTUNITIES AND FACILITATING CONDITIONS FOR POLICY CONSIDERATIONS (L02192) **110**
Sannegadu Rajesh, Erceg Aleksandar, Pudaruth Sharmila, Thanika Devi Juwaheer, Jovanka Damoska Sekuloska
BEYOND THE GREEN LABEL: ENTREPRENEURSHIP, GOVERNANCE, AND THE SUSTAINABILITY PARADOX - THE CASE OF BENGUERIR'S GREEN CITY (L02214) **130**
Najlaa Rachidi, Mouhcine Benaicha, Hicham Mouloudi
ENTREPRENEURSHIP AND EUROPEAN VALUES AS DRIVERS OF SUSTAINABLE INNOVATION AND DIGITAL TRANSFORMATION (L02171) **131**
Plotnic Olesea, Hămuraru Maria, Buzdugan Adriana
EVALUATING THE ROLE OF AGRICULTURAL SUBSIDIES IN AGRITOURISM DEVELOPMENT: A CASE STUDY FROM ALBANIA (L02130) **132**
Gecaj Merita, Grepcka Alketa, Malaj Mentor, Gjermizi Mirgjana
LEVEL OF DISASTER PREPAREDNESS OF LINDAWAN NATIONAL HIGH SCHOOL (L02256) **133**
Almeqbali Muhammad Abdula F., We-eng Zynlee M., Abelao Ernilyn R., Cayapa Kyla Andrea K., Tariagao, Abigeil T., Wagacon, Reshel D.
COMPARATIVE ANALYSIS OF LOCAL GOVERNMENT AND CITIZEN CONTRIBUTIONS TO SUSTAINABLE WASTE MANAGEMENT (SDG12) IN GREECE, ITALY, SERBIA, MOLDOVA (L02244) **134**
Mitoula Roido, Angelos Papavasileiou, Economou Agisilaos, Plotnic Olesea, Milosevic Isidora, Menshikova Maria

Session: **135**
"Culture - Museums - Religious and Cities"
Chaired by **Assoc Prof Astara Olga-Eleni** and **Prof Papaioannou Georgios**

EVALUATING THE ROLE OF MUSEUMS ON CITIES' SUSTAINABLE DEVELOPMENT: A COMBINED ANALYSISOF ATHENS AND SINGAPORE (L02025) **136**
Metaxas Theodore, Koutsoumpela Alexandra
KmVert "URBAN RELIGIOUS ARCHAEOLOGY": A SUSTAINABLE SOCIO-CULTURAL VISION FOR URBAN REGENERATION (L02027) **137**
Marcuccetti Andrea
WHICH FUTURE EXACTLY? JUSTICE AND SUSTAINABILITY IN AFROFUTURIST LITERATURE AND MODERN GREEK SPECULATIVE FICTION (L02131) **138**
Mousouli Rania
MARINE PARKS & CULTURAL SUSTAINABILITY: THE ROLE OF IONIAN AND SOUTH AEGEAN NATIONAL MARINE PARKS IN PROMOTING MARITIME CULTURAL HERITAGE AND ISLAND RESILIENCE (L02138) **154**
Rachiotis Theodoros, Poulaki Panoraia
MUSEUMS AND SUSTAINABLE GREEN DEVELOPMENT: THE CASE OF GREECE (L02159) **155**
Astara Olga-Eleni, Papaioannou Georgios
SUSTAINABLE CULTURAL DEVELOPMENT THROUGH AN INTERPRETATIVE APPROACH WITHIN THE FRAMEWORK OF THE CLIMATE CRISIS - A MATHEMATICAL MODEL AND FIELD RESEARCH: THE CASE OF DELPHI (L02189) **156**
Karagiannis Georgios, Mitoula Roido

VALUING UNDERWATER CULTURAL HERITAGE AS A RESOURCE FOR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF BANTRY BAY HARBOUR (L02240) **158**
Valasiadi Eva
URBAN EXPANSION AND THE "OTHER" CITY IN CINEMA. THE URGENT NEED FOR A SUSTAINABLE CITY. (L02190) **164**
Chatzifragkios Makrydakis Konstantinos
PROPOSAL FOR A CULTURAL ROUTE IN THE RUSSIAN MONASTERIES OF MOUNT ATHOS(L02246) **177**
Tsogkas Konstantinos

Session: **178**
"Promoting Sustainable cities"
Chaired by **Prof Angelidis Minas** and **Dr Prof Koutsoumpos Leonidas**

RETHINKING THE ECOLOGICAL NETWORK PROJECT CONSIDERING - NEW QUESTIONS RAISED BY URBAN COMPLEXITY (L02172) **179**
Carmen Angelillo, Martina Borini, Peraboni Carlo
THE CITY AS STAGE: SOCIALLY ENGAGED PERFORMANCES IN THE PUBLIC SPACES OF ATHENS (L02133) **181**
Linaki Eleni
THE CONTRIBUTION OF LOCAL GOVERNMENT TO THE PROMOTION OF SUSTAINABLE DEVELOPMENT – THE CASE STUDY OF THE MUNICIPALITY OF AMAROUSSION AND OF THE SYGGROU FOREST (L02137) **182**
Sereti Evangelia - Paraskevi
INTEGRATED URBAN AND ENVIRONMENTAL STRATEGIES FOR CLIMATE RESILIENCE IN THE ATHENS METROPOLITAN AREA (L02139) **210**
Kampolis Dimitrios
WIDENING OF THE INTERMEDIATE BETWEEN THE HILL AND THE CITY: AS A CASE STUDY, THE CORRELATION BETWEEN PHILOPAPPOU HILL AND ANO PETRALONA (L02206) **233**
Ydraios Nikiforos, Koutsoumpos Leonidas
THE SPATIOTEMPORAL EVOLUTION OF URBAN PLANNING IN THE HISTORIC CENTER OF KAVALA: CONTEMPORARY REFLECTIONS (L02220) **238**
Samourkasidou Elena, Nastou Marina
ASPFALT-ART AS AN INNOVATIVE WAY FOR SUSTAINABLE MOBILITY (L02219) **239**
Samourkasidou Elena
THE PHYSIOGNOMY AND SUSTAINABILITY OF RAFINA CITY THROUGH STUDENTS' PERSPECTIVE (L02237) **248**
Samara Anna
ENVIRONMENTAL LIVING CONDITIONS IN URBAN CENTERS AND THEIR IMPACTS ON HEALTH: CASE STUDY OF THE ATTICA REGION (L02196) **267**
Derventi Maria, Mitoula Roido, Theodoropoulou Eleni, Karagianni Vilelmini
SUSTAINABLE DEVELOPMENT CONDITIONS IN THE MUNICIPALITY OF MOSCHATO-TAVROS, ATTICA, GREECE: SWOT ANALYSIS OF GEOGRAPHICAL, ENVIRONMENTAL, ECONOMIC, SOCIAL AND CULTURAL DIMENSIONS (L02247) **268**
Kochetkova Aleksandra

Session: **282**
"Tackling socio-economic inequalities and in-work poverty"
Chaired by **Prof Papadakis Nikos** and **Lect Vlachadi Maria**

LABOUR MARKET, SOCIO-ECONOMIC INEQUALITIES AND IN-WORK-POVERTY, IN MOMENTOUS TIMES: THE ROLE OF THE WELFARE STATE AND THE POLICY CHALLENGES FOR SOCIAL SUSTAINABILITY (L02140) **283**
Papadakis Nikos, Tzagkarakis Stylianos-Ioannis

NEW TRENDS-TYPES OF MIGRANTS TOWARDS SUSTAINABLE CITES (L02151) **285**
Vlachadi Maria, Plougarlis Dimitrios

RETHINKING RESEARCH PARTICIPANT COMPENSATION IN URBAN SETTINGS: A SOCIAL EXCHANGE PERSPECTIVE ON SUSTAINABLE DEVELOPMENT (L02160) **304**
Ahimbisibwe Osborn, Ayebale Dan

THE ENVIRONMENTAL PHILLIPS CURVE: A CROSS-COUNTRY ANALYSIS OF UNEMPLOYMENT AND ENVIRONMENTAL DEGRADATION (L02164) **305**
Karsiotis Panagiotis, Adamopoulos Antonios, Maniatis Antonios, Irakleous Alexia

Session: **314**
"'Social' Architecture - Environment and Health"
Chaired by **Prof Dimelli Despina** and **Asst Prof Poli Maria**

DOES GENDER MATTER IN CONSPIRACY BELIEFS VACCINATION HESITANCY? EVIDENCE FROM COVID-19 VACCINATION IN UGANDA (L02157) **315**
Bacwayo Kukunda Elizabeth, Sebaggala Richard, Maractho Emilly, Amaniyo Mercy, Mwije Solomon, Kemigisha Evas, Kobusingye Jacqueline, Cheremoi Clare

NEIGHBOURHOOD PHARMACIES OF THE FUTURE: LOCAL NETWORKS FOR PERSONALIZED, 3D-PRINTED MEDICINES (L02197) **335**
Achillas Charisios, Vlachokostas Christos, Tsolakis Naoum, Koumpakis Dimitrios Aristotelis, Aidonis Dimitrios, Michailidou Alexia

ACCESSIBLE HOUSES FOR PEOPLE WITH DISABILITIES IN GREECE: A CRITICAL VIEW (L02154) **336**
Poli Maria, Malagas Konstantinos

BIOMIMETIC, SUSTAINABLE, AND ACCESSIBLE ARCHITECTURE: A HOLISTIC DESIGN PARADIGM (L02155) **349**
Poli Maria, Malagas Konstantinos

Session: **359**
"Urban and Regional Sustainable Development"
Chaired by **Prof Lalenis Konstantinos** and **Dr Econoou Agisilaos**

OPEN-AIR CITIES OF DEAD (L02148) **360**
Polymenidis Yannis

RELIGIOUS INSTITUTIONS: AN ANALYSIS OF THE LEGAL AND INSTITUTIONAL FRAMEWORK GOVERNING ZONING, CONSTRUCTION, AND BUILDING REGULATIONS AND THEIR INTEGRATION INTO SPATIAL PLANNING IN GREECE -A COMPARATIVE OVERVIEW WITH OTHER EU COUNTRIES (L02153) **364**
Lalenis Konstantinos, Zygouri Foteini

ONTOLOGICAL TRANSFORMATIONS THROUGH THE WORK OF GIOVANNI BATTISTA PIRANESI (L02184) **382**
Katsanevakis Evangelos

PARTICIPATORY MAPPING AND ASSESSMENT OF LANDSCAPES THROUGH CROWDSOURCING: FROM UNIVERSITY EDUCATION TO CROSSCULTURAL CITIZEN SCIENCE (L02194) **383**
Ioannidis Romanos

BEYOND SHELTER: DISPLACEMENT AT THE THRESHOLD OF ECOLOGICAL CHANGE (L02200) **384**
Xirogiannis Maria, Kyriakidis Charalampos, Moraitis Konstantinos

MAIN WOOD SPECIES USED IN GREEK WOODCRAFT: A HISTORICAL AND TECHNOLOGICAL STUDY (L02225) **393**
Ntalos George, Mitani Andromachi, Alexaki Pinelopi, Ntalos Paulos, Koutsianitis Dimitrios, Ninikas Konstantinos

TOURISM, CULTURE AND SUSTAINABLE DEVELOPMENT IN THE REGION OF BOEOTIA (L02146) **398**
Christou Dimitris

URBAN BUZZWORDS IN PRACTICE: RHETORIC, METHOD, AND THE POLITICS OF DIFFUSION (L02146) **403**
Vartholomaios Aristotelis

THE CONTRIBUTION OF CULTURAL ASSOCIATIONS AND LOCAL AUTHORITIES TO THE PRESERVATION AND PROMOTION OF THE CULTURAL HERITAGE OF A REGION. AS A CASE STUDY: THE MUNICIPALITY OF DORIDA (L02250) **404**
Chalioris Konstantinos, Roido Mitoula, Anastasia-Aspasia Gospodini, Maria Manola

NAVIGATING INTEGRATED PLANNING IN SMALL MUNICIPALITIES: LIMITATIONS, PATHWAYS FORWARD EMERGING OPPORTUNITIES. THE CASE OF DIDYMOTICHO. (L02255) **405**
Zountsa Stergiani, Skiadas V. Dimitrios

Session: **406**
"Tourism and Sustainable Development"
Chaired by **Asst Em Panagiotis Patargias** and **Asst Prof Skoultsos Sofoklis**

TOWARDS TO A NEW TOURISM MODEL ADJUSTMENT IN GREECE: SOME EMPIRICAL EVIDENCE FROM HOTEL EXECUTIVES (L02026) **407**
Metaxas Theodore, Andrinos Meletios, Avlogiaris Konstantinos

CULTURAL TOURISM AS A CATALYST FOR SUSTAINABLE URBAN AND REGIONAL DEVELOPMENT IN GREECE (L02141) **408**
Kriga Mimika (Dimitra)

TOURISM MUNICIPALITIES IN SPAIN (L02142) **409**
Maniatis Antonios, Adamopoulos Antonios

TOURISM POTENTIAL OF INDUSTRIAL HERITAGE: A STUDY OF TOBACCO WAREHOUSES IN KAVALA, GREECE(L02176) **410**
Grigoriadou Maria– Alexandra, KouveliAikaterini

TOWARDS SUSTAINABLE TOURISM IN CRETE: DELPHI EVALUATION OF PRIMARY SECTOR SYNERGIES AND REGIONAL PATHWAYS (L02185) **411**
Kritikos Antonis, Magoutas Anastasios, Chountalas T. Panos, Livieratos Antonis

CREATIVE TOURISM AND SUSTAINABLE DEVELOPMENT IN MOUNTAINOUS GREECE: THE VOVOUSA FESTIVAL, THE NOWSTALGISM PROJECT, THE LAKE STEFANIADA FESTIVAL (L02202) **412**
Pelagidou Maria Argyro

FROM ATTACHMENT TO INDIFFERENCE: RETHINKING TOURIST–DESTINATION RELATIONSHIPS (L02223) **413**
Briana Maria

URBAN SPACE "ON THE MOVE": EXPERIENTIAL AND DIGITAL ROUTES FOR THE 21th CENTURY TRAVELER (L02169) **414**
Moira Maria, Makris Dimitrios

SMILES AMONG THE RUINS AND CROWDS? RETHINKING TOURIST WELL-BEING AND HAPPINESS FOR SUSTAINABLE URBAN TOURISM IN ATHENS (L02203) **429**
Koliotasi Aigli, Karampela Sofia, Malesios Chrisovalantis, Kizos Thanasis

GEOTOURISM AS A TOOL FOR SUSTAINABLE TOURISM DEVELOPMENT: THE CASE OF LAVREOTIKI'S GEOPARK (L02236) **430**
Mezantonakis Georgios, Skoultsos Sofoklis

Session: **431**
"Environmental Sustainability- Waste Management- Circular Economy"
Chaired by **Prof Brzezińska-Rawa Anna** and **Prof Theodoropoulou Eleni**

THE BOTTLE-NECK OF SUSTAINABLE GOVERNANCE: LEGAL AMBIGUITIES IN POLAND'S MUNICIPAL WASTE MANAGEMENT AND THE EPR-BASED DEPOSIT SYSTEM (L02134) **432**
Karpus Karolina

BALANCING SUSTAINABILITY AND PERFORMANCE: COMPARING RECYCLED, BIO-BASED AND LOW-CARBON MATERIALS USING AHP (L02147) **433**
Zambujal-Oliveira João

CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT – EXAMPLES OF THE POLISH EXPERIENCE (L02165) **434**
Brzezińska-Rawa Anna

CIRCULAR BIOECONOMY TO SUPPORT THE GREEN TRANSITION IN INSULAR AREAS (L02201) **435**
Klontza Eleftheria, Lekkas Demetris-Francis

EXAMINING CIRCULAR ECONOMY BARRIERS, DRIVERS AND SPECIFICATIONS IN THE CONSTRUCTION SECTOR: KEY STAKEHOLDERS' SURVEY (L02218) **436**
Oikonomou I. Theoni, Karytsas Spyridon, Karytsas Constantine, Theodoropoulou Eleni

EXAMINING THE "RETHINK" AND "REFUSE" CIRCULAR ECONOMY PRACTICES IN THE CONSTRUCTION SECTOR: RESULTS FROM A SURVEY FOCUSED ON YOUTH ACROSS SEVEN EUROPEAN COUNTRIES (L02222) **438**
Karytsas Spyridon, Oikonomou I. Theoni, Lima Ana Teresa, Mao Ruichang, Aloini Davide, Zerbino Pierluigi, Sánchez María Nuria, Moreno Helena López, Calvo Oscar Seco, Kostakis Ioannis, Dürr H. Hans, Sameer Husam, Simoes G. Sofia, Barbosa Juliana, Genovese Andrea, Guru Ram Venkataraman, Karytsas Constantine

Session: **441**
"Consumers and Sustainability"
Chaired by **Prof Sardianou Eleni** and **Kostakis Ioannis**

PERSUASIVE TECHNOLOGIES AND SUSTAINABLE CONSUMER BEHAVIOR: A BIBLIOMETRIC MAPPING OF RESEARCH TRENDS (2015–2025) (L02168) **442**
Achamnou G Panagiota, Sardianou Eleni, Kalantonis Petros, Kostakis Ioannis

LAST-MILE DELIVERY WITH DRONES IN AN URBAN ENVIRONMENT. EMPIRICAL STUDY ON CONSUMER PERCEPTIONS. (L02228) **443**
Darras George, Malindretos George, Kostakis Ioannis, Karametou Panagiota

MEASURING THE EFFECTS ON WELL-BEING, SELF EFFICIENCY AND EMPLOYABILITY OF VULNERABLE POPULATION GROUP AFTER IMPLEMENTING A PLATFORM FOR MENTORING (L02239) **444**
Spyridaki Aikaterini, Papadakaki Maria, Vassilakis Kostas, Markakis George

Pre-organised Special Session: **455**
"Virtual cities" and social sustainability in EU framework- Cultural, sociological and communication perspectives"
Organised and Chaired by **Dr Bokolas Vassilis, Prof Vassilakou Tonia, Prof Colantoni Andrea, Assoc Prof Ferrigni Nicola, Prof Kaperonis Stavros, Assoc Prof Nosova Bogdana and Ntrouva Efi**

USER EXPERIENCE AND DIGITAL SKILLS IN VIRTUAL GAMIFIED ENVIRONMENTS: BETWEEN SCIENTIFIC RESEARCH AND EUROPEAN POLICY GUIDELINES (L02233) **456**
Kaperonis Stavros, Bokolas Vassilis

PRECARIOUS EMPLOYMENT IN THE GIG ECONOMY: UNVEILING THE EFFECTS OF WORK CONDITIONS ON THE HEALTH AND QUALITY OF LIFE OF MIGRANT FOOD DELIVERY WORKERS (L02229) **457**
Theodoros Fouskas, Tonia Vasilakou, George Koulierakis, Charalambos Economou, Despoina Papadopoulou, Manos Spyridakis, Petros Galanis, Maria-Teresa Terron Caro, Zoran Lapov, Anastasia Papachristou, Maria Petraki, Athanasios Raptis, Anastasios Chondrogiannis, Panagiotis Zikas, Panagiotis Spiliopoulos, Sintorela Chamiti, Athanasiou Stefanos, Alexandros Tziolas

VIRTUAL VULNERABILITIES AND REAL OBLIGATIONS: RETHINKING COMPENSATION PRACTICES IN DIGITALLY MEDIATED RESEARCH (L02224) **459**
Ahimbisibwe Osborn, Rozynska Joanna, Napakol Angella

VIRTUAL ENVIRONMENTS AND THE ELDERLY: RESEARCH, GOOD PRACTICES, AND TRAINING IN DIGITAL SKILLS IN THE EUROPEAN CONTEXT (L02232) **460**
Dimitrakopoulos Chris, Tsintari Elena

DIGITAL RELIGIOUS RHETORIC AND MEDIA LITERACY IN EUROPEAN CONTEXT: RESEARCH, GUIDELINES AND POLICY IMPLEMENTATION (L02238) **461**
Mandrapilias Tasos, Zotou Danai

DEVELOPING GREEN ENTERPRISE THROUGH INTEGRATED PCI–PGI GOVERNANCE AND DDCI EVIDENCE IN BAC NINH, VIETNAM (L02226) **462**
Trung-Luan Nguyen, Anh-Tai Do

THE INCLUSION OF INDIVIDUALS WITH NEURODEVELOPMENTAL DISORDERS IN THE CONTEXT OF SUSTAINABLE URBAN DEVELOPMENT: EDUCATION, INFRASTRUCTURE, AND SOCIAL COHESION (L02231) **480**
Koundourou Christiana, Zerva Irini, Bonti Eleni

GREEN AND SMART CITY APPROACHES: INSIGHTS FROM SUB-SAHARAN AFRICA (L02235) **481**
Judith Irene Nagasha, Simon Peter Musinguzi, Anne Nakagiri, Bosco Bwambale

ROLE OF INTRAPRENEURSHIP IN THE ENTREPRENEURIAL ORIENTATION OF UNIVERSITIES (L02251) **482**
Ines Troshani, Dardane Nuka, Ketrina Mijo, Kebjana Haka

ERASMUS+ GREENO2 AND GAME4CHANGE PROJECTS: SOCIAL SUSTAINABILITY, COMMUNICATION, AND A SOCIOLOGICAL PERSPECTIVE (L02252) **483**
Andrea Colantoni, Bogdana Nosova, Nicola Ferrigni, Simona Fallocco, Giorgia Di Domenico, Leonardo Bianchini, Valerio Di Stefano

DIGITAL SERIOUS GAMES FOR CLIMATE CHANGE EDUCATION: RESEARCH DATA AND FINDINGS (L02253) **485**
Bokolas Vassilis, Hordecki Bartosz, Karametou Panagiota, Katerynych Petro, Kornieiev Vitalii, Lorek Artur, Marto Anabela, Mitoula Roido, Bogdana Nosova, Ribeiro Roberto, Rodrigues Nuno, Sakson-Boulet Anna, Silva Fernando, Tsimpoulis Giorgos, Katerina Tzika, Volobuieva Anastasiia

Session: **487**
"Education and Sustainable Development"
Chaired by **Prof Kaldi Stavroula** and **Dr Dologlou Maria**

PHYSICAL EDUCATION AND SUSTAINABLE DEVELOPMENT: EDUCATING ACTIVE CITIZENS FOR SOCIAL TRANSFORMATION (L02170) **488**
Tassi Alexandra, Rachiotis Theodoros, Adamakis Manolis

THE ROLE OF SCHOOL LEADERSHIP IN FOSTERING INCLUSIVITY WITHIN THE FRAMEWORK OF SUSTAINABLE DEVELOPMENT (L02174) **489**
Anargyrou Aikaterini

TEACHER WELL-BEING AS A PILLAR OF EDUCATIONAL SUSTAINABILITY (L02181) **503**
Anargyrou Aikaterini

EDUCATION POLICY FOR SUSTAINABLE TRANSITION: STRATEGIES AT LOCAL AND REGIONAL LEVEL (L02180) **515**
Drakaki Maria, Papadakis Nikos

THE TEACHER AS AN AGENT OF CHANGE: EDUCATION FOR SUSTAINABLE DEVELOPMENT IN THE SCHOOL COMMUNITY (L02188) **529**
Dologlou Maria, Mitoula Roido

PROMOTING SUSTAINABLE DEVELOPMENT THROUGH PRIMARY EDUCATION TEXTBOOKS. CASE STUDY: GREECE (L02191) **530**
Papadopoulou Kl. Vasiliki, Mitoula Roido, Kaldi Stavroula, Sardianou Eleni

PLAY & GAMES AS METHODS OF REGENERATIVE ARCHITECTURAL "EDUTAINMENT" (L02216) **531**
Mouzakitis Stavros

Session: **532**
"Local and Regional Cultural Development"
Chaired by **Prof Maria Manola** and **Asst Prof Poli Maria**

CULTURAL ENTREPRENEURSHIP AND SUSTAINABLE TOURISM DEVELOPMENT IN THE HEROIC ISLAND OF PSARA (L02158) **533**
Manola Maria, Maniou Fotini, Poli Maria

IN THE FOOTSTEPS OF TRAVELLERS: SUSTAINABLE DEVELOPMENT THROUGH TRAVEL TEXTS IN THE REGION OF LASITHI (L02175) **549**
Tsatalmpasoglou Anna-Irini, Koltsikoglou Georgios, Manola Maria, Mitoula Roido, Maniou Fotini

THE CULTURAL HERITAGE OF TENEDOS AS A DRIVING FORCE FOR LOCAL DEVELOPMENT AND INNOVATIVE BUSINESS ACTIVITIES (L02182) **561**
Maniou Fotini

FROM STRATEGIC NAVAL BASE TO CULTURAL ASSE T- THE MILITARY HERITAGE OF LEROS(L02187) **568**
Koltsikoglou Georgios, Tsatalbassoglou Anna Eirini, Manola Maria

SUSTAINABLE DEVELOPMENT OF THE ANCIENT GREEK THEATRE, THE CASE STUDY OF PHILIPPI (L02128) **569**
Nastou P. Marina Panagiota, Zerefos C. Stelios

Session: **570**
"Digital transformation and sustainable development"
Chaired by **Assoc Prof Menshikova Maria** and **Assoc Prof Zamfir Natalia**

SUSTAINABLE URBAN REGENERATION IN MEDITERRANEAN CITIES: URBAN PLANNING PERSPECTIVES ON DIGITALIZATION AND ARTIFICIAL INTELLIGENCE (L02167) **571**
Kalemis Alexandros, Tsirigoti Dimitra

TOWARD ETHICAL AND SOCIALLY GROUNDED DIGITAL SUSTAINABILITY: HUMAN-CENTERED TECHNOLOGY AND THE METAVERSE IN INDUSTRY 5.0 (L02179) **591**
Kalemis Alexandros

HR SPECIALIST PROFILE IN THE DIGITAL ECONOMY: EVOLUTION OF SKILLS AND ATTITUDES THROUGH A GENDER PERSPECTIVE (L02183) **606**
Menshikova Maria

DIGITALIZATION OF THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS AS A TOOL FOR INTEGRATING THE SUSTAINABLE DEVELOPMENT GOALS (L02177) **607**
Zamfir Natalia, Zamfir Pavel

TRANSFORMING TRANSFER OF DEVELOPMENT RIGHTS(TDR) INTO DIGITAL ASSETS: BLOCKCHAIN, SMART CONTRACTS, PROPERTY TITLES, AND THE REIMAGINED DIGITAL LAND BANK (DLB) (L02178) **608**
Christodoulou Dimitrios

AI AND THE DYNAMICS OF CREATIVE DESTRUCTION IN THE GREEN TRANSITION. AS A CASE STUDY THE MUNICIPALITY OF NEA FILADELFIA-NEA CHALKIDONA, ATTICA, GREECE. (L02234) **632**
Chronopoulou Georgia

ESPORTS AND SOCIAL STABILITY: MORAL VALUES AND LEARNING OPPORTUNITIES IN VIRTUAL CITIES (L02227) **638**
Choustoulakis Emmanouil, Maragkos Fotios

Session: **639**
"Energy and Sustainable Development"
Chaired by **Prof KabassiKaterina** and **Kremlis George**

UNIVERSITY-LED SOLAR ENERGY INITIATIVES IN SUPPORT OF SDG 7 AND SDG 13: A LITERATURE REVIEW (2015–2025) (L02173) **640**
Kaloutsa Maria, Kabassi Katerina, Martinis Aristotelis, Kaldellis K. John

TOWARD SUSTAINABLE AND SOCIALLY EQUITABLE CITIES: A LOCAL CLIMATE ZONE APPROACH FOR PHOTOVOLTAIC DEPLOYMENT IN EUROPEAN CITIES (L02186) **641**
Dimitriou Tsampika, Skandalos Nikolaos, Karamanis Dimitrios

ENERGY TRANSITION, ENERGY MIX AND MARKET-BASED COMPLIANCE MECHANISMS FOR GREENHOUSE GAS EMISSIONS MITIGATION: A COMPARATIVE REVIEW (L02215) **642**
Thomaidou Foteini

STUDENTS' PERCEPTIONS OF GLOBAL WARMING CAUSES AND THEIR ENERGY FOOTPRINT TOWARDS SUSTAINABILITY (L02221) **662**
Kougias Konstantinos, Sardianou Eleni, Tsagarakis Konstantinos

Session: **663**
"Climate Change and Sustainable Development"
Chaired by **Prof Ntalos Georgios** and **Karytsas Spyridon**

ANIMALS' LEGAL PERSONHOOD IN MUNICIPAL (CLIMATE) ADAPTATION PLANS IN POLAND (L02156) **664**
Haładyj Anna

ENHANCING THE SUSTAINABILITY OF THE SHIPPING INDUSTRY THROUGH THE REDUCTION OF GREENHOUSE GAS EMISSIONS: A LITERATURE REVIEW (L02193) **666**
Kourouklis Antonios, Chatzitheodoridis Fotios, Boulouta Konstantina

CLIMATE-RELATED HAZARDS, URBANIZATION AND THE FATE OF AFRICA'S CHILD:CHILD SENSITIVE POLICY REFLECTION FROM UGANDA (L02198) **679**
Tumwebaze Jonathan

AICoSME: A HYBRID AI-POWERED TOOL FOR STRATEGIC CARBON FOOTPRINT MANAGEMENT IN SMEs (L02204) **680**
Karageorgos Anthony, Trigkas Marios, Papageorgiou Elpiniki, Lallas Eftymios, Ntalos Georgios, Ntounas Theodoros, Chrysikou Vasiliki, Stavridou Styliani , Sdroulias Georgios

SOCIETAL PERCEPTION OF CARBON CAPTURE, TRANSPORT AND STORAGE: OPPORTUNITIES AND RISKS, INSIGHTS FROM FOCUS GROUP MEETINGS (L02217) **697**
Mendrinos Dimitrios, Oikonomou I. Theoni, Karytsas Spyridon, Sprenkeling Marit, Terpstra Eva, Rambharos Shanita, Bannister Andrew, Wilkerson Brooke, Ljones Marie Louise, Bentsen Henrik Litlere, Otto Danny

THE CONTRIBUTION OF SMART AGRICULTURE AND SMALLHOLDERS TO SUSTAINABLE LOCAL DEVELOPMENT IN THE CONTEXT OF CLIMATE CHANGE: THE CASE OF GREECE (L02152) **715**
Petridis Dimitris, Kalantonis Petros, Astara Olga-Eleni, Mitoula Roido

THE EVOLUTION OF EUROPEAN ENVIRONMENTAL POLICY AND THE TRANSITION TO THE SUSTAINABLE DEVELOPMENT MODEL (L02257) **716**
Dimitriadi Evangelia, Pagratis Antonios-Konstantinos

Session: **729**
"Urban Resilience and Quality of Life"
Chaired by **Prof Salvati Luca** and **Assoc Prof Papadas Dimitrios**

NATURAL DISASTERS, URBAN TRADE DISRUPTIONS, AND SUSTAINABLE ECONOMIC DEVELOPMENT IN MENA CITIES: ENERGY AND FOOD SECURITY PERSPECTIVES (L02143) **730**
Papadas Dimitrios

SUSTAINABLE STORMWATER MANAGEMENT IN URBAN AREAS OF HIGH FLOOD RISK: DESIGN, SIMULATION AND EVALUATION OF THE APPLICATION OF NATURE – BASED SOLUTIONS IN THE CITY OF THESSALONIKI (L02199) **731**
Zafeirakou Antigoni, Samaras Evangelos

LISTENING TO CHILDREN: PARTICIPATORY PRACTICES IN THE DESIGN OF OPEN SPACES FOR PLAY (L02145) **754**
Tafidou Kyriaki, Katsavounidou Garyfallia

CARTOGRAPHIES OF URBAN METABOLISM TOWARDS SELF-SUSTAINING TERRITORIAL SYSTEMS (L02163) **770**
Apostolou Malvina

ADAPTIVE ROAD MANAGEMENT FOR WILDFIRE RESILIENCE. A CASE STUDY FROM THESSALY, GREECE (L02205) **771**
Stamatiou Christos, Matsouka Maria, Papageorgiou Grigorios

CULTURAL AND SPORTS ASSOCIATIONS AND SUSTAINABLE DEVELOPMENT: INSIGHTS FROM AGRINIO, GREECE (L02258) **782**
Koutsogiannou Sotiria, Chalioris Konstantinos, Karametou Panagiota, Mitoula Roido

Pre-organised Special Session: **793**
"Islands in Transition: Innovation, Sustainability, Tourism and Climate Resilience"
Organised and chaired by **Assoc Prof Maria P. Doumi, Assist Prof Ioanna Pagoni, Assist Prof Iason-Nikolaos Koufodontis** and **Em Prof Angelis Vasilis**

THE VOLUNTARY LOCAL REVIEWS (VLRs) AS A TOOL FOR SUSTAINABLE GOVERNANCE IN CITIES: THE CASE OF SKIATHOS (L02207) **794**
Bithas George, Kyriakopoulou Sotiria, Angelis Vasilis

CULTURAL LANDSCAPE AND TOURISM. THE CASE OF THE STONE-BUILD ROADS IN CHIOS. (L02208) **795**
Doumi P. Maria, Angelis-Dimakis Dimitris, Koufodontis Iason-Nikolaos, Fili Vasiliki, Tsompanis Konstantinos

CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT. THE CASE OF GREEK ISLAND MUNICIPALITIES. (L02209) **796**
Konteas Ioannis, Alexopoulos Andreas, Angelis Vasilis

THE SECURITY OF DIGITAL PLATFORMS AS A SUSTAINABILITY FACTOR IN THE URBAN ENVIRONMENT OF CHIOS (L02210) **797**
Anagnostou Kostas, Mennis Vangelis, Doumi P. Maria

ISLAND SUSTAINABLE STRATEGY: FROM VULNERABILITY TO RESILIENCE (L02211) **798**
Spilanis Ioannis

SUSTAINABLE ISLAND MOBILITY PLANS: PLANNING FOR PEOPLE, TOURISM, AND CLIMATE (L02212) **799**
Anagnostopoulos Kosmas, Pagoni Ioanna, Gioldasis Christos, Polydoropoulou Amalia, Spilanis Ioannis, Nikolopoulou Katerina, Stroumpas Savvas

DIGITAL ECOSYSTEMS AND BUSINESS INNOVATION AS ACCELERATORS OF SUSTAINABLE TRANSITION IN ISLAND SMART CITIES (L02213) **800**
Ntoumi Anastasia, Kutsikos Konstadinos, Doumi P. Maria, Angelis Vasilis

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INTERNATIONAL CONFERENCE
Local and Regional
Sustainable Development
& Urban Reconstruction
5 - 7 December 2025
Harokopio University of Athens
Organised by:
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CONCISE CONFERENCE PROGRAMME

1st DAY- Friday 5 December 202

09:00-10:00	Registration (Harokopio University) (main building)
10.00-10.30	OPENING CEREMONY (Amphitheater: Georgios Karabatzos)(main building)
10.30-13.30	**Keynote Speeches** (Amphitheater: Georgios Karabatzos)(main building)

13.30-14.30	Conference Lunch - Finger Food

17.30-20.00	Session 3: **"Local and Regional Development - Economy - Entrepreneurship"** Chaired by **Prof Olesea Plotnic** and **Angelos Papavasileiou** (Amphitheater: Georgios Karabatzos)(main building)
17.30-20.00	Session 4: **"Culture - Museums - Religious and Cities"** Chaired by **Assoc Prof Astara Olga-Eleni** and **Prof Papaioannou Georgios** (Room A1) (main building)
17.30-20.00	Session 5: **"Promoting Sustainable cities"** Chaired by **Prof Angelidis Minas** and **Dr Prof Koutsoumpos Leonidas** (Room A2) (main building)
17.30-18.45	Session 6: **"Tackling socio-economic inequalities and in-work poverty"** Chaired by **Prof Papadakis Nikos** and **Lect Vlachadi Maria** (Room A4) (main building)
18.45-20.00	Session 7: **"'Social' Architecture - Environment and Health"** Chaired by **Prof Dimelli Despina** and **Asst Prof Poli Maria** (Room A4) (main building)

2nd DAY-Saturday 6 December 2025

09.00-11.30	Session 12: **"Urban and Regional Sustainable Development"** Chaired by **Prof Lalenis Konstantinos** and **Dr Econoou Agisilaos** (Room A1) (main building)
09.00-11.30	Session 13: **"Tourism and Sustainable Development"** Chaired by **Asst Em Panagiotis Patargias** and **Asst Prof Skoultsos Sofoklis** (Room A2) (main building)
09.00-10.30	Session 14: **"Environmental Sustainability- Waste Management- Circular Economy"** Chaired by **Prof Brzezińska-Rawa Anna** and **Prof Theodoropoulou Eleni** (Room A4) (main building)
10.30-11.30	Session 15: **"Consumers and Sustainability"** Chaired by **Prof Sardianou Eleni** and **Kostakis Ioannis** (Room A4) (main building)

09.00-11.30	Pre-organised Special Session 18: **"Virtual cities" and social sustainability in EU framework- Cultural, sociological and communication perspectives"** Organised and chaired by **Dr Bokolas Vassilis, Prof Vassilakou Tonia, Prof Colantoni Andrea, Assoc Prof Ferrigni Nicola, Prof Kaperonis Stavros, Assoc Prof Nosova Bogdana and Ntrouva Efi** (Ceremony Hall) (New Library Building)

11.30-12.00	Coffee Break

12.00-15.00	Session 20: **"Education and Sustainable Development"** Chaired by **Prof Kaldi Stavroula** and **Dr Dologlou Maria** (Room A1) (main building)
13.45-15.00	Session 21: **"Local and Regional Cultural Development"** Chaired by **Prof Maria Manola** and **Asst Prof Poli Maria** (Room A1) (main building)
12.00-15.00	Session 22: **"Digital transformation and sustainable development"** Chaired by **Assoc Prof Menshikova Maria** and **Assoc Prof Zamfir Natalia** (Room A2) (main building)
13.45-15.00	Session 23: **"Energy and Sustainable Development"** Chaired by **Prof KabassiKaterina** and **Kremlis George** (Room A2) (main building)
12.00-15.00	Session 24: **"Climate Change and Sustainable Development"** Chaired by **Prof Ntalos Georgios** and **KarytsasSpyridon** (Room A4) (main building)
13.45-15.00	Session 25: **"Urban Resilience and Quality of Life"** Chaired by **Prof Salvati Luca** and **Assoc Prof PapadasDimitrios** (Room A4) (main building)
12.00-15.00	Pre-organised Special Session 26: **"Islands in Transition: Innovation, Sustainability, Tourism and Climate Resilience"** Organised and chaired by **Assoc Prof Maria P. Doumi, Assist Prof Ioanna Pagoni, Assist Prof Iason-Nikolaos Koufodontis** and **Em Prof Angelis Vasilis** (Room A5) (main building)

15.00-16.00	Conference Lunch - Finger Food

Closing of the Conference

KEYNOTE SPEAKERS

Moraitis Konstantinos
Professor, National Technical University of Athens
"URBAN SUSTAINABILITY: NOTES AND PARADIGMES ON THE ENVIRONMENTAL, CULTURAL AND POLITICAL IMPROVEMENT OF PLACE"

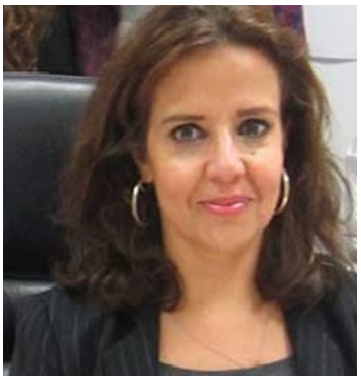
Salvati Luca
Professor, Sapienza University of Rome
"MULTIDISCIPLINARY PARADIGMS BETWEEN SCIENCE AND POLICY. POSITIVE AND NORMATIVE APPROACHES FOR THE ANALYSIS OF COMPLEX ECONOMIC AND ENVIRONMENTAL SYSTEMS"

Plotnic Olesea
Professor, Moldova State University
"INNOVATIVE ENTREPRENEURSHIP AS A CATALYST FOR SUSTAINABLE PROSPERITY AND COMPETITIVENESS IN EUROPEAN CITIES AND REGIONS"

Kremlis George
Honorary Director of the European Commission
Member of the Board of Directors of the European Public Law Organisation and Director of its Circular economy and Climate Institute, as well as Ambassador of the EPLO to Bulgaria
Chair of the Bureau of the Espoo Convention & the SEA Protocol and of their MOPs
"ACHIEVING CLIMATE NEUTRALITY: STRATEGIES AND CHALLENGES IN THE ENERGY TRANSITION"

Giacomo Di Foggia
Asst Professor, Universita Degli Study di Milano-Bicocca
"SCALING UP THROUGH COOPERATION: HOW VOLUNTARY AGGREGATION IN LOCAL ENVIRONMENTAL SERVICES SUPPORTS CIRCULAR ECONOMY GOALS"

Kaldi Stavroula
Professor, University of Thessaly
"EDUCATION FOR SUSTAINABLE DEVELOPMENT: THE EXAMPLE OF THE "GREENCOMP SCHOOL" CURRICULA AND LEARNING"



Dimelli Despina
Professor, Technical University of Crete

HISTORIC URBAN LANDSCAPES AND URBAN RESILIENCE: RETHINKING CULTURAL HERITAGE IN GREEK CITIES

Angelidis Minas
Professor, National Technical University of Athens

"OVERTOURISM AND BEYOND: TOURISM AND SUSTAINABILITY IN CITIES AND TERRITORIES"

Rodi Alcestis
Professor, University of Patras

"FROM FORMA URBIS TO FORMA HORTO: BLUE-GREEN ROOFS AS THE NEW URBAN GROUND"

Gospodini Anastasia-Aspasia
Professor, University of Thessaly

"HOUSING CRISIS IN POST-CRISIS ATHENS; INEFFECTIVE STATE POLICIES & THE POTENTIAL OF URBAN RENEWAL SCHEMES OF ABANDONED INDUSTRIAL SITES"

CONFERENCE SCHEDULE

1st DAY - Friday 5 December 2025

09:00-09:30 **Registration** (Harokopio University) (main building)

09.30-10.00 Welcome introduction by **Prof. Roido Mitoula**, Dean, School of Environment, Geography and Applied Economics, Harokopio University of Athens, Head of Postgraduate Program "Sustainable Development", Chair of the Organising & Scientific Committee

Prof George Dedoussis, Rector of Harokopio University of Athens

H.E. Mrs Marcela Hanusova, Ambassador of the Slovak Republic

Giannis Androulakis, President of the Green Fund

Prof Konstantinos Moraitis, Syros Institute

	Keynote Speeches
1. 10.00-13.30	Chaired by Em Prof Moraitis Konstantinos & Malindretos Georgios (Amphitheater: Georgios Karabatzos)(main building)
	URBAN SUSTAINABILITY: NOTES AND PARADIGMES ON THE ENVIRONMENTAL, CULTURAL AND POLITICAL IMPROVEMENT OF PLACE (L02144) **Moraitis Konstantinos**, *Professor Emeritus, National Technical University of Athens*
	MULTIDISCIPLINARY PARADIGMS BETWEEN SCIENCE AND POLICY. POSITIVE AND NORMATIVE APPROACHES FOR THE ANALYSIS OF COMPLEX ECONOMIC AND ENVIRONMENTAL SYSTEMS (L02136) **Salvati Luca**, *Professor, Sapienza University of Rome*
	INNOVATIVE ENTREPRENEURSHIP AS A CATALYST FOR SUSTAINABLE PROSPERITY AND COMPETITIVENESS IN EUROPEAN CITIES AND REGIONS (L02241) **Plotnic Olesea**, *Professor, Moldova State University*
	ACHIEVING CLIMATE NEUTRALITY: STRATEGIES AND CHALLENGES IN THE ENERGY TRANSITION (L02230) **Kremlis George**, *European Public Law Organisation and Director of its Circular economy and Climate Institute*
	SCALING UP THROUGH COOPERATION: HOW VOLUNTARY AGGREGATION IN LOCAL ENVIRONMENTAL SERVICES SUPPORTS CIRCULAR ECONOMY GOALS (L02248) **Giacomo Di Foggia**, *Asst Professor, Universita Degli Study di Milano-Bicocca*
	EDUCATION FOR SUSTAINABLE DEVELOPMENT: THE EXAMPLE OF THE "GREENCOMP SCHOOL" CURRICULA AND LEARNING (L02132) **Kaldi Stavroula,** *Professor, University of Thessaly*
	HISTORIC URBAN LANDSCAPES AND URBAN RESILIENCE: RETHINKING CULTURAL HERITAGE IN GREEK CITIES (L02129) **Dimelli Despina,** *Professor, Technical University of Crete*

	OVERTOURISM AND BEYOND: TOURISM AND SUSTAINABILITY IN CITIES AND TERRITORIES (L02161) **Angelidis Minas**, *Professor Emeritus, National Technical University of Athens*
	FROM FORMA URBIS TO FORMA HORTO: BLUE-GREEN ROOFS AS THE NEW URBAN GROUND (L02249) **Rodi Alcestis**, *Professor, University of Patras*
	HOUSING CRISIS IN POST-CRISIS ATHENS; INEFFECTIVE STATE POLICIES & THE POTENTIAL OF URBAN RENEWAL SCHEMES OF ABANDONED INDUSTRIAL SITES (L02243) **Gospodini Aspa**, *Professor, University of Thessaly*
13.30-14.30	Conference Lunch - Finger Food

3. 17.30-20.00	Session: **"Local and Regional Development - Economy - Entrepreneurship"** Chaired by **Prof Olesea Plotnic** and **Angelos Papavasileiou** (Amphitheater: Georgios Karabatzos) (main building)
17.30-17.45	THE ADAPTATION INVESTMENT CYCLE: THE MISSING LINK FOR BRIDGING THE REGIONAL ADAPTATION GAP IN EUROPE (L02135) **Dellis Konstantinos, Chourdaki Maria**
17.45-18.00	THE ROLE OF INTRAPRENEURSHIP IN THE ENTREPRENEURIAL ORIENTATION OF UNIVERSITIES (L02149) **Troshani Ines, Nuka Dardane, Cabiri Mijo Ketrina**
18.00-18.15	THE ROLE OF COACHING IN SHAPING LEADERS FOR A SUSTAINABLE WORLD(L02150) **Dologlou Maria, Mitoula Roido**
18-15-18.30	COSMETOLOGY PRODUCTS AND SUSTAINABILITY: GREEK CONSUMER'S SOCIAL AND ENVIRONMENTAL ATTITUDES AND PERCEPTIONS (L02166) **Lezou Vasiliki, Karametou Panagiota, Economou Agisilaos, Mitoula Roido**
18.30-18.45	THE GIG ECONOMY AND EMPLOYMENT CREATION IN THE DIGITAL ERA: EXPLORING THE OPPORTUNITIES AND FACILITATING CONDITIONS FOR POLICY CONSIDERATIONS (L02192) **Sannegadu Rajesh, Erceg Aleksandar, Pudaruth Sharmila, Thanika Devi Juwaheer, Jovanka Damoska Sekuloska**
18.45-19.00	BEYOND THE GREEN LABEL: ENTREPRENEURSHIP, GOVERNANCE, AND THE SUSTAINABILITY PARADOX - THE CASE OF BENGUERIR'S GREEN CITY (L02214) **Najlaa Rachidi, Mouhcine Benaicha, Hicham Mouloudi**
19.00-19.15	ENTREPRENEURSHIP AND EUROPEAN VALUES AS DRIVERS OF SUSTAINABLE INNOVATION AND DIGITAL TRANSFORMATION (L02171) **Plotnic Olesea, Hămuraru Maria, Buzdugan Adriana**
19.15-19.30	EVALUATING THE ROLE OF AGRICULTURAL SUBSIDIES IN AGRITOURISM DEVELOPMENT: A CASE STUDY FROM ALBANIA (L02130) **Gecaj Merita, Grepcka Alketa, Malaj Mentor, Gjermizi Mirgjana**
19.30-19.45	LEVEL OF DISASTER PREPAREDNESS OF LINDAWAN NATIONAL HIGH SCHOOL (L02256) **Almeqbali Muhammad Abdula F., We-eng Zynlee M., Abelao Ernilyn R., Cayapa Kyla Andrea K., Tariagao, Abigeil T., Wagacon, Reshel D.**
19.45-20.00	COMPARATIVE ANALYSIS OF LOCAL GOVERNMENT AND CITIZEN CONTRIBUTIONS TO SUSTAINABLE WASTE MANAGEMENT (SDG 12) IN GREECE, ITALY, SERBIA AND MOLDOVA (L02244) **Mitoula Roido, Angelos Papavasileiou, Economou Agisilaos, Plotnic Olesea, Milosevic Isidora, Menshikova Maria**

4. 17.30-20.00	Session: **"Culture - Museums - Religious and Cities"** Chaired by **Assoc Prof Astara Olga-Eleni** and **Prof Papaioannou Georgios** (Room A1) (main building)
17.30-17.45	EVALUATING THE ROLE OF MUSEUMS ON CITIES' SUSTAINABLE DEVELOPMENT: A COMBINED ANALYSISOF ATHENS AND SINGAPORE (L02025) **Metaxas Theodore, Koutsoumpela Alexandra**
17.45-18.00	KmVert "URBAN RELIGIOUS ARCHAEOLOGY": A SUSTAINABLE SOCIO-CULTURAL VISION FOR URBAN REGENERATION (L02027) **Marcuccetti Andrea**
18.00-18.15	WHICH FUTURE EXACTLY? JUSTICE AND SUSTAINABILITY IN AFROFUTURIST LITERATURE AND MODERN GREEK SPECULATIVE FICTION (L02131) **Mousouli Rania**
18-15-18.30	MARINE PARKS & CULTURAL SUSTAINABILITY: THE ROLE OF IONIAN AND SOUTH AEGEAN NATIONAL MARINE PARKS IN PROMOTING MARITIME CULTURAL HERITAGE AND ISLAND RESILIENCE(L02138) **Rachiotis Theodoros, Poulaki Panoraia**
18.30-18.45	MUSEUMS AND SUSTAINABLE GREEN DEVELOPMENT: THE CASE OF GREECE (L02159) **Astara Olga-Eleni, Papaioannou Georgios**
18.45-19.00	SUSTAINABLE CULTURAL DEVELOPMENT THROUGH AN INTERPRETATIVE APPROACH WITHIN THE FRAMEWORK OF THE CLIMATE CRISIS - A MATHEMATICAL MODEL AND FIELD RESEARCH: THE CASE OF DELPHI (L02189) **Karagiannis Georgios, Mitoula Roido**
19.00-19.15	VALUING UNDERWATER CULTURAL HERITAGE AS A RESOURCE FOR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF BANTRY BAY HARBOUR (L02240) **Valasiadi Eva**
19.15-19.30	URBAN EXPANSION AND THE "OTHER" CITY IN CINEMA. THE URGENT NEED FOR A SUSTAINABLE CITY. (L02190) **Chatzifragkios Makrydakis Konstantinos**
19.30-19.45	PROPOSAL FOR A CULTURAL ROUTE IN THE RUSSIAN MONASTERIES OF MOUNT ATHOS (L02246) **Tsogkas Konstantinos**
19.45-20.00	Discussion

5. 17.30-20.00	Session: **"Promoting Sustainable cities"** Chaired by **Prof Angelidis Minas** and **Dr Prof Koutsoumpos Leonidas** (Room A2) (main building)
17.30-17.45	RETHINKING THE ECOLOGICAL NETWORK PROJECT CONSIDERING - NEW QUESTIONS RAISED BY URBAN COMPLEXITY (L02172) **Carmen Angelillo, Martina Borini, Peraboni Carlo**
17.45-18.00	THE CITY AS STAGE: SOCIALLY ENGAGED PERFORMANCES IN THE PUBLIC SPACES OF ATHENS (L02133) **Linaki Eleni**

18.00-18.15	THE CONTRIBUTION OF LOCAL GOVERNMENT TO THE PROMOTION OF SUSTAINABLE DEVELOPMENT – THE CASE STUDY OF THE MUNICIPALITY OF AMAROUSSION AND OF THE SYGGROU FOREST (L02137) **Sereti Evangelia - Paraskevi**
18-15-18.30	INTEGRATED URBAN AND ENVIRONMENTAL STRATEGIES FOR CLIMATE RESILIENCE IN THE ATHENS METROPOLITAN AREA (L02139) **Kampolis Dimitrios**
18.30-18.45	WIDENING OF THE INTERMEDIATE BETWEEN THE HILL AND THE CITY: AS A CASE STUDY, THE CORRELATION BETWEEN PHILOPAPPOU HILL AND ANO PETRALONA (L02206) **Ydraios Nikiforos, Koutsoumpos Leonidas**
18.45-19.00	THE SPATIOTEMPORAL EVOLUTION OF URBAN PLANNING IN THE HISTORIC CENTER OF KAVALA: CONTEMPORARY REFLECTIONS (L02220) **Samourkasidou Elena, Nastou Marina**
19.00-19.15	ASPFALT-ART AS AN INNOVATIVE WAY FOR SUSTAINABLE MOBILITY (L02219) **Samourkasidou Elena**
19.15-19.30	THE PHYSIOGNOMY AND SUSTAINABILITY OF RAFINA CITY THROUGH STUDENTS' PERSPECTIVE (L02237) **Samara Anna**
19.30-19.45	ENVIRONMENTAL LIVING CONDITIONS IN URBAN CENTERS AND THEIR IMPACTS ON HEALTH: CASE STUDY OF THE ATTICA REGION (L02196) **Derventi Maria, Mitoula Roido, Theodoropoulou Eleni, Karagianni Vilelmini**
19.45-20.00	SUSTAINABLE DEVELOPMENT CONDITIONS IN THE MUNICIPALITY OF MOSCHATO-TAVROS, ATTICA, GREECE: SWOT ANALYSIS OF GEOGRAPHICAL, ENVIRONMENTAL, ECONOMIC, SOCIAL AND CULTURAL DIMENSIONS (L02247) **Kochetkova Aleksandra**

6. 17.30-18.45	Session: **"Tackling socio-economic inequalities and in-work poverty"** Chaired by **Prof Papadakis Nikos** and **Lect Vlachadi Maria** (Room A4) (main building)
17.30-17.45	LABOUR MARKET, SOCIO-ECONOMIC INEQUALITIES AND IN-WORK-POVERTY, IN MOMENTOUS TIMES: THE ROLE OF THE WELFARE STATE AND THE POLICY CHALLENGES FOR SOCIAL SUSTAINABILITY(L02140) **Papadakis Nikos, Tzagkarakis Stylianos-Ioannis**
17.45-18.00	NEW TRENDS-TYPES OF MIGRANTS TOWARDS SUSTAINABLE CITES (L02151) **Vlachadi Maria, Plougarlis Dimitrios**
18.00-18.15	RETHINKING RESEARCH PARTICIPANT COMPENSATION IN URBAN SETTINGS: A SOCIAL EXCHANGE PERSPECTIVE ON SUSTAINABLE DEVELOPMENT (L02160) **Ahimbisibwe Osborn, AyebaleDan**
18-15-18.30	THE ENVIRONMENTAL PHILLIPS CURVE: A CROSS-COUNTRY ANALYSIS OF UNEMPLOYMENT AND ENVIRONMENTAL DEGRADATION (L02164) **Karsiotis Panagiotis, Adamopoulos Antonios, Maniatis Antonios, Irakleous Alexia**
18.30-18.45	Discussion

7. 18.45-20.00	Session: **"'Social' Architecture - Environment and Health"** Chaired by **Prof Dimelli Despina** and **Asst Prof Poli Maria** (Room A4) (main building)
18.45-19.00	DOES GENDER MATTER IN CONSPIRACY BELIEFS VACCINATION HESITANCY? EVIDENCE FROM COVID-19 VACCINATION IN UGANDA (L02159) **Bacwayo Kukunda Elizabeth, Sebaggala Richard, Maractho Emilly, Amaniyo Mercy, Mwije Solomon, Kemigisha Evas, Kobusingye Jacqueline, Cheremoi Clare**
19.00-19.15	NEIGHBOURHOOD PHARMACIES OF THE FUTURE: LOCAL NETWORKS FOR PERSONALIZED, 3D-PRINTED MEDICINES (L02197) **Achillas Charisios, Vlachokostas Christos, Tsolakis Naoum, Koumpakis Dimitrios Aristotelis, Aidonis Dimitrios, Michailidou Alexia**
19.15-19.30	ACCESSIBLE HOUSES FOR PEOPLE WITH DISABILITIES IN GREECE: A CRITICAL VIEW (L02154) **Poli Maria, Malagas Konstantinos**
19.30-19.45	BIOMIMETIC, SUSTAINABLE, AND ACCESSIBLE ARCHITECTURE: A HOLISTIC DESIGN PARADIGM (L02155) **Poli Maria, Malagas Konstantinos**
19.45-20.00	Discussion

2nd DAY - Saturday 6 December 2025

12. 09.00-11.30	Session: **"Urban and Regional Sustainable Development"** Chaired by **Prof Lalenis Konstantinos** and **Dr Econoou Agisilaos** (Room A1) (main building)
09.00-09.15	OPEN-AIR CITIES OF DEAD (L02148) **Polymenidis Yannis**
09.15-09.30	RELIGIOUS INSTITUTIONS: AN ANALYSIS OF THE LEGAL AND INSTITUTIONAL FRAMEWORK GOVERNING ZONING, CONSTRUCTION, AND BUILDING REGULATIONS AND THEIR INTEGRATION INTO SPATIAL PLANNING IN GREECE -A COMPARATIVE OVERVIEW WITH OTHER EU COUNTRIES (L02153) **Lalenis Konstantinos, Zygouri Foteini**
09.30-09.45	ONTOLOGICAL TRANSFORMATIONS THROUGH THE WORK OF GIOVANNI BATTISTA PIRANESI (L02184) **Katsanevakis Evangelos**
09.45-10.00	PARTICIPATORY MAPPING AND ASSESSMENT OF LANDSCAPES THROUGH CROWDSOURCING: FROM UNIVERSITY EDUCATION TO CROSSCULTURAL CITIZEN SCIENCE (L02194) **Ioannidis Romanos**
10.00-10.15	BEYOND SHELTER: DISPLACEMENT AT THE THRESHOLD OF ECOLOGICAL CHANGE (L02200) **Xirogiannis Maria, Kyriakidis Charalampos, Moraitis Konstantinos**
10.15-10.30	MAIN WOOD SPECIES USED IN GREEK WOODCRAFT: A HISTORICAL AND TECHNOLOGICAL STUDY (L02225) **Ntalos George, Mitani Andromachi, Alexaki Pinelopi, Ntalos Paulos, Koutsianitis Dimitrios, Ninikas Konstantinos**

10.30-10.45	TOURISM, CULTURE AND SUSTAINABLE DEVELOPMENT IN THE REGION OF BOEOTIA (L02146) **Christou Dimitris**
10.45-11.00	URBAN BUZZWORDS IN PRACTICE: RHETORIC, METHOD, AND THE POLITICS OF DIFFUSION (L02146) **Vartholomaios Aristotelis**
11.00-11.15	THE CONTRIBUTION OF CULTURAL ASSOCIATIONS AND LOCAL AUTHORITIES TO THE PRESERVATION AND PROMOTION OF THE CULTURAL HERITAGE OF A REGION. AS A CASE STUDY: THE MUNICIPALITY OF DORIDA (L02250) **Chalioris Konstantinos, Roido Mitoula, Anastasia-Aspasia Gospodini, Maria Manola**
11.15-11.30	NAVIGATING INTEGRATED PLANNING IN SMALL MUNICIPALITIES: LIMITATIONS, PATHWAYS FORWARD EMERGING OPPORTUNITIES. THE CASE OF DIDYMOTICHO. (L02255) **Zountsa Stergiani, Skiadas V. Dimitrios**

13. 09.00-11.30	Session: **"Tourism and Sustainable Development"** Chaired by **Asst Em Panagiotis Patargias** and **Asst Prof Skoultsos Sofoklis** (Room A2) (main building)
09.00-09.15	TOWARDS TO A NEW TOURISM MODEL ADJUSTMENT IN GREECE: SOME EMPIRICAL EVIDENCE FROM HOTEL EXECUTIVES (L02026) **Metaxas Theodore, Andrinos Meletios, Avlogiaris Konstantinos**
09.15-09.30	CULTURAL TOURISM AS A CATALYST FOR SUSTAINABLE URBAN AND REGIONAL DEVELOPMENT IN GREECE (L02141) **Kriga Mimika (Dimitra)**
09.30-09.45	TOURISM MUNICIPALITIES IN SPAIN (L02142) **Maniatis Antonios, Adamopoulos Antonios**
09.45-10.00	TOURISM POTENTIAL OF INDUSTRIAL HERITAGE: A STUDY OF TOBACCO WAREHOUSES IN KAVALA, GREECE (L02176) **Grigoriadou Maria– Alexandra, Kouveli Aikaterini**
10.00-10.15	TOWARDS SUSTAINABLE TOURISM IN CRETE: DELPHI EVALUATION OF PRIMARY SECTOR SYNERGIES AND REGIONAL PATHWAYS (L02185) **Kritikos Antonis, Magoutas Anastasios, Chountalas T. Panos, Livieratos Antonis**
10.15-10.30	CREATIVE TOURISM AND SUSTAINABLE DEVELOPMENT IN MOUNTAINOUS GREECE: THE VOVOUSA FESTIVAL, THE NOWSTALGISM PROJECT, THE LAKE STEFANIADA FESTIVAL (L02202) **Pelagidou Maria Argyro**
10.30-10.45	FROM ATTACHMENT TO INDIFFERENCE:RETHINKING TOURIST–DESTINATION RELATIONSHIPS (L02223) **Briana Maria**
10.45-11.00	URBAN SPACE "ON THE MOVE": EXPERIENTIAL AND DIGITAL ROUTES FOR THE 21th CENTURY TRAVELER (L02169) **Moira Maria, Makris Dimitrios**
11.00-11.15	SMILES AMONG THE RUINS AND CROWDS? RETHINKING TOURIST WELL-BEING AND HAPPINESS FOR SUSTAINABLE URBAN TOURISM IN ATHENS (L02203) **Koliotasi Aigli, Karampela Sofia, Malesios Chrisovalantis, KizosThanasis**
11.15-11.30	GEOTOURISM AS A TOOL FOR SUSTAINABLE TOURISM DEVELOPMENT: THE CASE OF LAVREOTIKI'S GEOPARK (L02236) **Mezantonakis Georgios, Skoultsos Sofoklis**

14. 09.00-10.30	Session: **"Environmental Sustainability- Waste Management- Circular Economy"** Chaired by **Prof Brzezińska-Rawa Anna** and **Prof Theodoropoulou Eleni** (Room A4) (main building)
09.00-09.15	THE BOTTLE-NECK OF SUSTAINABLE GOVERNANCE: LEGAL AMBIGUITIES IN POLAND'S MUNICIPAL WASTE MANAGEMENT AND THE EPR-BASED DEPOSIT SYSTEM (L02134) **Karpus Karolina**
09.15-09.30	BALANCING SUSTAINABILITY AND PERFORMANCE: COMPARING RECYCLED, BIO-BASED AND LOW-CARBON MATERIALS USING AHP (L02147) **Zambujal-Oliveira João**
09.30-09.45	CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT – EXAMPLES OF THE POLISH EXPERIENCE (L02165) **Brzezińska-Rawa Anna**
09.45-10.00	CIRCULAR BIOECONOMY TO SUPPORT THE GREEN TRANSITION IN INSULAR AREAS (L02201) **Klontza Eleftheria, Lekkas Demetris-Francis**
10.00-10.15	EXAMINING CIRCULAR ECONOMY BARRIERS, DRIVERS AND SPECIFICATIONS IN THE CONSTRUCTION SECTOR: KEY STAKEHOLDERS' SURVEY (L02218) **Oikonomou I. Theoni, Karytsas Spyridon, Karytsas Constantine, Theodoropoulou Eleni**
10.15-10.30	EXAMINING THE "RETHINK" AND "REFUSE" CIRCULAR ECONOMY PRACTICES IN THE CONSTRUCTION SECTOR: RESULTS FROM A SURVEY FOCUSED ON YOUTH ACROSS SEVEN EUROPEAN COUNTRIES (L02222) **Karytsas Spyridon, Oikonomou I.Theoni, Lima Ana Teresa, Mao Ruichang, Aloini Davide, Zerbino Pierluigi, Sánchez María Nuria, Moreno Helena López, Calvo Oscar Seco, Kostakis Ioannis, Dürr H. Hans, Sameer Husam, SimoesG. Sofia, Barbosa Juliana, Genovese Andrea, Guru Ram Venkataraman, Karytsas Constantine**

15. 10.30-11.30	Session: **"Consumers and Sustainability"** Chaired by **Prof Sardianou Eleni** and **Kostakis Ioannis** (Room A4) (main building)
10.30-10.45	PERSUASIVE TECHNOLOGIES AND SUSTAINABLE CONSUMER BEHAVIOR: A BIBLIOMETRIC MAPPING OF RESEARCH TRENDS (2015–2025) (L02168) **Achamnou G Panagiota, Sardianou Eleni, Kalantonis Petros, Kostakis Ioannis**
10.45-11.00	LAST-MILE DELIVERY WITH DRONES IN AN URBAN ENVIRONMENT. EMPIRICAL STUDY ON CONSUMER PERCEPTIONS. (L02228) **Darras George, Malindretos George, Kostakis Ioannis, Karametou Panagiota**
11.00-11.15	MEASURING THE EFFECTS ON WELL-BEING, SELF EFFICIENCY AND EMPLOYABILITY OF VULNERABLE POPULATION GROUP AFTER IMPLEMENTING A PLATFORM FOR MENTORING (L02239) **Spyridaki Aikaterini, Papadakaki Maria, Vassilakis Kostas, Markakis George**
11.15-11.30	Discussion

18. 09.00-11.30	Pre-organised Special Session: **"Virtual cities" and social sustainability in EU framework- Cultural, sociological and communication perspectives"** Organised and chaired by **Dr Bokolas Vassilis, Prof Vassilakou Tonia, Prof Colantoni Andrea, Assoc Prof Ferrigni Nicola, Prof Kaperonis Stavros, Assoc Prof Nosova Bogdana and Ntrouva Efi** (Ceremony Hall) (New Library Building)

09.00-09.15	USER EXPERIENCE AND DIGITAL SKILLS IN VIRTUAL GAMIFIED ENVIRONMENTS: BETWEEN SCIENTIFIC RESEARCH AND EUROPEAN POLICY GUIDELINES (L02233) **Kaperonis Stavros, Bokolas Vassilis**
09.15-09.30	PRECARIOUS EMPLOYMENT IN THE GIG ECONOMY: UNVEILING THE EFFECTS OF WORK CONDITIONS ON THE HEALTH AND QUALITY OF LIFE OF MIGRANT FOOD DELIVERY WORKERS (L02229) **Theodoros Fouskas, Tonia Vasilakou, George Koulierakis, Charalambos Economou, Despoina Papadopoulou, Manos Spyridakis, Petros Galanis, Maria-Teresa Terron Caro, Zoran Lapov, Anastasia Papachristou, Maria Petraki, Athanasios Raptis, Anastasios Chondrogiannis, Panagiotis Zikas, Panagiotis Spiliopoulos, Sintorela Chamiti, Athanasiou Stefanos, Alexandros Tziolas**
09.30-09.45	VIRTUAL VULNERABILITIES AND REAL OBLIGATIONS: RETHINKING COMPENSATION PRACTICES IN DIGITALLY MEDIATED RESEARCH (L02224) **Ahimbisibwe Osborn, Rozynska Joanna, Napakol Angella**
09.45-10.00	VIRTUAL ENVIRONMENTS AND THE ELDERLY: RESEARCH, GOOD PRACTICES, AND TRAINING IN DIGITAL SKILLS IN THE EUROPEAN CONTEXT (L02232) **Dimitrakopoulos Chris, Tsintari Elena**
10.00-10.15	DIGITAL RELIGIOUS RHETORIC AND MEDIA LITERACY IN EUROPEAN CONTEXT: RESEARCH, GUIDELINES AND POLICY IMPLEMENTATION (L02238) **MandrapiliasTasos, Zotou Danai**
10.15-10.30	DEVELOPING GREEN ENTERPRISE THROUGH INTEGRATED PCI–PGI GOVERNANCE AND DDCI EVIDENCE IN BAC NINH, VIETNAM (L02226) **Trung-Luan Nguyen, Anh-Tai Do**
10.30-10.45	THE INCLUSION OF INDIVIDUALS WITH NEURODEVELOPMENTAL DISORDERS IN THE CONTEXT OF SUSTAINABLE URBAN DEVELOPMENT: EDUCATION, INFRASTRUCTURE, AND SOCIAL COHESION (L02231) **Koundourou Christiana, Zerva Irini, Bonti Eleni**
10.45-11.00	GREEN AND SMART CITY APPROACHES: INSIGHTS FROM SUB-SAHARAN AFRICA (L02235) **Judith Irene Nagasha, Simon Peter Musinguzi, Anne Nakagiri, Bosco Bwambale**
11.00-11.15	ROLE OF INTRAPRENEURSHIP IN THE ENTREPRENEURIAL ORIENTATION OF UNIVERSITIES (L02251) **Ines Troshani, Dardane Nuka, Ketrina Mijo, Kebjana Haka**
11.15-11.30	ERASMUS+ GREENO2 AND GAME4CHANGE PROJECTS: SOCIAL SUSTAINABILITY, COMMUNICATION, AND A SOCIOLOGICAL PERSPECTIVE (L02252) **Andrea Colantoni, Bogdana Nosova, Nicola Ferrigni, Simona Fallocco, Giorgia Di Domenico, Leonardo Bianchini, Valerio Di Stefano**
11.30-11.45	DIGITAL SERIOUS GAMES FOR CLIMATE CHANGE EDUCATION: RESEARCH DATA AND FINDINGS (L02253) **Bokolas Vassilis, Hordecki Bartosz, Karametou Panagiota, Katerynych Petro, Kornieiev Vitalii, Lorek Artur, Marto Anabela, Mitoula Roido, Bogdana Nosova, Ribeiro Roberto, Rodrigues Nuno, Sakson-Boulet Anna, Silva Fernando, Tsimpoulis Giorgos, Katerina Tzika, Volobuieva Anastasiia**

11.30-12.00	Coffee Break

20. 12.00-15.00	Session: **"Education and Sustainable Development"** Chaired by **Prof Kaldi Stavroula** and **Dr Dologlou Maria** (Room A1) (main building)

12.00-12.15	PHYSICAL EDUCATION AND SUSTAINABLE DEVELOPMENT: EDUCATING ACTIVE CITIZENS FOR SOCIAL TRANSFORMATION (L02170) **Tassi Alexandra, Rachiotis Theodoros, Adamakis Manolis**
12.15-12.30	THE ROLE OF SCHOOL LEADERSHIP IN FOSTERING INCLUSIVITY WITHIN THE FRAMEWORK OF SUSTAINABLE DEVELOPMENT (L02174) **Anargyrou Aikaterini**
12.30-12.45	TEACHER WELL-BEING AS A PILLAR OF EDUCATIONAL SUSTAINABILITY (L02181) **Anargyrou Aikaterini**
12.45-13.00	EDUCATION POLICY FOR SUSTAINABLE TRANSITION: STRATEGIES AT LOCAL AND REGIONAL LEVEL (L02180) **Drakaki Maria, Papadakis Nikos**
13.00-13.15	THE TEACHER AS AN AGENT OF CHANGE: EDUCATION FOR SUSTAINABLE DEVELOPMENT IN THE SCHOOL COMMUNITY (L02188) **Dologlou Maria, Mitoula Roido**
13.15-13.30	PROMOTING SUSTAINABLE DEVELOPMENT THROUGH PRIMARY EDUCATION TEXTBOOKS. CASE STUDY: GREECE (L02191) **Papadopoulou Kl. Vasiliki, Mitoula Roido, Kaldi Stavroula, Sardianou Eleni**
13.30-13.45	PLAY & GAMES AS METHODS OF REGENERATIVE ARCHITECTURAL "EDUTAINMENT" (L02216) **Mouzakitis Stavros**

21. 13.45-15.00	Session: **"Local and Regional Cultural Development"** Chaired by **Prof Maria Manola** and **Asst Prof Poli Maria** (Room A1) (main building)
13.45-14.00	CULTURAL ENTREPRENEURSHIP AND SUSTAINABLE TOURISM DEVELOPMENT IN THE HEROIC ISLAND OF PSARA (L02158) **Manola Maria, Maniou Fotini, Poli Maria**
14.00-14.15	IN THE FOOTSTEPS OF TRAVELLERS: SUSTAINABLE DEVELOPMENT THROUGH TRAVEL TEXTS IN THE REGION OF LASITHI (L02175) Tsatalmpasoglou Anna-Irini, Koltsikoglou Georgios, Manola Maria, Mitoula Roido, **Maniou Fotini**
14.15-14.30	THE CULTURAL HERITAGE OF TENEDOS AS A DRIVING FORCE FOR LOCAL DEVELOPMENT AND INNOVATIVE BUSINESS ACTIVITIES (L02182) **Maniou Fotini**
14.30-14.45	FROM STRATEGIC NAVAL BASE TO CULTURAL ASSET - THE MILITARY HERITAGE OF LEROS (L02182) **Koltsikoglou Georgios, Tsatalbassoglou Anna Eirini, Manola Maria**
14.45-15.00	SUSTAINABLE DEVELOPMENT OF THE ANCIENT GREEK THEATRE, THE CASE STUDY OF PHILIPPI (L02128) **Nastou P. Marina Panagiota, Zerefos C. Stelios**

22. 12.00-15.00	Session: **"Digital transformation and sustainable development"** Chaired by **Assoc Prof Menshikova Maria** and **Assoc Prof Zamfir Natalia** (Room A2) (main building)
12.00-12.15	SUSTAINABLE URBAN REGENERATION IN MEDITERRANEAN CITIES: URBAN PLANNING PERSPECTIVES ON DIGITALIZATION AND ARTIFICIAL INTELLIGENCE (L02167) **Tsirigoti Dimitra, Kalemis Alexandros**

12.15-12.30	TOWARD ETHICAL AND SOCIALLY GROUNDED DIGITAL SUSTAINABILITY: HUMAN-CENTERED TECHNOLOGY AND THE METAVERSE IN INDUSTRY 5.0 (L02179) **Kalemis Alexandros**
12.30-12.45	HR SPECIALIST PROFILE IN THE DIGITAL ECONOMY: EVOLUTION OF SKILLS AND ATTITUDES THROUGH A GENDER PERSPECTIVE (L02183) **Menshikova Maria**
12.45-13.00	DIGITALIZATION OF THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS AS A TOOL FOR INTEGRATING THE SUSTAINABLE DEVELOPMENT GOALS (L02177) **Zamfir Natalia, Zamfir Pavel**
13.00-13.15	TRANSFORMING TRANSFER OF DEVELOPMENT RIGHTS(TDR) INTO DIGITAL ASSETS: BLOCKCHAIN, SMART CONTRACTS, PROPERTY TITLES, AND THE REIMAGINED DIGITAL LAND BANK (DLB) (L02178) **Christodoulou Dimitrios**
13.15-13.30	AI AND THE DYNAMICS OF CREATIVE DESTRUCTION IN THE GREEN TRANSITION. AS A CASE STUDY THE MUNICIPALITY OF NEA FILADELFIA-NEA CHALKIDONA, ATTICA, GREECE. (L02234) **Chronopoulou Georgia**
13.30-13.45	ESPORTS AND SOCIAL STABILITY: MORAL VALUES AND LEARNING OPPORTUNITIES IN VIRTUAL CITIES (L02227) **Choustoulakis Emmanouil, Maragkos Fotios**

23. 13.45-15.00	Session: **"Energy and Sustainable Development"** Chaired by **Prof Kabassi Katerina** and **Kremlis George** (Room A2) (main building)
13.45-14.00	UNIVERSITY-LED SOLAR ENERGY INITIATIVES IN SUPPORT OF SDG 7 AND SDG 13: A LITERATURE REVIEW (2015–2025) (L02173) **Kaloutsa Maria, Kabassi Katerina, Martinis Aristotelis, Kaldellis K. John**
14.00-14.15	TOWARD SUSTAINABLE AND SOCIALLY EQUITABLE CITIES: A LOCAL CLIMATE ZONE APPROACH FOR PHOTOVOLTAIC DEPLOYMENT IN EUROPEAN CITIES (L02186) **Dimitriou Tsampika, Skandalos Nikolaos, Karamanis Dimitrios**
14.15-14.30	ENERGY TRANSITION, ENERGY MIX AND MARKET-BASED COMPLIANCE MECHANISMS FOR GREENHOUSE GAS EMISSIONS MITIGATION: A COMPARATIVE REVIEW (L02215) **Thomaidou Foteini**
14.30-14.45	STUDENTS' PERCEPTIONS OF GLOBAL WARMING CAUSES AND THEIR ENERGY FOOTPRINT TOWARDS SUSTAINABILITY (L02221) **Kougias Konstantinos, Sardianou Eleni, Tsagarakis Konstantinos**
14.45-15.00	Discussion

24. 12.00-15.00	Session: **"Climate Change and Sustainable Development"** Chaired by **Prof Ntalos Georgios** and **KarytsasSpyridon** (Room A4) (main building)
12.00-12.15	ANIMALS' LEGAL PERSONHOOD IN MUNICIPAL (CLIMATE) ADAPTATION PLANS IN POLAND (L02156) **Haładyj Anna**

12.15-12.30	ENHANCING THE SUSTAINABILITY OF THE SHIPPING INDUSTRY THROUGH THE REDUCTION OF GREENHOUSE GAS EMISSIONS: A LITERATURE REVIEW (L02193) **Kourouklis Antonios, Chatzitheodoridis Fotios, Boulouta Konstantina**
12.30-12.45	CLIMATE-RELATED HAZARDS, URBANIZATION AND THE FATE OF AFRICA'S CHILD:CHILD SENSITIVE POLICY REFLECTION FROM UGANDA (L02198) **Tumwebaze Jonathan**
12.45-13.00	AICoSME: A HYBRID AI-POWERED TOOL FOR STRATEGIC CARBON FOOTPRINT MANAGEMENT IN SMEs (L02204) **Karageorgos Anthony, Trigkas Marios, Papageorgiou Elpiniki, Lallas Eftymios, Ntalos Georgios, Ntounas Theodoros, Chrysikou Vasiliki, Stavridou Styliani, Sdroulias Georgios**
13.00-13.15	SOCIETAL PERCEPTION OF CARBON CAPTURE, TRANSPORT AND STORAGE: OPPORTUNITIES AND RISKS, INSIGHTS FROM FOCUS GROUP MEETINGS (L02217) **Oikonomou I. Theoni, Karytsas Spyridon, Sprenkeling Marit, Terpstra Eva, Rambharos Shanita, Bannister Andrew, Wilkerson Brooke, Ljones Marie Louise, Bentsen Henrik Litlere, Otto Danny, Mendrinos Dimitrios**
13.15-13.30	THE CONTRIBUTION OF SMART AGRICULTURE AND SMALLHOLDERS TO SUSTAINABLE LOCAL DEVELOPMENT IN THE CONTEXT OF CLIMATE CHANGE: THE CASE OF GREECE (L02152) **Petridis Dimitris, Kalantonis Petros, Astara Olga-Eleni, Mitoula Roido**
13.30-13.45	Discussion

25. 13.45-15.00	Session: **"Urban Resilience and Quality of Life"** Chaired by **Prof Salvati Luca** and **Assoc Prof Papadas Dimitrios** (Room A4) (main building)
13.45-14.00	NATURAL DISASTERS, URBAN TRADE DISRUPTIONS, AND SUSTAINABLE ECONOMIC DEVELOPMENT IN MENA CITIES: ENERGY AND FOOD SECURITY PERSPECTIVES (L02143) **Papadas Dimitrios**
14.00-14.15	SUSTAINABLE STORMWATER MANAGEMENT IN URBAN AREAS OF HIGH FLOOD RISK: DESIGN, SIMULATION AND EVALUATION OF THE APPLICATION OF NATURE – BASED SOLUTIONS IN THE CITY OF THESSALONIKI (L02199) **Zafeirakou Antigoni, Samaras Evangelos**
14.15-14.30	LISTENING TO CHILDREN: PARTICIPATORY PRACTICES IN THE DESIGN OF OPEN SPACES FOR PLAY(L02145) **Tafidou Kyriaki, Katsavounidou Garyfallia**
14.30-14.45	CARTOGRAPHIES OF URBAN METABOLISM TOWARDS SELF-SUSTAINING TERRITORIAL SYSTEMS (L02163) **Apostolou Malvina**
14.45-15.00	ADAPTIVE ROAD MANAGEMENT FOR WILDFIRE RESILIENCE. A CASE STUDY FROM THESSALY, GREECE (L02205) **Stamatiou Christos, Matsouka Maria, Papageorgiou Grigorios**
15.00-15.45	CULTURAL AND SPORTS ASSOCIATIONS AND SUSTAINABLE DEVELOPMENT: INSIGHTS FROM AGRINIO, GREECE (L02258) **Koutsogiannou Sotiria, Chalioris Konstantinos, Karametou Panagiota, Mitoula Roido**

26. 12.00-15.00	Pre-organised Special Session: **"Islands in Transition: Innovation, Sustainability, Tourism and Climate Resilience"** Organised and chaired by **Assoc Prof Maria P. Doumi, Assist Prof Ioanna Pagoni, Assist Prof Iason-Nikolaos Koufodontis** and **Em Prof Angelis Vasilis** (Room A5)(main building)
12.00-12.15	THE VOLUNTARY LOCAL REVIEWS (VLRs) AS A TOOL FOR SUSTAINABLE GOVERNANCE IN CITIES: THE CASE OF SKIATHOS (L02207) **Bithas George, Kyriakopoulou Sotiria, Angelis Vasilis**
12.15-12.30	CULTURAL LANDSCAPE AND TOURISM. THE CASE OF THE STONE-BUILD ROADS IN CHIOS. (L02208) **Doumi P. Maria, Angelis-Dimakis Dimitris, Koufodontis Iason-Nikolaos, Fili Vasiliki, Tsompanis Konstantinos**
12.30-12.45	CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT. THE CASE OF GREEK ISLAND MUNICIPALITIES. (L02209) **Konteas Ioannis, Alexopoulos Andreas, Angelis Vasilis**
12.45-13.00	THE SECURITY OF DIGITAL PLATFORMS AS A SUSTAINABILITY FACTOR IN THE URBAN ENVIRONMENT OF CHIOS (L02210) **Anagnostou Kostas, Mennis Vangelis, Doumi P. Maria**
13.00-13.15	ISLAND SUSTAINABLE STRATEGY: FROM VULNERABILITY TO RESILIENCE (L02211) **Spilanis Ioannis**
13.15-13.30	SUSTAINABLE ISLAND MOBILITY PLANS: PLANNING FOR PEOPLE, TOURISM, AND CLIMATE (L02212) **Anagnostopoulos Kosmas, Pagoni Ioanna, Gioldasis Christos, Polydoropoulou Amalia, Spilanis Ioannis, Nikolopoulou Katerina, Stroumpas Savvas**
13.30-13.45	DIGITAL ECOSYSTEMS AND BUSINESS INNOVATION AS ACCELERATORS OF SUSTAINABLE TRANSITION IN ISLAND SMART CITIES (L02213) **Ntoumi Anastasia, Kutsikos Konstadinos, Doumi P. Maria, Angelis Vasilis**
14.00-15.00	Discussion

15.00-16.00	Conference Lunch - Finger Food

Delegates will soon receive an email regarding a special visit for Saturday, December 6th, from 16:00 to 20:00, to 'The Ellinikon Excibition Centre' and 'The Ellinikon Experiece Park'.Your participation would be appreciated and confirmation for this visit is required. Please note that this visit is contingent on there being a minimum number of participants.

Closing of the Conference

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CONFERENCE PAPERS

Keynote Papers

URBAN SUSTAINABILITY: NOTES AND PARADIGMES ON THE ENVIRONMENTAL, CULTURAL, AND POLITICAL IMPROVEMENT OF PLACE

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Abstract
The proposals to be presented originate in a principally environmental prospect concerning the organization and the enforcement of the 'emerald necklace' of the Athenian metropolitan territory. They refer to the description of possible 'green porosity' of the Hellenic capital, to the way that an extended network of green urban corridors and parks could be organized. Nevertheless, this first organizational proposal may be invigorated by two additional ideas concerning a second project, a second proposal.

This second design effort refers to the need for active participation of the inhabitants of the Hellenic capital in a bottom-up approach to a dreamed environmental regeneration. An analogous approach was introduced in a diploma thesis in the School of Architecture N.T.U.A., a thesis under the irritating title 'Plato's Gardens,' concerning the organization of a collective urban agricultural area in the territory of Plato's Academy in Athens. This second paradigm clearly stated, besides its natural environmental accomplishment, that no landscape intervention in the Athenian territory could be historically and culturally neutral. This was a first, an additional crucial idea for our concept of the green Athenian porosity. On the contrary, analogous interventions could be culturally significant and present the possibility of multicultural references nowadays. This could be a second, additional significant idea concerning the socio-cultural porosity of the Athenian territory. Plato's collective gardening area could thus be offered not solely to native Greek inhabitants but also to immigrants or refugees installed in the vicinity of the historical territory of Plato's Academy.

Throughout post-Renaissance and neoteric Western history, landscape proposals in urban or peri-urban contexts were scarcely restricted to limited environmental and 'functional' denotational value. They were also empowered by symbolic references that reflected the cultural and political identities of the corresponding societies. Could we offer our present interventions analogous connotational meanings?

Keywords: Green Athenian porosity, Plato's Academy, Plato's Gardens, collective urban agriculture, urban multi-cultural co-existence and collaboration, socio-cultural porosity.

Ecological approaches of combined natural, cultural, and political validity

I shall begin my presentation with the statement that I shall refer to urban sustainability, to urban ecological approaches of combined natural, cultural, and political validity.

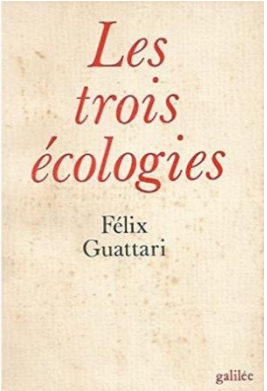
The proposals to be presented originate in a principally environmental prospect concerning the organization and the enforcement of the 'emerald necklace' of the Athenian metropolitan territory. 'Emerald necklace', a metaphoric description to which we shall repeatedly refer during our presentation. 'Emerald necklace' of the Athenian metropolitan territory, the description strongly refers to the possible 'green porosity' of the Hellenic capital,

to the way that an extended network of green urban corridors and parks could be organized. 'Porosity', 'Porosität' in German, a term introduced by Walter Benjamin, to describe the intense correlation of open-air urban public spaces with buildings. In our case, the concept of porosity, of 'green porosity', is used to describe the correlation of urban hardscape formation with green urban landscape. 'Green porosity', a condition surely extremely important for the natural sustainability of cities (Buck-Morss, 1989 - Demetz, edit. 1986 – Moraitis, 2024a: pp.306-368).

Img.1: *'Porosity'*, 'Porosität' in German, a term introduced by Walter Benjamin, to describe the intense correlation of open-air urban public spaces with buildings, an urban condition which Benjamin (bottom left) and his companion, Asja Lācis (upper left) met, during their travel to Naples (on the right).

Nevertheless, in the initial usage of the term by Benjamin, porosity was strongly associated with the social and political importance of the exterior, open-air urban spaces that invade the interior of buildings. Porosity could thus be regarded as a material and social quality as well. Furthermore, it is in Félix Guttari's book *The Three Ecologies - Les Trois Écologies* (Guattari, 1989) that the author insisted on the idea that the ecological approach is not restricted to a natural-oriented tendency solely. It must be associated, furthermore, with a conceptual ecological approach, with the social conscience of the importance of ecosophic thinking (Drengson, 1999) and, even more, with a third ecological approach, that of political ecological volition.

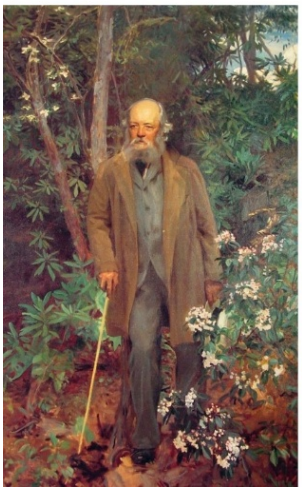
It is in this context that we shall strongly support the statement that we may not have urban sustainability by promoting material environmental improvement solely. We must extend our demand to cultural and political improvement, as well as cultural and political sustainability.

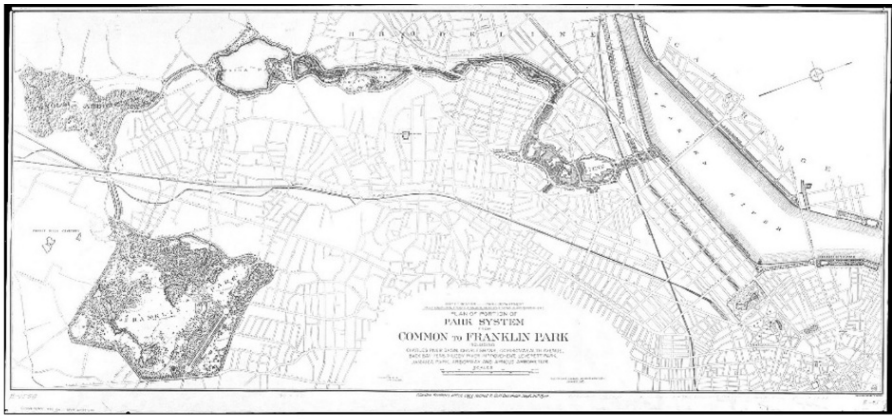


Img.2: Félix Guttari, in his book *The Three Ecologies - Les Trois Écologies,* emphasized that the ecological approach is not limited to a natural-oriented tendency alone.

Interventions of functional approaches combined with the promotion of political identity

We have presented an approach that seems to express important previous paradigms of garden and landscape art, characterizing the urban transformation of important Western capital cities at the end of the 19th century. According to Fredrick Law Olmsted, creator of New York Central Park, positive environment and landscape formations in urban and peri-urban contexts must be considered as a matter of political demand, as a matter of the democratic amelioration of public life in the late 19th century (Beveridge - Rocheleau, 2005). His approach, expressed in many landscape and garden art projects, was intensively presented in his idea of the green enrichment of the Boston area. In this ambitious project, a green network was created, not a park solely, but a network of parks connected with green corridors, a green network metaphorically named 'emerald necklace'; emeralds are precious stones of green colour.





Img.3: Fredrick Law Olmsted, creator of New York Central Park (on the left), and his proposal for the ***'emerald necklace'*** (on the right), the network of parks connected with green corridors, in the Boston area.

Olmsted's urban amelioration efforts are just a part of the 19th-century urban landscape interventions in the Western world. Big Western cities, for example, London or Paris, had to be environmentally transformed to express their 'capital', superior cultural and political quality, and to face the unbearable conditions of living in the quarters of the working-class settlements. To face those unbearable conditions, for example, the continuous epidemics, and in association with them, the political reactions of the impoverished citizens, governmental planning had to react. It was in this context that landscape and garden art reached the status of

central cultural and political activities (Chadwick, 1966). In the late 19th century, England presented the formation of the first public parks, the Arboretum of Derby by John Claudius Loudon, and Birkenhead Park, the latter by the famous gardener Joseph Paxton. We must also mention Loudon's proposal for a garden city, in the 1840s, forty years before Soria y Mata's proposal, in 1882, and sixty years earlier than Ebenezer Howard's proposal in 1902. Paxton, Joseph Paxton was also the creator of the Crystal Palace, a huge greenhouse in a huge urban park, in Hyde Park; a huge greenhouse, a cast-iron and plate-glass structure, that housed the Great Exhibition, the international exhibition of 1851 that had to promote the political, economic, and cultural status of the Great Empire, Queen Victoria's Britain.

Img.4: The Great Exhibition, the international exhibition of 1851, was housed not in a regular 'hard structure' building, but in a huge greenhouse in the interior of a huge urban park. Landscape architecture seems to be culturally and politically central.

Img.5: The *Peterloo Massacre* (upper left), against impoverished protestors, took place at St Peter's Field, Manchester, on Monday, 16 August 1819. In his *Maps Descriptive of London Poverty* (upper right), Charles Booth offered, in 1889, a social mapping approach of the living conditions of the English capital's population. A mapping approach describing the lower classes' housing zones with black color.

Nevertheless, British splendor had to face the political reaction of the lower parts of society, the Peterloo protest and the Peterloo massacre of the protesters, to face the *Condition of the Working Class in England*, as described in the homonymous book of Friedrich Engels (Engels, 1987), or in Charles Booth's *Maps of Poverty*, or in Gustav Dore's engravings of the 'dark' *Pilgrimage to London*. It was in the British capital city that, in a Gothic horror novel by

Scottish author Robert Louis Stevenson, the honest Dr. Jekyll was transformed, during the night, into a criminal personality, Mr. Hyde (Stevenson. 2024). In an analogous dark, fictional voyage, in a metaphorical narration of urban agony, Bram Stoker's Dracula reached England (Stoker, 2008), bringing with him the plague (Moraitis, 2024b).

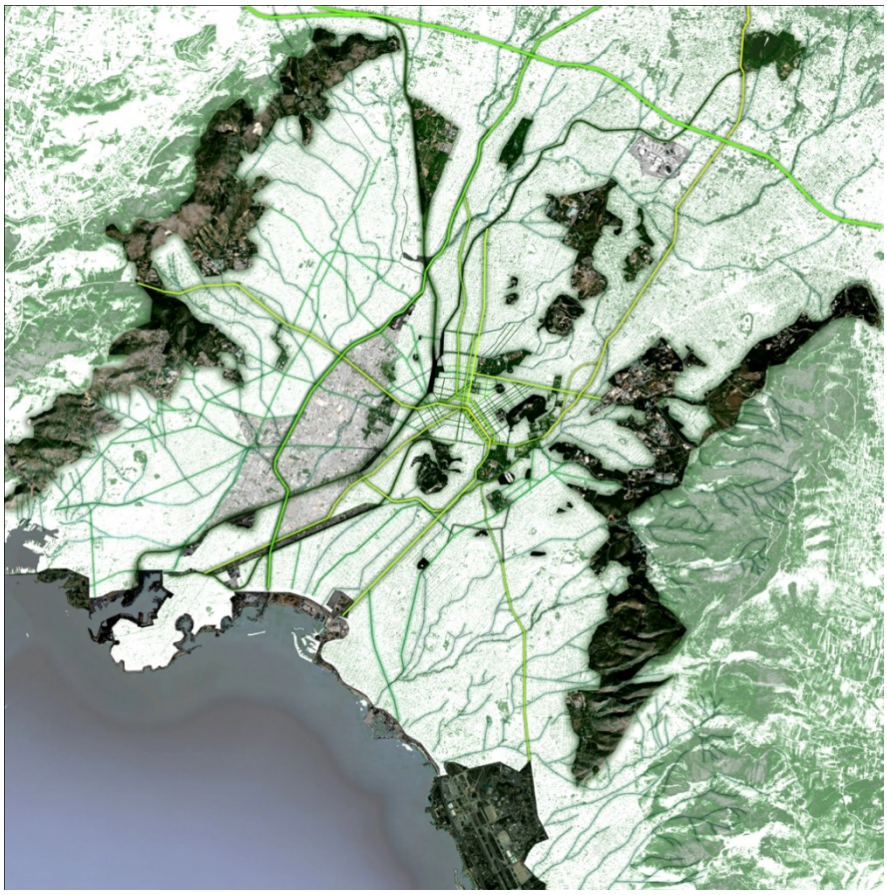
Was a landscape reaction a political reaction against those social calamities? In France, Napoleon III had to face urban and social deterioration. He had to face political reaction and repeated revolutionary movements. It was in this negative socio-political context that he had to react and support an urban reform organized and realized by his official Baron Georges-Eugène Haussmann, a radical urban renewal program that offered Paris a network of important parks.

Img.6: In France, Napoleon III had to face urban and social deterioration, political reaction and repeated revolutionary movements (upper right, executed citizens during the Paris Commune). It was in this negative socio-political context that he had to react and support an urban reform organized and realized by his official Baron Georges-Eugène Haussmann (upper left, Napoleon III and Baron Haussmann), a radical urban renewal program, that offered Paris a network of important parks, as the Boulogne Park - *Le Bois de Boulogne* (bottom image).

Were the previously described landscape interventions in England and France, and in the United States as well, limited to functional, material transformations? Do they also possess a high cultural and political symbolic value (Howard, 1902 - Burlen, edit 1987)***?***

Athenian green porosity and its cultural and political, symbolic validity

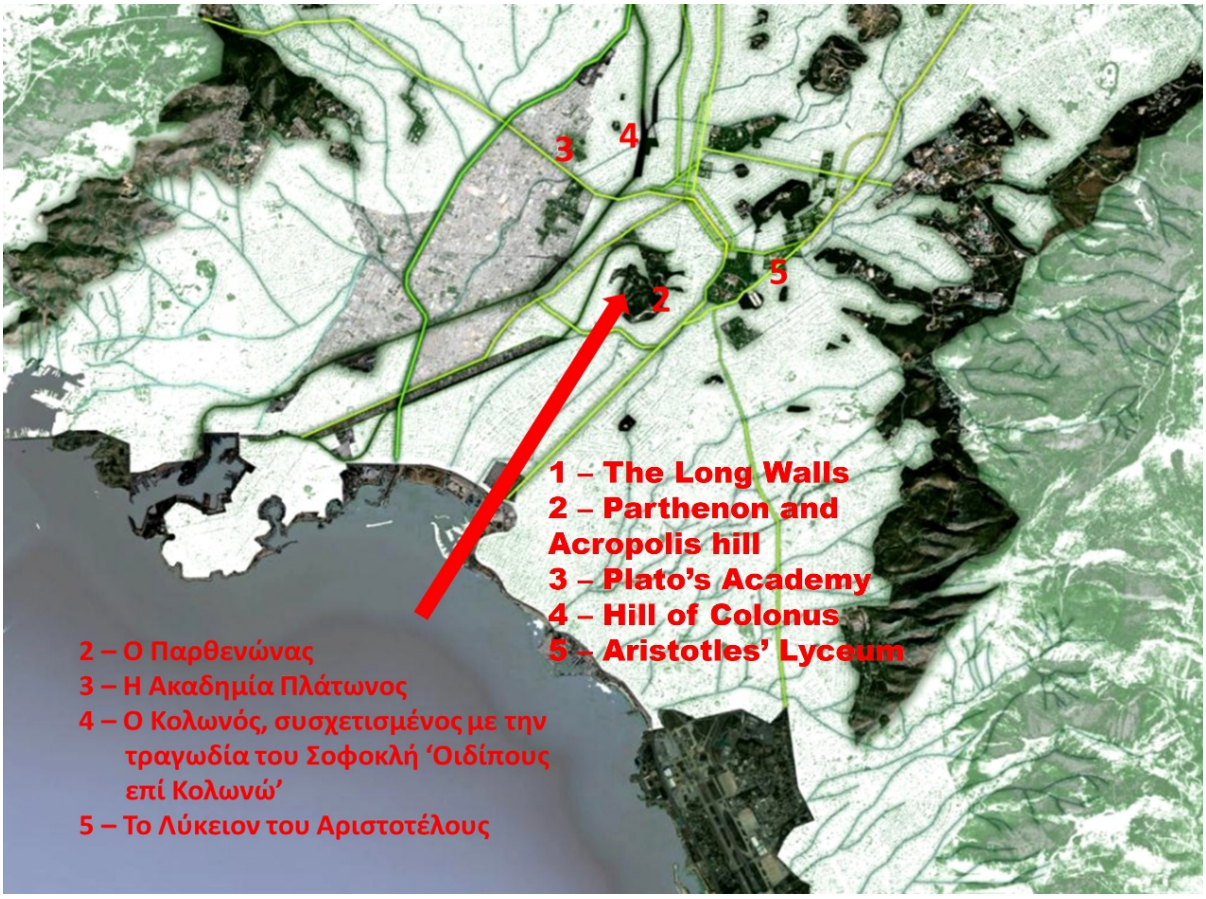
The proposals to be presented originate in a principal environmental prospect concerning the organization and the enforcement of the 'emerald necklace' of the Athenian metropolitan territory. They refer to the description of the possible 'green porosity' of the Hellenic capital, to the way that an extended network of green urban corridors and parks could be organized.



Img.7: The research program "Changing Characters and Policies in the Center of Athens and Piraeus," organized by the Hellenic Ministry of Environment, Energy and Climate Change, proposed a network of green places, existing parks or open-air planted spaces that could be transformed to parks and could be interconnected with green lines, 'green corridors', green planted corridors.

The first of them was correlated with an extended research program carried out by the School of Architecture of N.T.U.A., a research program concerning the "Changing Characters and Policies in the Center of Athens and Piraeus," that was organized by the Hellenic Ministry of Environment, Energy and Climate Change. In the context of this research program, we have tried to organize a network of green places, existing parks or open-air planted spaces that could be interconnected with 'green lines, green corridors', green planted corridors. Analogous green linear connecting places could be provided by the open-air urban railroad route that could be conceived as a linear extended urban garden, or by a planted network of streets, or, according to a proposal of high environmental validity, by the uncovering and re-naturalization of the numerous urban rivers and streams that have been covered during the

recent history of the Athenian landscape. This last dreamy urban desire would surely offer, if brought to reality, a radical climate amelioration of the complex of the Athenian basin. Nevertheless, the Athenian rivers and the streams are not solely material geographic elements. There, the ancient gods were coming down to feel the blessing of the running water, and the nymphs used to flaunt their charm.



Img.8: 'Landscape urbanism' in the case of the Athenian basin does not refer to its natural identity solely. It must also refer, emphatically,…

…to its cultural and political identity to all these important historical places (on the left)

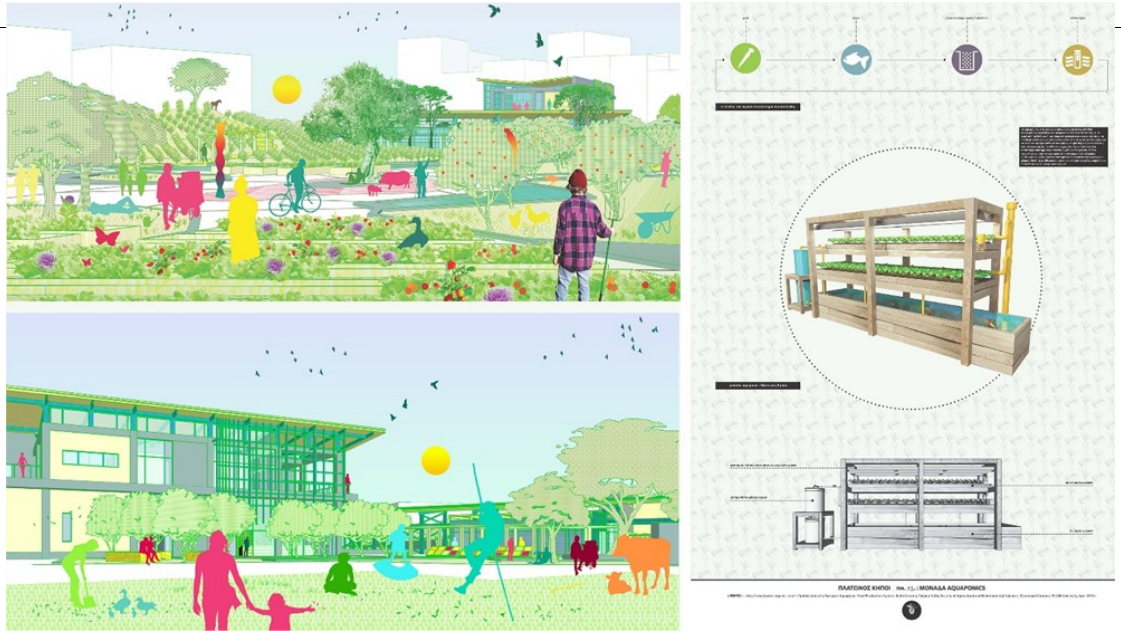
On this oneiric voyage, the contemporary visitor could be guided, visiting the Parthenon together with the ancient procession of Panathenaea, visiting together with Plato or Aristotle, Plato's Academy or Aristotle's Lyceum. Together with Oedipus, he could ask mercy from the gods on the nowadays strongly planted hill of Colonus. He could, our contemporary visitor, walk down to the Hippodamian Piraeus, to the first urban-designed port of universal history, using the ancient itinerary of the fortified Long Walls, today a possible planted corridor in the heart of the densely built city. I need to remember the Funeral Speech of Pericles. I take pride in this first description of the democratic regime. I feel proud of speaking a language related to the one Pericles spoke, and I would like to emphasize the sustainability of this pride, which is also linked to the environmental sustainability of my city. Athenian green porosity, the sustainability of the Athenian environment, must be associated with the cultural and political, symbolic validity of the Hellenic capital and its peripheral territory.

Img.9: Could we meet again nymphs at the Athenian Illisus River? Could we revitalize it again as natural and cultural landscape? The river Illisus and Stadion Bridge, ca. 1900 (bottom middle), the only nowadays un-canalized part of the bed of the river (upper right) and the 'mummified' part of it at the territory of Moschato (bottom right).

Landscape interventions and the socio-cultural porosity of the Athenian territory

Moreover, the previous first organizational proposal may be invigorated by two additional ideas concerning a second project, a second proposal.

Img.10: "Plato's Gardens": Green urban porosity and the formation of focal places of collective urban agriculture – a graduate diploma thesis in the School of Architecture NTUA, by Chr. Golemi.



Img.11: "Plato's Gardens": 3D descriptions of the gardens (on the left) and reference to the proposed hydroponic activity (on the right).

This second design effort refers to the need for active participation of the inhabitants of the Hellenic capital in a bottom-up approach to a dreamed environmental regeneration. An analogous approach was introduced in a diploma thesis at the School of Architecture N.T.U.A., a graduate thesis under the irritating title 'Plato's Gardens,' concerning the organization of a collective urban agricultural area in the territory of Plato's Academy in Athens (Moraitis, 2024a: pp.359-363). This second paradigm clearly stated, besides its natural environmental accomplishment, that no landscape intervention in Athenian territory could be historically and culturally neutral. This was an additional crucial idea for our concept of the green Athenian porosity. We shall insist on the fact that collective urban agriculture, socially active urban landscape interventions, could be culturally important and could present, moreover, nowadays, the possibility of multicultural references; this could be an additional significant idea, concerning the socio-cultural porosity of the Athenian territory. Plato's collective gardening area could thus be offered not solely to native Greek inhabitants but also to immigrants or refugees installed in the vicinity of the historical territory of Plato's Academy.

Were the previous proposals associated with neoteric urban landscape interventions or with present proposals solely?

Throughout post-Renaissance and neoteric Western history, landscape proposals in urban or peri-urban contexts were scarcely restricted to limited environmental and 'functional' denotational value. They were also empowered by symbolic references that reflected the cultural and political identities of the corresponding societies. Could we offer our present interventions analogous connotational meanings? In Renaissance Italy, Tuscan gardens reinterpreted Roman and Greek antiquity, and the redesign of the Capitoline Hill, the Piazza del Campidoglio, symbolized the papal reestablishment of Roman grandeur. In the Baroque Versailles Gardens, the place formation glorified the royal sovereignty of Louis XIV, the Sun King – Apollo, in Stowe Gardens of Britain, the landscape architecture referred to the British

political quality in comparison to the ancient Greek political paradigm. In this overall context, the American Boston park network, described by Frederick Law Olmsted as democratic, as a political right of the urban population, must not be regarded as culturally isolated. The difference between Olmsted's statement and the previous historically connotational, symbolic approach of the previous landscape intervention paradigms was not a difference between connotational and non-connotational, solely denotational approaches, but a difference between the exact socio-political orientation of those approaches.

Closer to us, the important paradigm of the Parisian Les Halles re-design projects, Bernard Tschumi's awarded competition proposal, as well as the proposal by the OMA architects' team, presented not solely environmental landscape interventions, not even functional proposals restricted to the use of Les Halles Park. They, moreover, presented proposals related to the historical background of the place and of the history of the landscape and architectural design. Both previous proposals, presented in the Les Halles International Architectural Competition, insisted on the newly emerging tendencies of the cultural and expressive theory of the era. They both insisted on the newly emerging tendencies of post-structural theory and, in many ways, on the denial of the all-encompassing, stable, everlasting meta-narratives. Nevertheless, we need to create new structures of expression and important cultural and political narratives, bringing into contact our "archeology of knowledge" and our present cultural and political identity in our urban formations.

Conclusive remark

It is in this context that the previous proposals concerning the Athenian metropolitan area, and especially the territory of Plato's Academy and the newly formed multi-ethnic and multicultural formation of the city, may present interesting paths towards urban sustainability: environmental, cultural, and political sustainability.

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MULTIDISCIPLINARY PARADIGMS BETWEEN SCIENCE AND POLICY. POSITIVE AND NORMATIVE APPROACHES FOR THE ANALYSIS OF COMPLEX ECONOMIC AND ENVIRONMENTAL SYSTEMS

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Abstract
Cognitive systems in socioeconomic networks have strongly influenced the representation of complex system dynamics, highlighting the emergence of new structures centered on adaptive actors, local interactions, the development of poles of attraction, and increased innovation capacity. In a context of urban fragmentation, economic uncertainty, and changing social attitudes and political rules, regional systems have increasingly been viewed as open systems shaped by nonlinear dynamics involving anticipatory agents and emerging types of spatial units. Relatively low-level interactions between agents produce these new spaces at two main levels of observation: the morphological and functional levels, which emerge from citizen decisions and feedback interactions, and the spatial organization of economic activities, which reflects adaptive and competitive strategies and relationships between districts, municipalities, and individual areas. Relational issues complicate the evaluation of any regional system. Isolating the interactions between different levels of organization for measurement purposes appears to be a daunting task. However, the evolutionary trajectory of regional systems reveals, in many cases, some common patterns, including selection, cooperation, imitation, and adaptation to change. These models typically reflect self-organized development rather than behavior controlled by a central institution, even in the face of exogenous stresses (e.g., climate change), which impact their sustainability characteristics and resilience potential. This seminar discusses complex systems from a multidisciplinary perspective, providing concrete environmental and economic examples, and revealing—from an operational and planning perspective—how "complex thinking and acting" is useful not only for science but also for policy implications.

Keywords: Science and Policy, Complex Economic and Environmental Systems

INNOVATIVE ENTREPRENEURSHIP AS A CATALYST FOR SUSTAINABLE PROSPERITY AND COMPETITIVENESS IN EUROPEAN CITIES AND REGIONS

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Abstract
Innovative entrepreneurship represents more than a growth driver; it constitutes a key mechanism within the complex architecture of socio-economic and territorial transformation in the European Union. As urban and regional systems confront multidimensional challenges—including climate crisis, digital transition, demographic pressures, and deepening socio-economic inequalities—entrepreneurial ecosystems emerge as dynamic platforms for fostering sustainability, resilience, and inclusive prosperity. Anchored in the EU's strategic frameworks such as the Green Deal, the Digital Strategy, and the Industrial Strategy, innovative entrepreneurship enables the co-creation of adaptive solutions through open innovation processes, multi-level governance, and cross-sectoral collaboration.

A critical analysis is offered on the role of innovative entrepreneurship as a transformative force shaping territorial competitiveness, sustainable prosperity, and systemic resilience. The discussion highlights how entrepreneurship interacts with regulatory frameworks, technological infrastructures, and cultural-educational systems to generate socio-technical transitions at the urban and regional level. Emphasis is placed on the interplay between innovation policies, sustainable development objectives, and the integration of EU values in local governance. By linking theory with policy practice, the analysis contributes to understanding how entrepreneurial ecosystems can accelerate green and digital transitions, support territorial cohesion, and advance the 17 Sustainable Development Goals, positioning European cities and regions as active agents of systemic change.

Key-words: Innovative Entrepreneurship; Socio-technical Transitions; Territorial Competitiveness; Resilience; Multi-level Governance; Entrepreneurial Ecosystems; Open Innovation; EU Policy; Green and Digital Transition; Sustainable Development Goals (SDGs).

ACHIEVING CLIMATE NEUTRALITY: STRATEGIES AND CHALLENGES IN THE ENERGY TRANSITION

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Abstract
The path to climate neutrality, requires an ambitious energy and green transition and a holistic circular economy strategy to reach net zero.

Achieving climate neutrality represents a profound systemic transformation that necessitates the decarbonization of energy production, industrial processes, and consumption patterns within an integrated socio-economic framework. The transition towards a net-zero economy entails both technological innovation and structural policy reform, aimed at reducing greenhouse gas emissions, while fostering sustainable growth. Within this context, the European Union (EU) has emerged as a global leader, embedding the objective of climate neutrality by 2050 into binding legislation through the European Climate Law and operationalizing it via the European Green Deal.

The EU's strategy emphasizes the acceleration of renewable energy deployment, enhancement of energy efficiency, and diversification of energy sources under the REPowerEU plan, designed to reduce reliance on fossil fuel imports and enhance energy security. Complementary initiatives, such as the Fit for 55 package, seek to align sectoral policies with intermediate emission reduction targets by 2030 and 2040. Investments in green hydrogen, battery storage technologies, and carbon capture and utilization (CCU/CCS) are central to addressing emissions in hard-to-abate sectors.

Moreover, the EU's Circular Economy Action Plan underpins the energy transition by promoting resource efficiency, waste minimisation, and sustainable product design, thereby reinforcing the decoupling of economic growth from environmental degradation. Nonetheless, the transition entails significant challenges, including uneven regional capacities, high capital requirements, and potential socio-economic disparities. To mitigate these, the Just Transition Mechanism and the Innovation Fund provide financial and technical support to vulnerable regions and emerging clean technologies.

Collectively, these measures illustrate the EU's comprehensive and multi-level governance approach to achieving climate neutrality, demonstrating how policy coherence, innovation, and solidarity can jointly drive the transformation toward a sustainable, low-carbon future.

Key words: Climate Neutrality, Energy Transition, EU's Circular Economy Action Plan

SCALING UP THROUGH COOPERATION: HOW VOLUNTARY AGGREGATION IN LOCAL ENVIRONMENTAL SERVICES SUPPORTS CIRCULAR ECONOMY GOALS

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Abstract
One key challenge in the provision of local services is balancing efficiency and public governance. This paper explores how different organisational models can combine these two objectives in achieving sustainability goals. Focusing on municipal solid waste and water management, the study discusses the expected welfare gains from business integration and introduces a model of voluntary municipal aggregation centred on a public industrial operator. Such an approach enables scale-up processes, allowing small municipalities to enhance service quality, investment capacity, and coordination efficiency through collective organisation. The proposed framework clarifies the interplay between scale, control, and social welfare. Results confirm the benefits of scale and scope and highlight how innovative institutional solutions can align efficiency objectives with circular economy principles. This work contributes to the debate on local public service governance by linking industrial organisation, public control, and sustainability within an integrated analytical perspective, highlighting how aggregations can unlock investments otherwise unattainable in fragmented contexts, which are essential to achieving circular economy goals requiring adequate infrastructure and plant capacity.

Key words: Public governance, waste management, water management in-house providing, public economics, Circular economy.

EDUCATION FOR SUSTAINABLE DEVELOPMENT: THE EXAMPLE OF THE "GREENCOMP SCHOOL" CURRICULA AND LEARNING MATERIALS

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Abstract
Education for sustainable development (ESD) empowers learners with knowledge, skills, values, and behaviors that support environmental, economic, and social dimensions of sustainability. Bibliometric reviews highlight a surge in ESD research since the 1990s, with notable growth after 2018, and call for greater attention to social sustainability themes. Recent studies advocate reconceptualizing sustainability education by embracing "degrowth" principles—focusing on ecological responsibility and equity—and emphasize critical, interdisciplinary pedagogies. ESD also fosters transformative learning through teacher development, digital inclusion, and community partnerships, reinforcing its role in policy integration and global citizenship education. To fully realize sustainable futures, ESD must continue evolving with empirical research, curriculum innovation, and inclusive, value-based approaches.

In line with the above the GreenComp School ERASMUS-EDU-2022-PI-FORWARD project was developed in response to the European Council's "GreenComp Framework," an initiative under the European Green Deal aimed at fostering sustainability competences among European citizens. Specifically targeting primary education, the project seeks to identify and promote sustainability competences tailored to the needs of primary school stakeholders. It introduces twelve competences grouped into four key areas, aiming to instill a sustainability mindset in schools. The project emphasizes the transferability of its outcomes across various educational contexts to enhance the sustainability performance of primary schools and other learning institutions. In support of the European Green Deal, GreenComp School offers a revised, field-tested model for primary education, along with flexible, interdisciplinary training programs for educators across sectors, including schools, higher education institutions, and vocational education and training (VET). It also provides micro-certification courses for teachers and encourages curriculum reforms to support the long-term implementation of sustainability education.

Key words: education, sustainable development, GreenComp school project

HISTORIC URBAN LANDSCAPES AND URBAN RESILIENCE: INTEGRATING CULTURAL HERITAGE INTO SUSTAINABLE PLANNING IN MEDITERRANEAN CITIES

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Abstract
Historic cities across the Mediterranean are increasingly facing complex and interrelated pressures arising from climate change, tourism intensification, socio-economic transformation, and fragmented governance systems. These dynamics place significant strain not only on the physical fabric of cultural heritage but also on the social and ecological systems that sustain historic urban environments. Conventional heritage management approaches have traditionally focused on the protection of individual monuments or architectural ensembles. While valuable, such approaches often fail to address the broader urban processes and environmental challenges that affect historic districts as living and evolving systems.

In response to these limitations, the Historic Urban Landscape (HUL) approach, introduced by UNESCO in 2011, proposes a more comprehensive framework that integrates heritage conservation with sustainable urban development, climate adaptation, and urban resilience strategies. This article explores the potential of the HUL approach to strengthen resilience in Mediterranean historic cities through an in-depth case study of Chania, Crete. The research adopts a qualitative multi-method design that combines spatial analysis of urban form, policy review of planning and governance frameworks, and semi-structured interviews with key stakeholders involved in heritage management and urban development.

The findings highlight several structural challenges, including institutional fragmentation, tourism-driven spatial transformations, limited community participation in planning processes, and insufficient integration of climate adaptation measures into heritage management practices. At the same time, emerging initiatives—such as adaptive reuse projects, participatory cultural programs, and growing awareness of climate-related risks—indicate opportunities for more integrated planning approaches. The study argues that historic urban environments should be understood as complex socio-ecological systems where heritage conservation, community well-being, environmental sustainability, and local economic activity are deeply interconnected and mutually dependent.

Keywords: historic urban landscape, cultural heritage management, urban resilience, Mediterranean cities, tourism pressure, climate adaptation, Chania

1. INTRODUCTION

Historic cities represent some of the most culturally significant and socially complex urban environments in the world. Their layered urban fabrics reflect centuries of architectural, social, economic, and political transformations, creating landscapes that embody collective memory and cultural identity. In Europe, historic cities play a central role in cultural tourism, regional development, and urban identity. However, these cities are also increasingly exposed to environmental, economic, and social pressures that challenge traditional approaches to heritage conservation.

Mediterranean historic cities are experiencing profound transformations driven by climate change, global tourism dynamics, demographic shifts, and evolving urban development patterns. These pressures are especially pronounced in coastal historic settlements, where environmental risks intersect with intense tourism activity and rapid socio-economic change. As a result, many historic urban areas face growing tensions between conservation objectives, economic development strategies, and community needs.

Traditional heritage management frameworks have often focused on preserving individual monuments, historic buildings, or architectural ensembles through regulatory protection mechanisms. While such approaches have been successful in safeguarding important cultural assets, they have proven insufficient for addressing broader urban challenges such as climate adaptation, housing pressures, tourism impacts, and infrastructure modernization ((Bandarin, & Van Oers, 2012)). In many cases, heritage policies operate separately from urban planning systems, resulting in fragmented governance structures that hinder integrated decision-making.

In recent years, international heritage policy has increasingly emphasized the need for holistic approaches that integrate cultural heritage conservation into broader urban development strategies. One of the most influential initiatives in this direction is the Historic Urban Landscape (HUL) Recommendation, adopted by UNESCO in 2011. The HUL framework redefines historic cities as dynamic landscapes shaped by the interaction of cultural, natural, and socio-economic processes over time (UNESCO, 2011)

Rather than focusing solely on preserving physical structures, the HUL approach emphasizes the management of urban changes in ways that respect historical identity while accommodating contemporary development needs. This shift reflects a growing recognition that historic cities must remain living environments capable of adapting to evolving environmental and socio-economic conditions.

The integration of heritage conservation with urban resilience planning is particularly important in the context of climate change. Coastal historic cities across the Mediterranean face increasing risks from sea-level rise, extreme heat events, flooding, and water scarcity. These environmental threats pose significant challenges for heritage preservation and urban infrastructure systems alike.

At the same time, tourism growth has become a defining feature of many historic cities. While tourism provides important economic benefits, it can also generate negative impacts such as overcrowding, housing displacement, infrastructure strain, and commercialization of historic spaces ((Buitrago & Yñiguez, 2021) . These processes often transform historic neighborhoods into visitor-oriented environments that gradually lose their social diversity and cultural authenticity.

This article explores the role of the Historic Urban Landscape framework in addressing these interconnected challenges. Through a detailed case study of Chania, a historic city on the island of Crete, the research examines how heritage management practices interact with tourism dynamics, environmental vulnerabilities, and urban governance systems.

The present study seeks to explore and address three central research questions that guide the overall analysis and structure of the investigation. Specifically, it examines the range of environmental, socio-economic, and governance-related challenges that affect and shape historic urban landscapes in Mediterranean cities, where the interaction between heritage conservation, urban growth, and environmental pressures often creates complex management conditions. In addition, the research investigates how increasing tourism pressures, together with emerging climate-related risks such as rising temperatures, extreme weather events, and environmental degradation, influence patterns of urban development and spatial

transformation within historic districts. Furthermore, the study considers how the Historic Urban Landscape approach may provide an integrated conceptual and practical framework capable of supporting more resilient, adaptive, and sustainable forms of heritage management in historic urban environments.

By examining these issues in a comprehensive manner, the article contributes to broader interdisciplinary discussions on cultural heritage management, sustainable urban development, and urban resilience planning in historic cities. In doing so, it aims to provide insights that may inform both academic debates and policy-oriented strategies for balancing conservation objectives with the evolving social, environmental, and economic dynamics that characterize historic urban areas.

2. CULTURAL HERITAGE AND URBAN RESILIENCE

Urban resilience refers to the capacity of cities to absorb disturbances, adapt to changing conditions, and maintain essential functions while transforming ((Meerow, Newell, & Stults, 2016) . While resilience research has traditionally focused on infrastructure systems, environmental processes, and disaster management, recent studies emphasize the importance of social and cultural dimensions in shaping urban adaptive capacity.

Cultural heritage plays a crucial role in this context because it contributes to social cohesion, identity, and continuity that support community resilience (Diekmann & Gillot, 2010). Historic environments often contain dense networks of social relationships and cultural practices that enable communities to respond collectively to environmental or economic disruptions. Furthermore, heritage assets frequently serve as key economic resources, particularly in tourism-dependent regions. Historic districts attract visitors, generate employment opportunities, and support local businesses. However, excessive dependence on tourism can also create vulnerabilities, especially when economic activity becomes highly seasonal or externally driven. Scholars increasingly argue that heritage conservation should be integrated into broader resilience strategies rather than treated as a separate policy domain (Van Oers, 2008). Such integration requires interdisciplinary approaches that consider cultural, environmental, and socio-economic factors simultaneously.

3. THE HISTORIC URBAN LANDSCAPE FRAMEWORK

The **Historic Urban Landscape (HUL) approach** represents a significant transformation in the way cultural heritage is understood and managed within contemporary urban contexts. Emerging from evolving debates in international heritage policy and formally articulated in the UNESCO Recommendation on the Historic Urban Landscape (UNESCO, 2011), the HUL framework moves beyond traditional conservation paradigms that primarily focus on the preservation of individual monuments, historic buildings, or architecturally significant ensembles. Instead, it proposes a more comprehensive and dynamic understanding of historic cities as complex, layered urban landscapes, shaped over long periods through the interaction of cultural, environmental, economic, and social processes.

Within this perspective, historic urban areas are not treated as static entities frozen in time but as living environments that continuously evolve in response to changing societal needs, environmental conditions, and economic dynamics. The HUL approach, therefore, recognizes that heritage conservation must engage with broader urban systems and development processes. By situating cultural heritage within the wider urban landscape, the framework emphasizes the importance of understanding how historical layers, natural features,

spatial structures, and community practices collectively shape the identity and functionality of cities (UNESCO, 2013).

A central premise of the HUL approach is that heritage conservation should be integrated into broader strategies for sustainable urban development. This requires moving beyond sectoral policies that treat heritage management as an isolated domain. Instead, heritage must be considered alongside urban planning, environmental management, economic development, and social policy. In this way, the HUL framework promotes a holistic and interdisciplinary perspective that acknowledges the interconnected nature of urban systems and the multiple values embedded in historic environments.

Several core principles underpin the implementation of the Historic Urban Landscape framework. One of the most important elements is the integration of urban planning and heritage conservation. Rather than separating heritage protection from development planning, the HUL approach encourages coordinated strategies that allow historic cities to accommodate change while safeguarding their cultural significance. This integration helps ensure that new urban interventions—such as infrastructure upgrades, tourism development, or housing initiatives—are compatible with the historical character and spatial structure of the urban landscape (Bandarin, 2006).

Another key component of the HUL framework is the emphasis on participatory governance and stakeholder engagement. Effective heritage management requires the active involvement of multiple stakeholders, including local communities, public authorities, heritage professionals, private sector entities, and civil society organizations. By fostering inclusive decision-making processes, the HUL approach aims to strengthen the social legitimacy of conservation policies and ensure that heritage management reflects the diverse values and priorities of local communities (Wang, Fan, & You, 2025).

The framework also promotes a landscape-based approach to analysis and planning, which involves examining the relationships between cultural heritage assets, natural ecosystems, urban morphology, and socio-economic activities. Through comprehensive mapping and assessment of these interconnected elements, planners and heritage practitioners can gain a deeper understanding of the spatial and functional dynamics that shape historic cities (Barrado-Timón, & Hidalgo-Giralt, 2019). This broader perspective helps identify both the tangible and intangible components of urban heritage, including public spaces, traditional land-use patterns, cultural practices, and environmental features. In addition, the HUL approach highlights the importance of adaptive management strategies that allow historic cities to respond to ongoing social, environmental, and economic transformations. Rather than attempting to prevent change, the framework focuses on managing change in ways that respect historical continuity while supporting sustainable development. Adaptive management tools may include regulatory frameworks, urban design guidelines, heritage impact assessments, and monitoring systems that track the long-term effects of development decisions on historic landscapes. Taken together, these principles encourage urban planners, conservation experts, and policymakers to view historic cities as **dynamic and evolving systems**ratherthan as static collections of monuments or architectural artifacts. This conceptual shift reflects a broader understanding of heritage as a living resource that contributes to urban identity, social cohesion, and economic vitality.

Bandarin and van Oers (2012) further emphasize that the successful implementation of the HUL framework requires **innovative governance models** capable of coordinating multiple policy domains and institutional actors. Because heritage conservation intersects with urban development, environmental management, tourism planning, and community interests, traditional hierarchical governance structures often prove insufficient. Instead, more

collaborative and cross-sectoral governance arrangements are needed to facilitate information exchange, joint decision-making, and integrated planning (Bandarin, & Van Oers, 2012).

Such governance frameworks typically involve partnerships between municipal authorities, heritage agencies, planning departments, academic institutions, and community organizations (Zeayter & Mansour , 2017). By promoting collaboration among these actors, the HUL approach aims to ensure that heritage protection is aligned with broader objectives related to environmental sustainability, social inclusion, and economic development. In this sense, the Historic Urban Landscape framework provides not only a conceptual model for understanding historic cities but also a **practical strategy for managing urban change in culturally sensitive and sustainable ways**.

Ultimately, the HUL approach reflects a growing recognition that the long-term preservation of historic urban environments depends on their ability to remain **vibrant, functional, and socially meaningful places**. By integrating heritage conservation into broader urban planning processes and encouraging participatory governance, the framework offers a pathway for balancing the protection of cultural heritage with the demands of contemporary urban life (Dimelli, 2022).

4. RESEARCH METHODOLOGY

This study employs a qualitative case study methodology to explore the complex and multidimensional relationships between cultural heritage conservation, urban development processes, tourism dynamics, and emerging environmental risks within the historic city of Chania. The selection of a qualitative methodological framework reflects the need to investigate not only the physical characteristics of the historic urban landscape but also the institutional structures, governance mechanisms, and stakeholder perceptions that influence heritage management and urban resilience. Historic cities are shaped by interrelated spatial, social, and political processes, and therefore require research approaches capable of capturing these interactions in a holistic and context-sensitive manner. Case study research has been widely used in urban and heritage studies to analyze complex socio-spatial systems where multiple variables interact and where contextual conditions play a critical role in shaping outcomes. In the context of historic urban landscapes, the case study approach allows for an in-depth investigation of local dynamics, institutional arrangements, and community perspectives, providing insights that might not emerge through purely quantitative methods. The city of Chania was therefore selected as a representative case through which broader issues affecting Mediterranean historic cities—such as tourism pressure, climate vulnerability, and governance fragmentation—can be examined in detail.

To capture the multiple and interrelated dimensions of the historic urban landscape, the research design adopts an integrated methodological framework that combines several complementary approaches. The first component involves a spatial analysis of urban morphology and land-use patterns to examine the physical structure of the urban environment, the distribution of functions within the historic area, and the ways in which spatial transformations have affected the historic fabric over time. The second component focuses on a policy-oriented analysis of existing planning frameworks, regulatory instruments, and governance structures, aiming to understand how institutional arrangements, planning policies, and administrative processes influence heritage protection and urban development in historic districts. The third component consists of qualitative interviews conducted with key stakeholders involved in heritage management and urban development, including public authorities, planning professionals, local experts, and community representatives. Through

these interviews, the study seeks to capture diverse perspectives, practical experiences, and perceptions regarding the challenges and opportunities associated with managing historic urban landscapes in a sustainable and resilient manner. The integration of these methods allows for methodological triangulation, which strengthens the validity of the research by combining different types of data and analytical perspectives. By examining spatial patterns, institutional frameworks, and stakeholder experiences simultaneously, the study develops a comprehensive understanding of how heritage conservation interacts with urban change and resilience planning.

Spatial analysis constitutes a central component of the research methodology, providing insight into the physical structure of Chania's historic center (Fig 1) and the spatial distribution of heritage assets, tourism activities, and urban functions. The analysis focuses on the urban morphology of the Old Town, examining how the historical layers of development—from the Minoan and Byzantine periods to Venetian and Ottoman urban forms shaped contemporary spatial patterns. Mapping techniques were used to identify and visualize several key spatial indicators relevant to the Historic Urban Landscape framework. These include the distribution of heritage assets, such as listed monuments, historic buildings, archaeological sites, and culturally significant public spaces. Understanding the spatial concentration and typology of these assets is essential for assessing the vulnerability of heritage resources and their relationship with surrounding urban activities.

In addition, the spatial analysis examined tourism intensity zones within the historic center. Tourism-related land uses, including hotels, restaurants, retail establishments, and short-term rental accommodations, were mapped to identify areas experiencing the highest levels of visitor pressure. This analysis helped reveal how tourism development has reshaped the functional structure of the historic city, often concentrating on commercial activities around key attractions such as the Venetian harbor and major public squares. Another important dimension of spatial analysis involved the examination of land-use transformations over time. By comparing historical and contemporary land-use patterns, the research traced the gradual conversion of residential buildings into tourism-related functions, as well as the expansion of commercial activities into traditionally residential neighborhoods. These changes have significant implications for the social sustainability of historic districts, as they can lead to declining residential populations and the erosion of local community networks.

Furthermore, the spatial analysis considered the connectivity and accessibility of the historic center in relation to the broader urban area of Chania. The narrow and irregular street network within the fortified Old Town creates challenges for mobility, service delivery, and emergency access, particularly during periods of peak tourism. Mapping these spatial constraints helps identify areas where urban management strategies may need to address infrastructural limitations while respecting the historical integrity of the urban fabric. Overall, the spatial analysis provides a detailed picture of how physical, functional, and environmental pressures intersect within the historic urban landscape, offering valuable insights into the spatial dimensions of urban resilience.

Figure.1 The historic center of Chania

The second methodological component of the research involves a systematic analysis of policy frameworks and governance structures that influence heritage management and urban development in Chania. Heritage conservation does not occur in isolation but is shaped by a complex set of regulatory instruments, planning policies, and institutional arrangements operating at national, regional, and municipal levels. To understand these governance dynamics, a range of policy documents and planning instruments were reviewed. These include the Special Spatial Plan for Chania, municipal development strategies, sustainable urban development plans, tourism management policies, heritage conservation regulations, and climate adaptation initiatives. Together, these documents provide insight into how public authorities conceptualize urban development priorities and how heritage protection is integrated—or sometimes insufficiently integrated—within broader planning agendas. The policy analysis focused on several key aspects. First, it examined the regulatory framework governing historic areas, including building regulations, conservation guidelines, and land-use restrictions applicable to the Old Town. These regulations aim to safeguard the architectural and cultural value of historic buildings but can also create administrative complexities when applied within rapidly evolving urban environments.

The analysis explored the relationship between tourism development policies and heritage conservation objectives. In many Mediterranean cities, tourism is a major driver of economic growth, but it can also generate significant pressures on historic districts. By examining policy documents related to tourism promotion, infrastructure investment, and cultural programming, the research assesses whether current strategies adequately balance economic benefits with the long-term preservation of cultural heritage. The policy review considered the extent to which climate adaptation strategies address the vulnerabilities of historic urban areas. As coastal Mediterranean cities face increasing risks associated with sea-level rise, extreme heat, and water scarcity, it is important that climate resilience measures are incorporated into heritage management frameworks. The analysis therefore evaluated whether local planning policies recognize these environmental risks and provide mechanisms for integrating climate adaptation into conservation practices. Policy analysis also highlights issues of institutional coordination and governance fragmentation. Heritage management responsibilities are often distributed across multiple governmental bodies, including municipal

planning departments, national cultural heritage authorities, and regional development agencies. This institutional complexity can lead to overlapping responsibilities, regulatory inconsistencies, and delays in decision-making. Understanding these governance dynamics is essential for assessing the feasibility of implementing integrated planning approaches such as the Historic Urban Landscape framework.

The third methodological component of the research consists of qualitative data collection through semi-structured interviews with key stakeholders involved in heritage management, urban planning, tourism development, and community representation. Interviews provide valuable insights into how different actors perceive the challenges facing Chania's historic urban landscape and how they interpret the effectiveness of current governance arrangements. Semi-structured interviews were selected as the primary qualitative data collection method because they allow for both consistency across respondents and flexibility to explore emerging themes during the conversation. An interview guide was developed to address several key topics, including perceptions of tourism pressure, challenges in heritage conservation, governance coordination, climate risks, and opportunities for more integrated planning approaches. Participants were selected through purposive sampling, targeting individuals with direct knowledge or professional involvement in urban development and heritage management. The interview sample included urban planners, conservation architects, municipal officials, tourism entrepreneurs, representatives of local cultural organizations, and community leaders. This diversity of perspectives was essential for capturing the multi-actor nature of heritage governance in historic cities. The interviews revealed a range of experiences and viewpoints regarding the management of Chania's historic urban landscape. Municipal officials highlighted the difficulties of balancing economic development objectives with heritage conservation requirements, particularly in the context of strong tourism demand. Heritage professionals emphasized the need for stronger regulatory enforcement and improved coordination between planning and conservation authorities. Tourism stakeholders discussed the economic importance of visitor activity while also acknowledging concerns about overcrowding and infrastructure pressures. Community representatives and residents raised issues related to housing affordability, loss of residential character, and limited opportunities for public participation in planning decisions. These perspectives are particularly important because they reflect the lived experience of urban change and the social consequences of tourism-driven development. Interview data were analyzed thematically, allowing recurring patterns and key concerns to emerge across different stakeholder groups. This qualitative analysis provides a deeper understanding of the institutional, social, and political dimensions of heritage management, complementing the spatial and policy analyses described earlier.

The combination of spatial analysis, policy review, and stakeholder interviews enables a comprehensive examination of Chania's historic urban landscape from multiple analytical perspectives. While spatial analysis reveals the physical patterns of urban change, policy analysis provides insight into the institutional frameworks guiding development, and interviews capture the perceptions and experiences of actors directly involved in these processes.

By integrating these methodological approaches, the research seeks to identify both structural challenges and emerging opportunities for implementing the Historic Urban Landscape approach within the Greek planning context. This multi-method strategy also allows the study to bridge the gap between theoretical frameworks of heritage resilience and the practical realities of urban governance. Ultimately, the methodological design supports the broader objective of the study: to explore how historic urban landscapes can be managed in

ways that simultaneously protect cultural heritage, support sustainable economic development, strengthen community resilience, and address the environmental challenges facing Mediterranean cities.

5. CASE STUDY: THE HISTORIC CITY OF CHANIA

The historic city of Chania, located on the northwestern coast of Crete, is one of the most culturally significant urban centers in Greece and the Mediterranean. With a continuous settlement history spanning several millennia, the city represents a layered historic urban landscape shaped by successive civilizations. These historical influences have contributed to the spatial organization, architectural character, and cultural identity of the city. Chania therefore provides a valuable case study for examining the relationship between heritage conservation, urban development, tourism pressures, and environmental vulnerability in Mediterranean historic cities.

The earliest settlement dates to the Minoan period, when the area functioned as the important city of Kydonia. Archaeological evidence indicates that development was concentrated around Kastelli Hill, a strategic elevated site overlooking the harbor. Although much of the Minoan city remains buried beneath later construction, its archaeological significance continues to influence conservation policies in the historic center. Major transformations occurred during the Venetian period (1204–1645), when the Republic of Venice developed Chania into an important maritime and commercial hub. The Venetian harbor, along with extensive fortifications, arsenals, and public buildings, shaped the compact urban form that still characterizes the Old Town (Fig.2).

Figure 2 Representation of Chania during the Venetian period

Following the Ottoman conquest in 1645, new architectural and cultural elements were introduced, including mosques, hammams, and traditional houses with wooden balconies and courtyards. These additions enriched the city's cultural diversity. During the nineteenth and twentieth centuries, urban expansion, modernization, wartime destruction, and post-war reconstruction further transformed Chania's urban fabric, sometimes introducing architectural forms that did not fully respect the historic character of the city.

These reconstruction processes produced a complex urban landscape in which modern buildings coexist with structures from earlier historical periods. While several restoration

initiatives successfully rehabilitated important monuments and historic neighborhoods, other developments prioritized rapid rebuilding and economic growth. Consequently, the contemporary city presents a diverse architectural environment that reflects both historical continuity and the disruptions of modern urbanization (Dimelli, 2021). From the perspective of heritage management, this layered historical development presents both opportunities and challenges. On the one hand, the coexistence of multiple historical periods within a relatively compact urban area enhances the cultural richness and tourism appeal of Chania's historic center. Visitors encounter a diverse urban landscape where different historical narratives are expressed through architecture, public spaces, and urban morphology (Doxiadis Associates, Roikos, Lionis, & Pavlaki, 2017). On the other hand, the presence of multiple historical layers complicates conservation strategies and planning decisions. Efforts to preserve architectural elements from one period must consider the significance of later additions and transformations, which may themselves hold cultural value. Heritage management therefore requires careful evaluation of how different historical layers interact within the broader urban landscape (Petrou, 2017).

At the same time, the historic city of Chania faces increasing pressures related to tourism growth, infrastructure demands, and environmental change. Tourism development has intensified economic activity in the Old Town, particularly around the Venetian harbor, leading to the proliferation of hospitality services, commercial establishments, and short-term accommodation rentals. While tourism contributes significantly to the local economy, it also places considerable strain on historic buildings, public spaces, and municipal infrastructure (Dimelli, 2022)

These challenges highlight the importance of adopting integrated planning frameworks, such as the Historic Urban Landscape (HUL) approach, which seek to balance heritage conservation with sustainable urban development (UNESCO, 2011) By conceptualizing historic cities as dynamic socio-spatial systems shaped by cultural, environmental, and economic processes, the HUL framework offers a valuable tool for managing urban change while preserving the historical identity of places like Chania (Bandarin, & Van Oers, 2012). In this context, the historic city of Chania provides an insightful case for exploring how Mediterranean historic cities can respond to contemporary pressures while safeguarding their cultural landscapes for future generations.

6. RESULTS

The analysis of spatial data, policy documents, and stakeholder interviews revealed several critical issues influencing the management and resilience of Chania's historic urban landscape. The findings highlight four key thematic areas: institutional fragmentation in governance structures, tourism-driven transformations of land use, increasing climate-related vulnerabilities, and the emergence of innovative practices that integrate sustainability with heritage conservation. These findings illustrate the complex interactions between governance systems, socio-economic dynamics, and environmental pressures that shape the future of historic Mediterranean cities.

One of the most significant findings concerns the fragmented governance framework responsible for heritage conservation and urban planning in Chania. The research revealed that several administrative bodies are involved in decision-making processes related to heritage protection, spatial planning, tourism management, and environmental policy. These institutions often operate within separate regulatory frameworks and institutional mandates, resulting in limited coordination and inconsistent implementation of planning policies.

In Greece, cultural heritage protection is largely administered by the Ministry of Culture and Sports, while urban planning and development policies fall under municipal and regional authorities. Tourism development is influenced by both national tourism strategies and local economic development initiatives, while environmental and climate policies are governed through separate administrative channels. Although each of these policy domains plays a critical role in shaping the urban landscape, their lack of coordination often complicates efforts to develop integrated strategies for managing historic urban areas. Stakeholder interviews confirmed that this fragmentation frequently leads to bureaucratic delays, overlapping regulations, and difficulties in implementing coordinated planning interventions within the historic center. Projects involving the restoration or adaptive reuse of historic buildings often require approvals from multiple authorities, including planning departments, heritage agencies, and environmental regulators. This multi-layered approval process can significantly slow down urban regeneration initiatives and discourage investment in heritage rehabilitation.

These findings are consistent with broader international research suggesting that effective heritage management requires integrated governance structures capable of bridging institutional boundaries (Bandarin, & Van Oers, 2012). The Historic Urban Landscape (HUL) approach emphasizes the need for collaborative governance frameworks that align cultural heritage policies with urban planning, environmental management, and socio-economic development strategies (UNESCO, 2011). In the case of Chania, however, the absence of strong cross-sectoral coordination mechanisms remains a significant barrier to the implementation of such integrated planning models.

The second major finding relates to the significant impact of tourism development on land-use patterns and socio-economic dynamics within Chania's historic center. Tourism has become a central component of the local economy, attracting large numbers of visitors to the Venetian harbor and surrounding historic districts. While this activity generates substantial economic benefits for local businesses and municipal revenues, it has also led to considerable spatial and social transformations. Spatial analysis indicates that tourism-related activities are highly concentrated within the Old Town, particularly around the Venetian harbor and major cultural landmarks. Over time, many traditional residential buildings have been converted into short-term rental accommodations, boutique hotels, restaurants, and commercial establishments serving the tourism sector. This process has significantly altered the functional structure of the historic center. One of the most notable consequences of this transformation is the decline in long-term residential populations within the historic neighborhoods. Interviews with local residents and community representatives revealed concerns regarding rising housing costs and the increasing scarcity of affordable housing options. As property owners prioritize tourism-oriented uses that generate higher economic returns, many long-term residents are gradually relocating to other areas of the city.

These dynamics reflect broader processes of tourism-driven gentrification observed in many historic cities worldwide, where the rapid expansion of visitor economies can disrupt traditional community structures and weaken social cohesion. In addition to demographic changes, tourism growth also places pressure on urban infrastructure and public spaces. During peak tourist seasons, the narrow streets and limited public squares of Chania's Old Town experience high levels of congestion, while municipal services such as waste management, water supply, and transportation systems face increased demand. The findings therefore highlight the need for balanced tourism management policies that safeguard the economic benefits of visitor activity while protecting the social sustainability and residential character of historic urban areas.

A third key finding concerns the growing exposure of Chania's historic urban landscape to climate-related risks. As a coastal Mediterranean city, Chania is particularly vulnerable to environmental changes associated with global climate change. The research identified several major risks, including coastal flooding, extreme heat events, and seasonal water shortages, all of which have implications for both cultural heritage preservation and urban resilience. The historic harbor area is particularly vulnerable to coastal flooding and sea-level rise, which may threaten historic waterfront buildings, public infrastructure, and tourism-related facilities. Increasing storm intensity and wave action (Fig 3) may accelerate the deterioration of coastal structures and historic fortifications.

Figure 3 The harbor during winter

Extreme heat events also represent an emerging challenge for the historic center. Dense building patterns, limited vegetation, and narrow streets contribute to the urban heat island effect, intensifying heat exposure during summer months. Such conditions not only affect residents' health and comfort but may also influence visitor experiences and tourism patterns. Water scarcity during peak tourism seasons constitutes another significant environmental concern. Increased water demand associated with visitor activity places pressure on municipal water supply systems and surrounding ecosystems. Similar challenges have been documented across Mediterranean island regions where tourism demand and climate variability intersect (Postma, Papp , & Koens, 2018)

Despite these emerging risks, the policy analysis revealed that climate adaptation strategies remain only partially integrated into heritage conservation planning. International research increasingly emphasizes the importance of incorporating climate resilience into heritage management frameworks to protect historic urban landscapes from future environmental shocks (Dimelli, 2021). The findings from Chania suggest that further efforts are needed to maintain climate considerations within local planning and conservation practices.

Despite the structural challenges identified above, the research also identified several promising initiatives that demonstrate opportunities for more sustainable and integrated heritage management practices. These initiatives suggest that incremental progress is being made toward aligning urban development with the principles of the Historic Urban Landscape framework.

One particularly positive development is the increasing adoption of adaptive reuse strategies for historic buildings. Rather than demolishing or abandoning aging structures, several projects in Chania have successfully rehabilitated historic properties while introducing new functions compatible with contemporary urban needs. In many cases, these projects incorporate energy-efficient technologies, improved building insulation, and sustainable materials, demonstrating that heritage conservation can be combined with environmental sustainability goals.

Adaptive reuse is widely recognized as a key strategy for sustainable heritage management, as it extends the life cycle of existing buildings while reducing the environmental impacts associated with new construction. Additional positive initiatives include community-oriented cultural programs and local heritage events, which help strengthen residents' engagement with the historic urban landscape. Such activities encourage a broader understanding of heritage as a living cultural resource rather than simply a tourism commodity.

Furthermore, stakeholder interviews indicated that municipal awareness of climate-related risks to heritage is gradually increasing, creating opportunities for future policy innovation. Although comprehensive climate adaptation strategies have not yet been fully implemented, discussions surrounding sustainable urban development and heritage resilience are becoming more prominent within local planning debates. Overall, these emerging practices suggest that while Chania faces significant governance, environmental, and socio-economic challenges, there is also growing recognition of the need for integrated and sustainable approaches to managing historic urban landscapes.

7. DISCUSSION

The findings of this study underscore the necessity of conceptualizing historic cities as socio-ecological-technical systems, wherein architectural heritage, environmental dynamics, infrastructural networks, and social structures are deeply intertwined. This perspective aligns with contemporary scholarship emphasizing the multilayered nature of urban heritage, where interventions in one domain often produce cascading effects across others (Bandarin, 2006), (Muminović, Radosavljević, & Beganović, 2020).

Chania exemplifies the ways in which historic urban landscapes are subject to cumulative pressures arising from tourism, climate change, and socio-economic transformation. The spatial concentration of tourism in the Old Town, combined with a fragmented governance system, illustrates how economic incentives can inadvertently undermine the social cohesion and cultural integrity of historic neighborhoods (UNESCO, 2016) . Similarly, climate-related risks, including coastal flooding, heatwaves, and water scarcity, present emergent challenges that traditional conservation approaches are ill-equipped to manage (Meerow, Newell, & Stults, 2016)

The Historic Urban Landscape (HUL) framework offers a conceptual and operational pathway for reconciling heritage conservation with contemporary urban challenges (UNESCO, 2016)). By shifting the focus from isolated monuments to interconnected urban systems, HUL encourages holistic strategies that integrate cultural, environmental, social, and economic considerations. In Chania, the incremental application of HUL principles—through adaptive reuse projects, community-based cultural programming, and initial climate risk assessments—demonstrates the potential for heritage-led urban resilience (Bandarin, & Van Oers, 2012).

Nevertheless, successful implementation of the HUL approach is contingent on institutional reforms and cross-sectoral collaboration. Fragmented governance, bureaucratic

silos, and limited participatory mechanisms hinder the ability of local authorities to coordinate heritage, planning, and environmental objectives effectively. These challenges echo findings from other Mediterranean contexts, where municipal capacities, regulatory overlaps, and stakeholder engagement deficits limit integrated heritage management Addressing these gaps requires the establishment of coordinated governance platforms that bring together planners, heritage authorities, environmental engineers, and community representatives. Such arrangements facilitate adaptive decision-making, ensure policy coherence, and enable urban interventions that respect both historic integrity and contemporary needs. (Diekmann & Gillot, 2010)

The study also highlights the critical role of community participation in supporting sustainable heritage outcomes. Resident engagement enhances social legitimacy, strengthens local stewardship of heritage resources, and mitigates adverse social effects of tourism and gentrification (UNESCO, 2008) . Participatory approaches, including community heritage councils, participatory mapping, and structured consultation mechanisms—have proven effective in fostering inclusive heritage governance in other European historic cities (Harrison, 2013; Aubert et al., 2019). In Chania, such mechanisms remain underdeveloped, but the emerging interest in cultural programming and localized heritage initiatives points toward a gradual shift toward more socially integrated urban management.

Finally, integrating climate adaptation strategies into heritage planning is essential for long-term urban resilience. The case study demonstrates that conservation efforts alone are insufficient to safeguard historic urban landscapes under increasing environmental pressures. Adaptation measures—including flood risk assessments, resilient infrastructure, heat-mitigating urban design, and sustainable water management—can complement heritage preservation, ensuring both the protection of cultural assets and the continued functionality of urban systems (Dimelli, 2021).

In summary, the Chania case illustrates that effective historic urban landscape management requires a multi-dimensional approach. Heritage, environment, socio-economic dynamics, and governance must be considered as part of an interconnected system, with interventions designed to balance conservation, development, and resilience objectives. This integrated perspective provides a model for Mediterranean cities facing similar pressures and highlights the broader applicability of HUL principles in contemporary urban planning.

Historic urban landscapes across the Mediterranean are increasingly exposed to intersecting pressures from climate change, tourism growth, and socio-economic transformation. The case of Chania illustrates that these pressures cannot be addressed through traditional, sectoral approaches to heritage conservation alone. Instead, integrated planning frameworks, particularly the Historic Urban Landscape (HUL) approach, provide a pathway toward more resilient, sustainable, and socially inclusive urban management.

Understanding historic cities as complex socio-ecological-technical systems is essential for effective urban heritage management. In such systems, heritage assets, infrastructure networks, social structures, and environmental processes interact dynamically, producing both opportunities and vulnerabilities (Bandarin, & Van Oers, 2012) . This perspective enables planners and policymakers to anticipate the cascading effects of urban interventions, from tourism-driven property conversions and public space commercialization to climate-induced flooding and heat events, ensuring that strategies are responsive to both immediate pressures and long-term urban dynamics.

Governance and institutional coordination are fundamental to the successful implementation of HUL principles. In Chania, fragmented responsibilities among heritage authorities, municipal planning departments, tourism regulators, and environmental agencies

have historically limited the potential for integrated action. Establishing cross-sectoral collaboration, participatory governance mechanisms, and clearly defined institutional roles is necessary to facilitate information sharing, joint decision-making, and adaptive management. These arrangements allow heritage policies to be aligned with broader urban planning and environmental objectives, enhancing the resilience of historic urban systems.

Tourism presents both opportunities and challenges for historic urban areas. While tourism contributes significantly to local economic activity, it also imposes spatial and social pressures, including the conversion of residential properties into short-term rentals, the displacement of long-term residents, and the commercialization of public and cultural spaces. Sustainable management of tourism requires policies that balance economic benefits with community needs, protect social cohesion, and ensure equitable distribution of resources, thereby preventing the erosion of neighborhood identity and social networks (Diekmann & Gillot, 2010)

Climate adaptation represents a critical dimension of heritage management in Mediterranean cities. Historic districts are increasingly vulnerable to coastal flooding, extreme heat events, and water scarcity, particularly during peak tourism seasons. Integrating climate risk assessments into conservation planning, implementing resilient infrastructure designs, and adopting nature-based solutions can safeguard both built heritage and urban functionality. Measures such as heat-mitigating urban materials, water-saving interventions, and retrofitted energy systems can protect historic assets while enhancing the resilience of urban communities (Dimelli, 2021)

Adaptive reuse and community engagement offer additional pathways toward sustainable heritage management. Retrofitting historic buildings with energy-efficient technologies, water-saving systems, and environmentally responsible infrastructure preserves architectural authenticity while accommodating contemporary urban needs. Complementing these physical interventions with participatory initiatives—such as community heritage councils, neighborhood workshops, and participatory mapping—fosters local stewardship and ensures that heritage management reflects the knowledge, priorities, and values of residents.

The Chania case study demonstrates that heritage conservation, urban development, and environmental sustainability are mutually reinforcing when guided by an integrated, system-level approach. Historic cities can adapt to contemporary socio-economic, environmental, and tourism pressures while maintaining cultural identity and social cohesion. The HUL framework offers practical tools for achieving this integration, emphasizing the interconnectedness of heritage assets, urban systems, governance, and community dynamics.

Ultimately, the lessons from Chania suggest that Mediterranean historic cities can enhance resilience and sustainability through coordinated governance, meaningful participatory processes, and adaptive, system-oriented planning. By aligning heritage preservation with climate adaptation, socio-economic development, and sustainable tourism strategies, cities can navigate the complex challenges of the twenty-first century while safeguarding the cultural and social fabric that defines their unique urban landscapes.

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OVERTOURISM AND BEYOND: TOURISM AND SUSTAINABILITY IN CITIES AND TERRITORIES

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Abstract
Tourism has undoubtedly contributed significantly to the development of many territories over the last century. In recent decades, world tourism has grown at an accelerating rate, which has had considerable impacts on the economy, society and the environment of the expanding tourist areas of cities and territories.

The increase in tourist flows (more pronounced during the last two years, that followed the covid period), created pressures that exceed any "capacity limits" of the destination areas. This has been explained in terms of city «overtourism» - characteristically intense in Venice but also in several urban zones / mainly historical (including Athens) and coastal or islandic territories of Europe.

More severe tensions due to overtourism in territories -expressed through the impressive rise of the Airbnb sector- concern housing; in particular, increase in rents for natives. Other important tensions include infrastructure (transportation, parking, health facilities) and changes in land use - at the expense of green spaces and areas with traditional building ensembles. These particularly strong pressures in many territories caused strong protests from the residents, who asked for the drastic reduction of the factors that lead to overtourism in order to protect the environment and their quality of life.

All this requires a new approach for tourism and territories, aligned with the respective UN Sustainable Development Goals (SDGs). Relevant policies should include objectives and measures to address the housing problem, protect and promote cultural heritage and regulate infrastructures and land uses.

However, this is not enough. It is necessary to integrate strategic priorities for the actual new model of territorial division of tourism into overall strategic territorial planning at all spatial levels, promoting economic, social and environmental sustainability.

The paper outlines proposals for a new, holistic, sustainability-oriented tourism model as well as more specific proposals for the tourist zones of Athens.

Key words: *Overtourism, sustainable development, cities, territories, Athens, European Union*

1. INTRODUCTION: ACTUAL TOURISM AS A GROWING CHALLENGE FOR CITIES AND TERRITORIES

Tourism changes worldwide and hypertourism

In recent decades, global tourism has expanded at an unprecedented rate, reshaping local economies, societies, and environments These impacts were more significant for the most: (a) in the **very touristic zones of cities** and even more pronounced in the historic zones of several cities (b) in some **highly touristic coastal zones**.

In last years, the increase in tourist flows has been clearly more pronounced, especially during the last two years, since tourist movements that had been suspended during the period of restrictions due to covid-19 were added. The **tourism intensity** -measured by nights spent in tourist accommodation establishments per inhabitant-, reached the level of 2019 in 2024, both in European Union and in Greece - **Figure 1**. See, among others, in (Eurostat 2024).

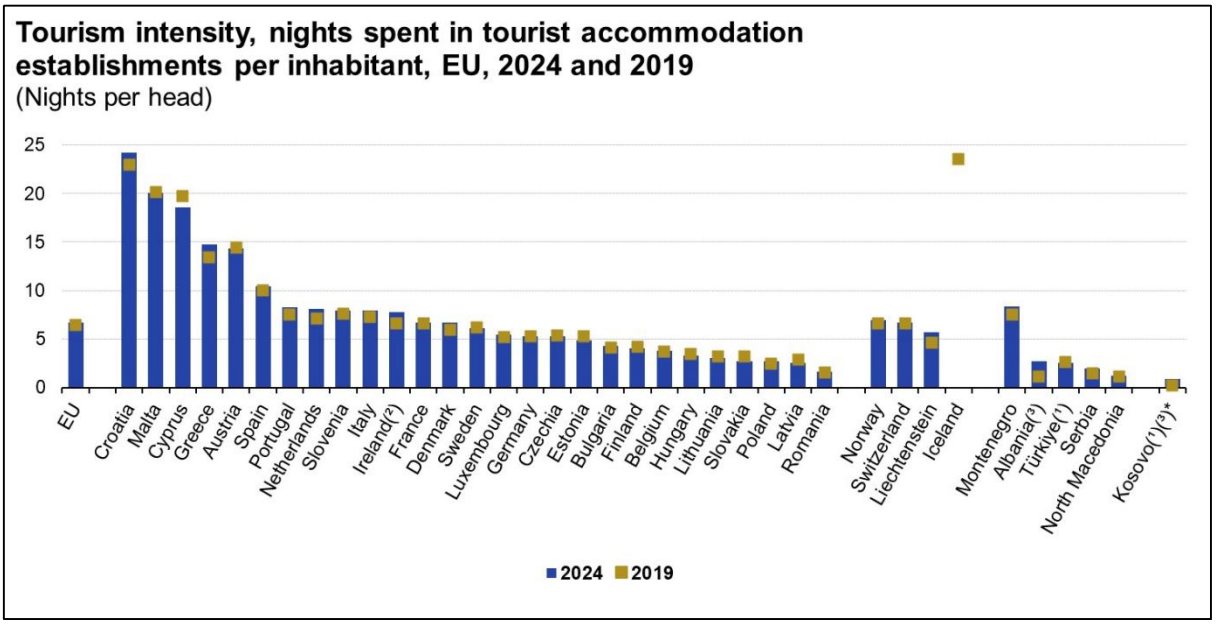


Figure 1: Tourism intensity: nights spent in tourist accommodation establishments per inhabitant, EU, 2024 and 2019. Source: (Eurostat 2024)

The intense pressures contributed to overcoming **any "capacity limits" of the destinations**. This has been explained in terms of **«overtourism»** -overtourism or hypertourism in English, surtourisme in French. See, indicatively, the following publication on overtourism: (Pechlaner – Innerhofer – Philipp (Eds.) 2024), (lázquez-Salom - Cladera - Sard 2023), (Nádasi - Kovács -Szőllős-Tóth 2024), (Mihalič 2024).

The first international "**Overtourism Index"**, which analyses 70 of the world's most popular holiday destinations, seeks to assess their level of exposure to visitors" (Money-tourism 2024). The index was created by management consultancy Roland Berger, based on the travel platform Evaneos. See also: (Fes 2024) and (Roland Berger and Evaneos 2024).

To measure the degree of exposure to overtourism, each destination is scored from 1 to 5 based on four **objective criteria: the number of international tourists per inhabitant, the number of international tourists per square kilometre, seasonality and the maturity of the host country in terms of sustainability.** This last criterion of evaluation considers factors such as "the social impact of the tourist activity, the state of the host infrastructure or the development of transport" (Money-tourism 2024).

We mention here that in a recent publication - see (Angelidis 2025)-, we examined the characteristics of overtourism and its impact on the historic area of Athens. In the present publication, we start with a brief investigation of overtourism, but the main body of the discussion is the overall territorial change of tourism, the consequent negative effects from the point of view of sustainability and the discussion and evaluation of the proposals to address the problem in terms of economic, social and environmental sustainability.

Overtourism is characteristically intense in **Venice.** In 2021, the Italian coastal region of Venice had the highest number of overnight stays in tourist accommodation (27.1 million). **S**ee in more extent in (Angelidis 2025).

In particular, the use of the term "overtourism" raises the questions of:

(a) whether there are "upper limits" to the development of tourism in a given area or

(b) whether there is some form of «**capacity» or «carrying capacity»** to the development of tourism in the area - in general and in particular in developed tourist areas (urban, coastal etc.) that interest us here (see, indicatively, for tourism carrying capacity in (Coccossis 2022)).

In our opinion, despite that several analyses of "overtourism", as exceeding the "tourist capacity" of destinations, have been made a few decades ago, we should now have a largely new discussion.

Anti-hypertourism protests

A *wave of anti-tourism protests* has hit Europe as residents in popular destinations push back against the overwhelming influx of visitors, with *demonstrations flaring, among other, in the Netherlands, Greece, Italy, Portugal, and notably Spain.*

Only last year, **citizens in Barcelona made global headline news when they started soaking unsuspecting visitors with water guns while chanting "tourists go home."** This growing rebellion against overtourism is taking root in other communities around the world,

Similar issues plague other popular destinations like Lisbon, Athens, Las Palmas, and Ibiza. These territories, while benefiting from tourism revenue, are increasingly concerned about losing their working-class residents, local grocery stores, and cultural identity.

2. METHODOLOGICAL CHOICES: A HOLISTIC APPROACH TO THE ACTUAL TOURISM CHANGES AND POLICY DILEMMAS

At that time -as we will explain in more detail below-, the relevant analyses were not narrowly focused on tourist demand as an explanatory factor of «overtourism», as is largely the case today. On the contrary, the explanation of "overtourism" seemed to be related to multi-sectoral, multi-level, **holistic analyses of the impact of tourism development on host zones** (in coastal areas, in urban zones, in entire cities and regions, in entire countries) - see in detail, among others, in Angelidis 1994, Angelidis 2000, Angelidis - Economou 2008.

While in the past a type of «hypertourism» appeared mainly in coastal and island zones, for a few years now, **we also have «hypertourism» in some touristic zones (mostly historical) of cities or even entire cities**. **In some coastal zones or entire islands,** we have now more "hypertourism" -see **Photo 1** for the case of Santorini (ekathimerini 2021).

Our **basic hypothesis**, however, is that to be able to analyze today this *new model of tourism, related to hypertourism* (meaning tourism that excessively pressures specific areas), with the sustainable development of territories, it is necessary to examine *holistically* the sustainability of this development.

We clarify, in addition, that overtourism is not only associated with an "excessive" number of tourists in relation to the population (per inhabitant, etc.) and the society of the host

areas as well as their natural resources, infrastructure and cultural heritage, but *also brings about a set of negative consequences on the local and regional economy, society and environment.*

At a first level, this intensification of tourism uses, **increasing the pressures on the natural and cultural resources of several areas, leads to the degradation of their quality, which, however, constitutes the main basis for the development of tourism activity.**

We clarify that the above is not related to views that support, usually generally, vaguely and "voluntary", the restriction of tourism activities.

Therefore, both for the maintenance of satisfactory environmental quality in «congested» areas of Greek territories and for their further tourist development, the implementation of appropriate forms of their planning is required - in particular, effective ways of implementing specific territorial policies.

Photo 1: Overtourism in Santorini 2021. Photo: e-kathimerini

In line with the above, we have prioritized the determination of the ***drivers of change*** the territorial tourist model and the corresponding weaknesses, so that we can then propose a "reverse model" of really sustainable tourism development of territories.

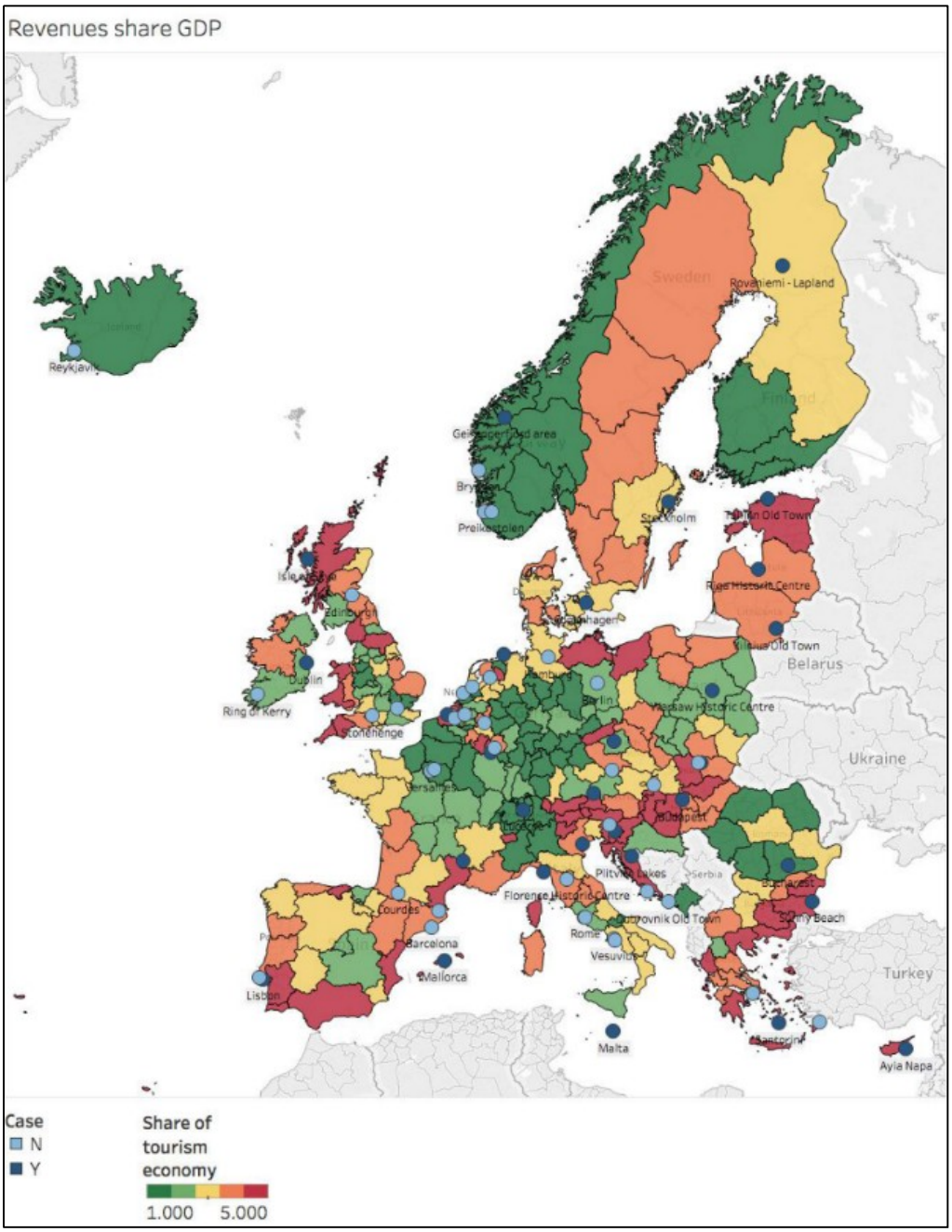
3. HYPERTOURISM AND TOURISM TERRITORIAL DIVISION IN EU, GREECE AND ATHENS

In European Union

In general, overall tourism development and the more specific model of «hypertourism» constitute a major challenge for several countries of the EU -including Greece- for many reasons, the first of which is that *these countries derive a very large part of their GDP from*

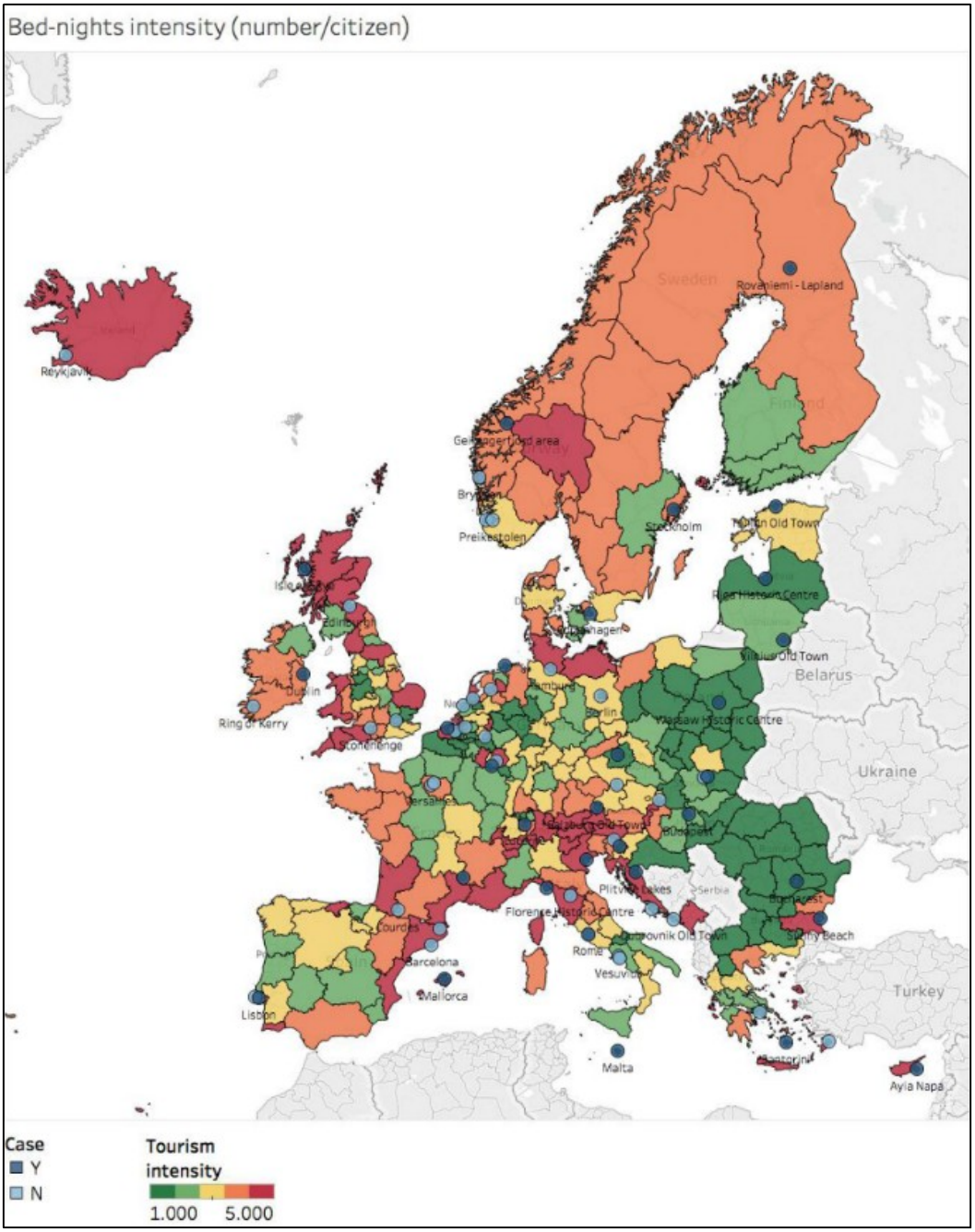
tourism activities -see (Peeters et al 2018) (European Parliament), especially the **Map 1** – Revenues share GDP (share of tourism economy).

As it turns out, the countries of the Southern part of the European Union, as well as several countries of the Eastern part, have a high rate of participation of tourism in the total GDP of their economy. Most regions of Greece show increased values of this index.



Map 1: Revenues share GDP (share of tourism economy). Source of the Map: Peeters et al 2018

A significant spatial differentiation in terms of the intensity of tourism (beds – overnight stays per inhabitant) and region arises in EU but also inside Greece - see **Map 2**.



Map 2: Intensity of tourism by region (beds - overnight stays per inhabitant)
Source of the Map: Peeters et al 2018

In Greece

In general, overall tourism development and even more «hypertourism» constitute a major challenge for Greece – for many reasons, the first of which is that the country derives a very large part of its GDP -25 to 30 percent- from tourism activities (with this number increasing to 90 percent on the island of Santorini) (Norman 2024). Specifically, regarding GDP, as an important indicator of the economic aspect of tourism development: according to a study by the National Bank of Greece (NBG), Greek tourism was projected to have revenues of 22 billion euros in 2024 -see in (TornosNews.gr 2024). See for the Greek tourist development

and policy, among others, in (Tsartas – Sarantakou 2022), (Sarantakou 2025) (Economou – Mitoula 2017), Lagarias – Stratigea - Theodora, Y. (2023).

The increased GDP is associated with an increased number of arrivals and overnight stays in the country. The number of visitors to Greece has increased particularly sharply: by 120% between 2019 and 2023. In 2023, approximately 33 million tourists came to Greece, while it was expected to reach 35 million in 2024 (record of arrivals).

The ratio of the number of tourists to the natives / residents of the country -as an indicator of the deterioration of the population's life conditions and the «excessive» change of the socio-historical physiognomy of the territory- reached 3 to 1 in Greece (3 tourists per inhabitant).

Greece is among the four countries most affected by overtourism. The remaining three are Cyprus, Mauritius and Croatia.

Furthermore, destinations that experience particularly high flows during the summer in a large part of their territory include Spain, Italy, Portugal and France.

It is of great importance that it has been documented that Greece has a very high value of the (above-mentioned) overtourism index compared to other countries. Consequently, an appropriate strategy should be formulated in Greece and measures should be taken to limit overtourism.

We point out here that in Greece there is an overconcentration of tourism in a few areas: Attica, Crete, Dodecanese, Corfu, Cyclades, etc. (Angelidis 2000). See **Map 3** for the number of overnight stays per thousand inhabitants in the regional units of Greece in 2020 (author of the map: M. Angelidis).

In more detail, the spatial concentration corresponding to the value of the above index is much higher *in certain small zones*, such as in particular in certain coastal areas but also in areas of historical centers. Conversely, however, the value of the index is currently well below the "capacity limit" in many "inland" areas (far from the coasts and historical cities), often very attractive for tourism development.

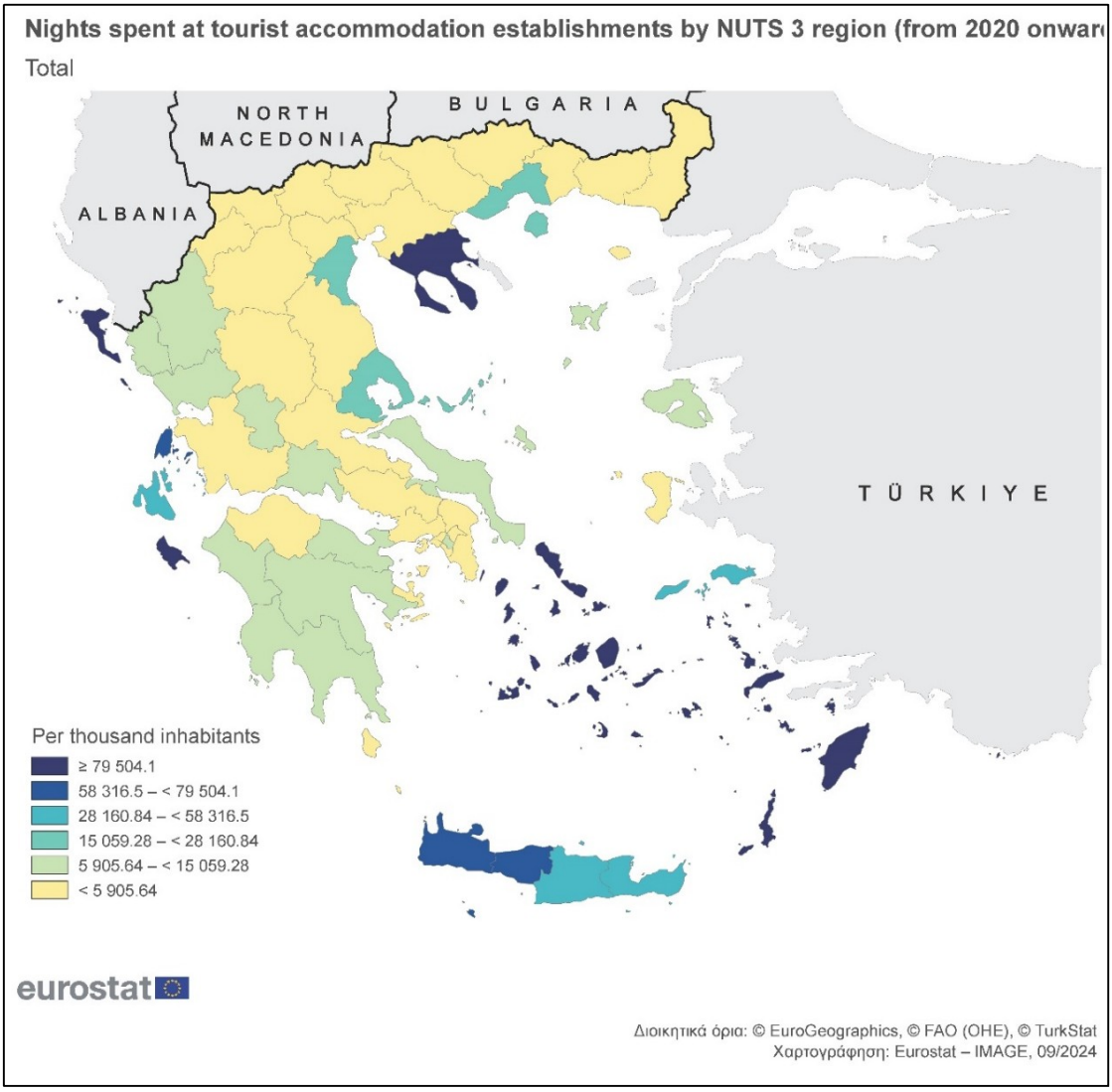
In the tourist areas of many *Greek historical centers*, similar to what happened in the world (see above), the phenomena of "overtourism" that had appeared in a comparatively slighter form before the covid period, intensified very significantly in 2023 and 2024, largely due to the pressure relief for tourist travel after the end of the covid restrictions period.

More specific pressures and tensions due to overtourism in 2024 in general in Greece and in particular in territories concern:

- *Infrastructure (transportation, parking, health services ...),*
- *Housing* - in particular: increase in rents for natives due to excessive expansion of the Airbnb sector (See, among others, in: Balabanidis D., Papatzani E., Pepas D. 2021)
- *Several more specific environmental and quality of life issues. The latter includes to a certain extent the change in land use* - at the expense of green and natural spaces as well as areas with traditional buildings.

For several decades in Greece, the greatest pressure has been exerted on the thin, but of great environmental importance, zone between the land area and the sea, which constitutes the extreme part of the wider coastal zones towards the sea.

In recent years, the very intense expansion of Airbnb accommodation in urban areas, especially in historical zones of the cities, has created *a great deal of pressure on the environment of historical zones* - beyond its contribution to the extreme increase in rents in these areas.



Map 3: Overnight stays per thousand inhabitants in the regional units of Greece in 2020.
Data source: Eurostat Processing: Minas Angelidis, using appropriate Eurostat tools

In Athens

Tourism developed comparatively earlier (as early as the 1950s) in Athens than in other regions of Greece due to the existence of globally significant historical zones in the Capital.

Subsequently, the "front" of intense tourist development shifted towards the coastal zones and the islands of Greece, while in the last decade (and a little before) the arrival of tourists to Athens increased significantly. Despite any (relatively limited) decentralization of tourist development at the levels of the Attica Basin and the Attica Region, the main part of the tourist demand is directed to some, well-known to foreigners but relatively small areas of ancient cultural heritage as well as heritage of more recent times - indicatively: Plaka, Monastiraki, Thisio, Keramikos. These zones were expanded with the implementation of some infrastructures - e.g. the "archaeological walk of Athens", but not on a large scale, nor is it easy to quickly expand on a large scale.

Therefore**,** *the impressive increase in the number of tourists -with the "adding" of many Airbnb accommodations*- led to "overtourism" in several places. Of course, as is the case in

historical cities abroad, at emblematic spots such as the Acropolis, the numbers of visitors "reached the ceiling", as we will see later.

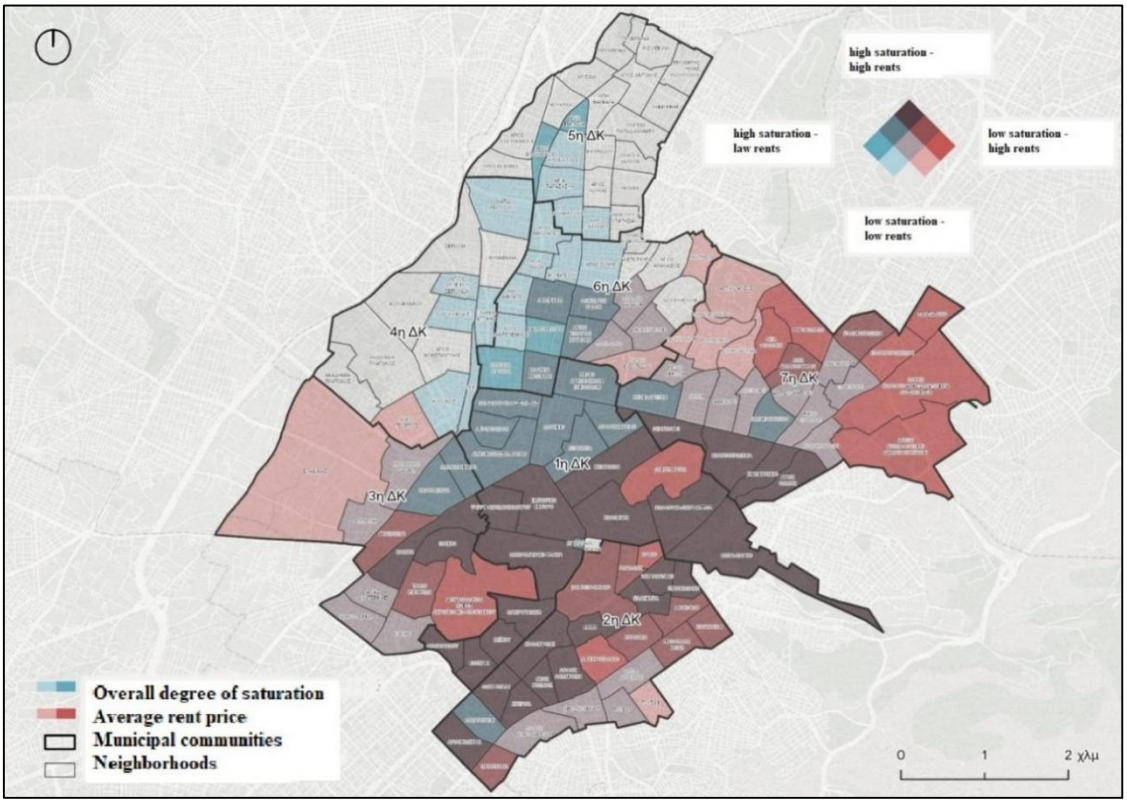
We refer here to a relevant article in the magazine "reporter" in 2024 (Norman 2024): "The authorities in Athens have already expressed concerns about this … exponential increase in tourist numbers, as the crowds have become uncontrollable. In order to stop the attack and bring some control to Athens, last year the maximum number of tourists who could visit the Acropolis was set at 20,000 per day."

Athens Mayor Haris Doukas told Fortune magazine a few months ago (on 2024): "…The challenge of too many visitors and the impact it has on local communities and the city itself means that **tourism in its current form is not sustainable**." "Every visitor brings €0.40 to the city, and we haven't seen that money yet," the mayor told Euronews. "We need to find a way to make tourism sustainable."

The municipality of Athens then commissioned the preparation of the study **«Athens Tourism Carrying Capacity Study"** (Develop Athens S.A., University of Piraeus, and Gimisis + Associates 2024) which has been completed.

The study shows that Athens, although "not characterized as a city with overtourism" op. cit.), but has a "tourist fragility" and a sensitivity to the pressure of its infrastructure from rising tourism in recent years.

The study identifies spatial over-concentrations in specific saturated neighbourhoods of the city centre (shopping centre, Monastiraki-Plaka, Psyrri-Koumoundourou, Makrigianni - more or less the ones we mentioned above), which observes significant pressures by permanent residents and visitors/tourists, as well as energy and waste (which culminate in saturated areas). - see **Map 4**.



Map 4: Area of the Municipality of Athens: Correlation of the degree of saturation of short-term lease with long-term lease
Source of the Map: Develop Athens etc., Athens Tourism Carrying Capacity Study, 2024

However, tourism trends - pressures in the more peripheral areas appear (medium and low saturation - Durgouti, Fokionos Negri, Kato Patisia, Agios Nikolaos, Ampelokipoi), with corresponding significant impacts on the standard of living and the market.

According to the study: "The increase in rents is the most significant negative impact although residents acknowledge that it is not just tourism" (op.cit.).

4. TOURISM AND TERRITORIES IN THE UN (AND EU) SUSTAINABLE DEVELOPMENT GOALS (SDGS)

Let's move on to a **second approach** to the relationship between tourism and sustainable development of territories: how this relationship is analyzed and evaluated within the framework of the sustainable development strategy in general and the UN's set of Sustainable Development Goals (SDGs) in particular (see for the sustainable development of territories, among others, in: (Angelidis M., Drakouli E., Tsigkas E. 2024)).

We need to emphasize from the beginning that while the UN SDGs are very useful both for assessing the "degree" of sustainable development of tourist territories and for formulating intervention policies in the direction of sustainable development, *they are often characterized by fragmentation and lack of interconnection with strategic priorities of sustainable development.*

In other words, the "literal" use of the SDGs, as well as corresponding indicators, may, for example, **present** an area with low-level tourism growth and employment and dependent on other areas as an area that grows quickly and satisfactorily.

Regarding the **UN SDGs**, we will start with the SDGs that are most closely linked to tourism and territories and then delve deeper into Goal 8.9 - Promote healthy and sustainable tourism and 12.B - Tools for monitoring the impact of sustainable development on sustainable tourism.

SDGs related to tourism

Tourism-related goals have been included in the SDGs:

- *Goal 8 - sustainable and inclusive economic growth*
- *Goal 12 - sustainable consumption and production (SCP) and*
- *Goal 14 - sustainable use of oceans and marine resources*, respectively.

We considered it appropriate to deal more here with the proposals for tourism in Goals 8 and 12 (without underestimating those related to Goal 14) (UN / Department of Economic and Social Affairs 2024).

It is useful to mention here that the *World Tourism Organization* (WHO) defines sustainable tourism as "***tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities***" (UN / Department of Economic and Social Affairs 2024).

We point out that this definition is to a significant extent *global (holistic)* because it refers to *the economic, social and environmental impacts of tourism all together.*

Finally, the set of SDGs for tourism are strongly related to SDG 11 - sustainable cities and communities (see discussion of this SDG, among others, in: Stefanou I. - Mitoula R. 2024).

Goal 8.9 - Promote beneficial and sustainable tourism
The UN "2030 Agenda for Sustainable Development" *includes target 8.9: Promote Beneficial and Sustainable Tourism.* Specifically, SDG *8.9 aims to "by 2030, design and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products*"**.** It is noted that ICCROM has developed a series of indicators that are linked to the achievement of target 8.9 - see ICCROM 2019.

SDG 12.b on tools for monitoring the impact of sustainable development on sustainable tourism
The importance of sustainable tourism is also highlighted in SDG *12.b*, which aims to develop and use tools to monitor the impact of sustainable development on sustainable tourism, which *creates jobs and promotes local culture and products.* It is interesting that an appropriate (according to those responsible for the SDGs) evaluation *indicator 12.b.1* has already been created by the UN experts: "Implementation of standardized accounting tools to monitor the economic and environmental aspects of tourism sustainability".

The SDGs of EU policies and the UN SDGs - Comparison and notes on SDG implementation
As stated in the relevant documents, the SDGs of EU policies and the UN SDGs on tourism, and territories are almost identical. The EU has adopted the UN SDGs in their entirety. It has only specialized certain sub-chapters of the Goals.

With this in mind, reports are also being made on the implementation of the SDGs in Member States - including Greece.

But beyond the gaps and ambiguities contained in the SDGs and indicators assessing their implementation, the fact that **their implementation is not mandatory** significantly limits their contribution to a sustainable development path for territories - which are of particular interest to us here.

5. EU POLICIES FOR TOURISM, SUSTAINABILITY AND TERRITORIES

European Union' strategic framework and policies for tourism
The EU bodies have formulated strategies and implemented actions and interventions for both tourism and territories - which are of most interest to us here. All these strategies and actions converge, as we will see, in promoting the most important global strategies of the Union: **"Green", "Digital"**, etc.

Of course, these EU policies influence those implemented in the tourist areas of a country, as, for example, Greece: those situated in urban areas / mainly historical areas as well as the coastal and islandic areas etc. (see, among others, Angelidis 2004).

It is not possible to expand here more to the *territorial impact* of strategies and policy guidelines for tourism in Greece. We refer, inter alia, to: (Lampropoulos V., Panagiotopoulou M, Stratigea A. 2021). However, here it is possible and useful to discuss the EU strategies and policy guidelines for territorial tourism and sustainability themselves.

The EU institutions have been developing strategic frameworks for tourism for several years. More recently, the European Council (in 2022) adopted the "**European Agenda for Tourism 2030**" (Council of the European Union 2022) - which, according to the Commission, includes "the commitment of EU countries to make tourism ***greener, more digital and resilient***".

As stated in the Council of the European Union 2022, the agenda includes a programme of actions to be taken by EU countries, the Commission and the tourism ecosystem. "… The agenda covers five priority areas: ***the green transition, the digital transition, resilience and inclusion, skills and support, and the enabling policy framework and governance***".

It is obvious, as a declaration of intentions in principle, that the agenda is called upon to contribute to the implementation of the major current EU policies: "Green Deal", "Digital Europe", etc. "Within the framework of each priority, various actions are defined, such as *the differentiation of tourist services between seasons and locations (*in italic by us*), the reduction of the environmental footprint and the support of accessibility in tourism…".* (Council of the EU 2022 – see also in European Commission 2022).

On 28 May 2025, the EC / DG for Mobility and Transport has published the report: "Progress towards a green and digital tourism" (Green report on European tourism) (EC / DG for Mobility and Transport 2025). "The report shows concrete results in all action areas, supported by the engagement of tourism players across all EU Member States and beyond…" (European Commission 2022)

Tourism, sustainability and territories in EU Territorial Agendas

Spatial aspects of tourism and sustainability are presented in the following agendas for territorial (spatial and urban) EU issues: *Urban Agenda for the EU* (EC / European Commission 2017), *Territorial Agenda 2030* / TA30 (Ministers for Spatial Planning – EU 2020) and *New Leipzig Charter* / NLC (Ministers on Urban Matters – EU 2020).

Sustainable tourism in the TA2030 and the NLC is not only encouraged but explicitly framed as part of integrated, place-based development. In **TA2030**, it warns that "urbanisation and mass tourism threaten cultural assets and landscapes and may fragment natural habitats …" (Ministers for Spatial Planning – EU 2020). Similarly, TA2030 calls for "cooperation … between places, levels of governments, policy sectors and societal groups" to address such challenges (Pertoldi et al 2022). The Agenda defines two overarching objectives - a *Just Europe* and a *Green Europe* - which strongly support sustainable tourism as a means to territorial cohesion (Ministers for Spatial Planning – EU 2020)

In the **NLC**, cities are described as "historically grown centres of outstanding cultural value … shaping Europe's urban heritage" - meaning that tourism should help preserve cultural identity, not erase it (Ministers on Urban Matters – EU 2020). The Charter also emphasises that "culture is at the core of any sustainable urban development, including the preservation … of the built and other cultural heritage." (ibid). Furthermore, high-quality public spaces allow people to "interact, exchange and integrate into society," thus making tourism part of a socially inclusive city life (ibid).

Together, these texts suggest that sustainable tourism must be **environmentally responsible**, **culturally respectful**, and **socially inclusive**, embedded in multi-level governance and strategic spatial planning.

See some notes on the specific role of culture / heritage in tourism - territories in ANNEX

6. SPECIFIC POLICIES OF EU AND MEMBER STATES TO FACE OVERTOURISM

European Union and Member States have formulated policies and taken actions to deal with overtourism in the conditions that have developed in recent years In the relevant report of the European Commission: (Research for TRAN Committee - Overtourism: impact and possible

policy responses ...- see detailed references) (Peeters et al. 2018) *both some key findings on the effects of overtourism and proposals for dealing with it by Member States*.
The following are almost identical to our own findings in the context of this paper as well as to our main proposals for tackling over-tourism in EU and Member States

- The effects of overtourism are potentially severe and **both natural and cultural heritage sites are at risk of losing their appeal as desirable tourism destinations due to overtourism.**
- **The character of overtourism impacts – environmental, economic and social - depends on the type of destination**. The most vulnerable destinations are not necessarily cities, but rather coastal, islands and rural heritage sites.
- *Most destinations are managed based on a growth-paradigm, mainly valuing growth of visitors' numbers*, **without considering carrying capacity and other policy goals** (Peeters et al. 2018)
- We have pointed out that both in the EU as a whole and in most Member States and in Greece, emphasis is placed, especially in recent years, on the expansion of the number of tourists in the "revenues" from tourism, etc., and not on the -absolutely necessary (see also in the following) holistic treatment of the phenomenon.
- «The most frequent measures taken by destination management organisations and local governments to soften the negative effects of overtourism are related **to spreading visitors in time and space»»** (Peeters et al. 2018).

7. SPECIFIC ACTIONS OF EU COUNTRIES AND TERRITORIES TO FACE OVERTOURISM

Serious overtourism problems have appeared in some amazing destinations around the world, especially in EU countries and territories which are influenced by EU policies for tourism and sustainability in territories etc.

Support by EU for the actions of cities and coastal areas to deal with overtourism
The EU is investing via **Cohesion Policy** to promote sustainable tourism in tourism-intensive areas: 17 Interreg (Mediterranean) programmes target greener, inclusive tourism.

The **Urban Agenda for the EU** includes a *Sustainable Tourism Partnership* (since 2022) focused on governance, climate adaptation, and preserving local culture

The EU's first-ever **Tourism Strategy**, being developed, aims to balance economic growth, environmental preservation and community well-being.

The **EU Tourism Dashboard** provides destination-specific data (e.g. density, seasonality) to help local policymakers detect and manage overtourism (DG for Mobility and Transport 2025)

The **Community-Led Local Development (CLLD)** approach supports locally driven projects in coastal or urban areas, involving local stakeholders in planning responses.

Within CLLD, **FLAGs** (Fisheries Local Action Groups) have supported innovation and economic diversification in coastal areas.

The **"NA-Tour4CChange" project**, under Interreg, pilot's climate-adaptive governance models in tourism-heavy coastal regions.

The EU supports **crisis management and governance** in tourism via funded projects to improve resilience (e.g. for destination management)

Macro-regional strategies, like the **Adriatic-Ionian Strategy (EUSAIR)**, include coastal tourism actions in their revised action plans.

Through **ERDF (European Regional Development Fund)**, the EU allocates billions to sustainable tourism infrastructure, especially in urban and coastal areas.

The specific nature of actions (in EU and other countries)

In the following, we will also refer to policies and interventions that have been implemented in non-EU countries, but we will insist on what has been implemented in EU countries.

Following the often-strong protests about over-tourism, which we examined in sub-section 1.2, many national, regional and local governments, councils and officials **are starting to act**.

In Barcelona and Venice, **restrictions for cruises** already have been placed – "resulting in the withdrawal of major cruise line Norwegian - other destinations at risk include Norway, France, and Greece, where cruise lines such as Royal Caribbean and Celestyal generate significant revenue".

Similarly, in 2023, New York City made it illegal to rent out an apartment in the short term unless the tenant is registered with the city, and Berlin banned short-term rentals altogether.

The methods they're taking are varied - levying tourist taxes, restricting access by location and time, refocusing on sustainability and imposing far stricter regulations on tourist behavior. The impact they will have, only time will show. But if they don't work, ever more extreme measures are expected.

Spain's recent **crackdown on Airbnb and vacation rentals** *is expected to help - by prioritizing responsible travel.* Plan smartly, pick sustainable transport methods, book with companies and guides that promote environmental and cultural preservation. Less crowded, more memorable places.

Measures

Countries which have sustainability regulations and environmental restrictions

Italy, Ecuador, Japan, Thailand

Countries which restrict tourist access to overtourism areas

Greece (Athens, Mykonos, Santorini), Peru (Machu Picchu), *Spain (Ibiza, Menorca, Barcelona)***,** Netherlands (Amsterdam), South Korea (Seoul), Austria (Hallstatt), Italy (Trentino Alto Adige), French Polynesia

Which cities have a tourist tax?

*Barcelona, Venice, Santorini, Mykonos***,** Kyoto, Bhutan, Galapagos Islands, Bali, Seville, Edinburgh

Cities and countries which have tourist behavior regulations

Amsterdam (Netherlands), Sardinia, Portofino, Rome (Italy), Dubrovnik (Croatia),
Prague (Czechia)

Cities which have bans and regulations on holiday rentals

Cornwall, Yorkshire Dales (England), Malaga (Spain), Florence (Italy), Marseille (France), Penang (Malaysia).

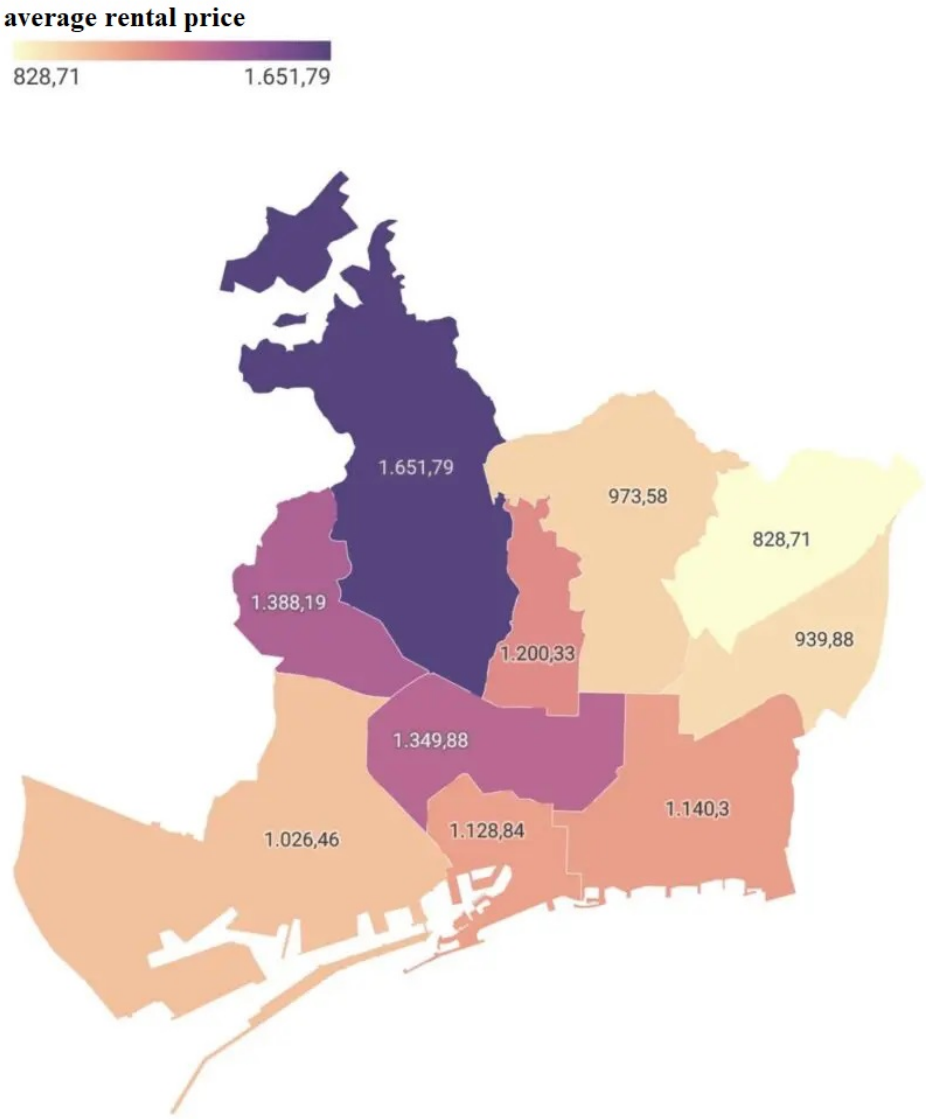
A case study: Barcelona

"Barcelona is the fourth most-visited European city, the first destination of Mediterranean cruise ships and the seventh largest European airport. While there were 3,7 million bookings in 1990, in 2016, Barcelona had more than 31 million bookings. *Barcelona's tourism industry leads to very serious impacts and conflicts for the local society and the environment – social movements raise critique.*" (Stay Grounded Network)

A very important ascertainment: *"the price of rentals in Barcelona reached a new record!"* (EO Mobility Consultancy (Barcelona) 2024) – see **Map 5.**

Measures which have been taken by different levels authorities[1]:

- *Regulating Short-Term Rentals – Enforcing stricter rules on platforms* like Airbnb to prevent housing shortages and rising rents.
- *Limiting Air Traffic* – Reducing flights to curb emissions and over-tourism.
- *Strengthening Workers' Rights – Ensuring fair wages and better conditions for tourism industry employees.*
- *Promoting Sustainable Tourism – Encouraging local, low-impact tourism models.*



Map 5: Price of rent in Barcelona in Euros per month in 2024
Source of the map: EO Mobility Consultancy (Barcelona) 2024

[1] (compiled from: Stay Grounded Network 2024)

8. A NEW TOURISM TERRITORIAL MODEL NEEDING HOLISTIC APPROACH

A new model of tourism territorial division - Need for holistic approach and territorial "decentralization"

The most important finding of our work, on which this paper is based, is that the overall development and territorial division of tourism has changed in recent years so significantly that we can talk to a large extent to a **new model, developmental and territorial**, of tourism. In this context, we found that policies and interventions to deal with overtourism, when they remain spatially and sectorally limited, are less effective than necessary. Only holistic approaches – multisectoral, multi-level -can be very effective. Illustrative example: Let's assume that we take the usual measures nowadays to restrict Airbnb and that the pressures on rents for residents are reduced. However, if there is no **"decentralization"** of demand from tourists for this area - both spatially and temporally (extension of the tourist season throughout the year), the pressures on rent, infrastructure, land use, etc. will continue to grow (in the hypothesis that world tourism demand will continue to grow highly in next years).

In more general: from more balanced (holistic, sustainable) paradigms to growth paradigms and again to balanced paradigms

In several countries where decentralization of tourism demand had advanced in a frame of balanced tourism development, before roughly 2010, shifting part of the tourist demand from congested to less developed tourist areas have been relatively easier.

Looking at **Greece as an example** of the territorial decentralization of tourism:

For several years a strategy has been formulated to relieve the saturated tourist areas (urban, coastal etc.) and strengthen the "inland" areas (including mountainous areas, etc.). The results of this policy were limited - below the targets, however slowed down to some extent the pressure on congested destinations.

After roughly 2010, the views that supported the **growth paradigm** (an increase in tourist demand everywhere, a reduction in state regulation) were significantly strengthened (generally speaking), everywhere (including the EU and the Member States). The relevant policies have failed to reduce spatial and temporal bottlenecks. That is why, in a way, the "return" (in today's terms, obviously) of the more balanced policies – which necessarily require some appreciable degree of state regulation. Of course, a more extensive discussion of this issue is needed – but it is not possible to do so in the context of this work.

9. CONCLUSIONS

General

- Global tourism has intensified dramatically, **producing "overtourism" pressures, especially (but not only) in historic urban areas and sensitive coastal zones and island territories.** Post-Covid rebound further amplified visitor flows, exceeding the carrying capacity of many destinations.
- Excessive tourist concentration / congestion degrades natural and cultural assets, undermining the very foundations of tourism development in the congested areas.
- Residents across Europe increasingly **protest** against hypertourism' impacts on housing, public space, and cultural identity.
- Fragmentary measures such as, for example: sole restrictions of Airbnb, although they can be useful, don't really address the problem.

- The UN SDGs (especially 8, 11, 12, 14) offer a useful but fragmented framework; tools like SDG 8.9 and 12.b support monitoring but need better integration with territorial priorities.
- Overtourism cannot be explained solely by demand; it requires **holistic, multi-sectoral analysis integrating economic, social, environmental and cultural dimensions.**
- Sustainable **planning is essential** to balance tourism growth with environmental quality, livability, social equity / inclusiveness and preservation of cultural identity.

Greece and Athens

They are examined here as an example.

Greece is among the countries most affected by overtourism, with extreme concentration in specific islands and historic city districts. But the fact that tourism corresponds to a large proportion of its economy restricts measures to stop over -tourism.

Athens, including many individual historical zones, shows intense overtourism, which has accelerated the use of houses as Airbnb accommodation. This had strong negative consequences for increasing rental prices for natives, the serious additional burden on the city's infrastructure and the relative limitation of the use of free spaces by residents. The measures taken did not substantially contribute to the overturning of overtourism in the historic area of the city.

Policies of European Union and member states to face overtourism

EU strategies (Green, Digital, Tourism Agenda 2030) call for greener, more resilient, **seasonally-and-spatially diversified tourism**.

European cities increasingly adopt measures such as tourist taxes, rental restrictions, access limits, and cruise controls. Examples from Barcelona (which we examined in more detail), Venice, Amsterdam and others show that unregulated tourism erodes affordability and urban cohesion.

The entire EU / EU countries and local authorities' action to contain overtourism is well under the demands, mainly because it remains fragmentary - that is, not holistic. In particular, the individual actions that have a social and environmental orientation are insufficient.

Summarizing

A new tourism model must **move beyond growth-paradigms** and place territorial sustainability, community well-being as well as nature and cultural heritage protection at its core.

Spreading tourism across space (towards often inland areas or even mountainous areas) and time (extension of the tourist season) is a key mitigation strategy.

10. PROPOSAL FOR A REALLY SUSTAINABLE TOURISM MODEL

In order to contain "overtourism" in urban (mainly historical) and non-urban (mainly coastal) areas, a comprehensive (multi-sectoral, multi-level) readjustment of tourism development is required, first of all, with economic, social, environmental and cultural priorities that are related to the UN (and EU) SDGs but also linked to the specific characteristics of sustainable development of each country and territory. In other words, strategies, policies / plans and

actions - towards sustainable tourism' territorial development in countries and individual territories should be formulated.
In more detail, we propose:

Strategic, holistic governance

- Adopt a **holistic tourism governance model** linking economic, social, environmental and cultural impacts. Replace the current **growth-driven paradigm** with a sustainability-centred approach integrating carrying capacity assessments.
- Create **multi-level territorial tourism observatories** (local–regional–national) to monitor congestion, housing, infrastructure pressures and environmental degradation.
- Institutionalize **mandatory SDG-based monitoring** (SDGs 8.9, 11, 12.b, 14) adapted to local territorial realities.
- Introduce (or upgrade any existing) **integrated territorial planning tools** that explicitly limit tourism density in saturated urban and coastal areas.

Territorial and temporal decongestion

- Implement **territorial decentralization of tourism**, developing inland, mountainous and less-known regions through targeted incentives and infrastructure.
- Promote **seasonal redistribution**, extending tourism beyond peak months via cultural, educational and nature-based programs.
- Set **visitor caps** at sensitive heritage sites (e.g., Acropolis, Venice model) using digital reservation systems. Regulate cruise flows and disembarkation schedules in saturated ports. Design **tourism mobility plans** prioritizing public transport, pedestrian zones and reduced car dependency.

Housing, local economy and social protection

- Impose **strict regulation on short-term rentals** (caps / ceilings, licenses, taxation, exclusion zones in historic centres). Establish **affordability protections for residents**, including rent controls and incentives for long-term leases.
- Redirect part of tourism revenue to **local community funds** supporting public spaces, social services and cultural programs. Encourage **local supply chains** and traditional businesses through procurement rules, branding and subsidies. Require **corporate social responsibility standards** from tourism operators regarding labour rights and environmental performance.

Cultural & Environmental Safeguards

- Strengthen **legal protection of cultural heritage zones** and enforce strict environmental limits in coastal areas. Develop **carrying-capacity-based cultural tourism plans**, balancing visitor access with conservation. Promote **low-impact tourism forms**, including eco-tourism, cultural interpretation routes and community-based tourism.
- Invest in **waste, water and energy management systems** that can withstand peak tourism loads. Implement **visitor behaviour codes** with clear penalties (as in Amsterdam, Rome, Dubrovnik).

EU funding

- Align national tourism strategies with the **EU Tourism Agenda 2030**, the European Green Deal and Digital Europe – **considering the national realities and needs.**

- Utilize **ERDF, Cohesion Fund and Creative Europe** resources for sustainable tourism, and infrastructure upgrading. Require all EU-funded tourism projects to include **climate resilience and community benefit criteria**.
- Create an **EU-wide framework for overtourism risk assessment**, harmonizing indicators and data systems. Promote **cross-border cooperation** for sustainable tourism corridors and decongestion strategies.

Similar proposals need to be implemented in the total of **Greece** as well as in the total of Athens with emphasis in the more specific zones that face greater pressure from overtourism.

Specifically, for overtourism zones of **Athens:**

(a) The protection of the individual historical areas, such as Plaka, Monastiraki and Keramikos, must be a priority in the tourism structural and city plan.

(b) Critical infrastructures of the city need to be improved. This includes both transport and public services, such as health services and waste management. These infrastructures must be sufficient for visitors and permanent residents, so as to maintain a balance between tourism and the local community.

(c) The implementation of appropriate regulations for Airbnb accommodation is urgently needed: reduction of the total permitted capacity and adjustment of the conditions of their establishment and operation in order to limit or eliminate their negative impacts on the housing sector (rents, etc.) of the city's residents.

Overall priority: Overcoming overtourism needs a **new holistic tourism strategy**:
Reorientation of the territorial plans of tourism with appropriate "decentralization" at all levels and strengthening the goals and measures for economically, socially and environmentally sustainable tourism.

ANNEX

Some notes on the specific role of culture / heritage in tourism – territories

We refer here in ssummary to the *specific role of the culture / heritage in tourism - territories, due to the great importance of this role.* See for a much more extensive analysis in (Angelidis 2025).

Strategic framework for EU cultural policy

For cultural policy, the EU has also formulated appropriate strategic frameworks over time. Following the 2007 European Agenda for Culture, the European Commission adopted the **new European Agenda for Culture** in **2018** (European Commission 2018), in order to consider recent developments in the cultural sector. The new agenda and accompanying documents constitute the framework for cooperation in the cultural sector at EU level. They focus on the positive contribution of culture to Europe's society, economy and international relations. Member States define the main themes and working methods for political cooperation in the field of culture through work programmes for culture, which are adopted by the Council of the European Union.

Regarding **cultural heritage** in particular, the European Commission proposed the *first European Framework of Action for Cultural Heritage* in December 2018. The *EU policy for cultural heritage* is continuously adapted, to this day, with relevant documents, actions, etc. See, among others, in (EU Partnership on Culture / Cultural Heritage 2024), (EC / European Commission 2020), (EC / European Commission (2024).

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FROM FORMA URBIS TO FORMA HORTO: BLUE-GREEN ROOFS AS THE NEW URBAN GROUND

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Abstract
In city centers—often urban palimpsests shaped by centuries of transformation—the pursuit of sustainable development and urban reconstruction must balance the ambition to maximise environmental and economic performance with the imperative to minimise social and cultural disruption, all while preserving built heritage. Central to this challenge is the reclaiming of nature-based systems through blue–green infrastructure within the urban fabric, marking a shift from *Forma Urbis*—a 'stone-and-mortar' conception of the city—to *Forma Horti*, an urban form emerging from nature and is interwoven with living ecological systems.

Achieving this transformation requires navigating spatial and aesthetic constraints, competing land uses, preservation mandates, and fragmented governance. Yet these same limits reveal opportunities for climate resilience. The presentation will demonstrate how overlooked urban surfaces—especially rooftops, the building's *"fifth façade"*—can be repurposed as blue–green infrastructure to mitigate heat stress, manage stormwater, capture pollutants, support biodiversity, improve public health and create much-needed green spaces for citizens, while preserving architectural integrity and cultural identity.

Alongside technological and governance innovations, the presentation will draw on vernacular traditions that integrated blue-green aspects into the urban fabric. Building on this traditional wisdom, and combining contemporary design and governance, the presentation will explore culturally rooted, climate-responsive urban interventions, with Citizen Science as a key participatory tool for co-designing and evaluating their impact.

Key words: Blue-green roofs, nature based-solutions, citizen science, urban regeneration

HOUSING CRISIS IN POST-CRISIS ATHENS; INEFFECTIVE STATE POLICIES & THE POTENTIAL OF URBAN RENEWAL SCHEMES OF ABANDONED INDUSTRIAL SITES

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Abstract
Housing crisis emerged more intensively in Greek public debates during the last few years, concerning mainly Athens and the large Greek cities. Housing crisis is framed mostly as

(a) an affordability problem in articulation to the broader cost of living and high energy prices, as opposed to low income of middle classes;
(b) and more recently as a supply problem of the housing market – grounded in the reality that one out of four housing apartments are kept 'closed' by the owners for various reasons (high taxation, deceitful tenants, expensive renovation) .

The recent housing crisis has been fueled by other conditions, such as

(c) Institutional investments in the housing market aiming at high rates of interest by means of short-leasing for tourists, given that the housing market in Greece is still considerably discounted in comparison with other EU countries;
(d) foreign investments in housing by individuals outside EU looking for Greek *'Golden Visa'*;
(e) foreign investments in housing by retired individuals of welfare countries searching for quality of life under the Mediterranean climate conditions;
(f) foreign investments in housing by remote-working Nomads willing to establish in Greece for a short time-period.

Under all the above conditions, house prices in Greece have since 2017 recorded an annual increase of about 10% and registered a cumulative rise of 66.4% from 2017 to 2024.8 According to indexes provided by online real-estate advertisement platforms, rent prices also increased by more than 75% between 2015 and 2024. In 2023, housing prices in Greece have reached the level of the previous historical peak of 2007, when cheap mortgaged lending had contributed to their rapid escalation.

This presentation first criticizes the recent state policies to facilitate the problem, such as *'Sptiti mou 1", 'Spiti mou 2", "Public Sponsoring of Housing Renovation and Rent",* et al. It then, evaluates the potential of urban renewal schemes of abandoned old industrial sites in central Athens and Piraeus, aiming at affordable housing mainly for young people. It presents successful examples of urban renewal schemes of abandoned old industrial sites in European cities, where redevelopment is supervised and controlled by the state. As opposed to this, there are emerging examples of urban renewal schemes of abandoned old industrial sites in central Athens and Piraeus, but they remain uncontrolled by state policies and exclusively motivated by international private investments and interests.

Keywords: Housing crisis, Athens, ineffective state policies, the potential of urban renewal schemes of abandoned old industrial sites.

SESSION

"Local and Regional Development – Economy - Entrepreneurship"

Chaired by **Prof Olesea Plotnic** and **Angelos Papavasileiou**

THE ADAPTATION INVESTMENT CYCLE: THE MISSING LINK FOR BRIDGING THE REGIONAL ADAPTATION GAP IN EUROPE

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Abstract
Europe, as the fastest warming continent, faces major climate risks with an annual adaptation finance gap of €15-64 billion (EEA, 2024; World Bank, 2024). Current funding relies heavily on public sources, highlighting the important and urgent need for private sector involvement (CPI, 2023). Regions and cities in the Eu and beyond face significant barriers in their effort to muster financial resources to translate high-level adaptation strategies into tangible projects to promote climate and socioeconomic resilience. The Adaptation Investment Cycle (AIC) developed in the HEU Pathways2Resilience project is a flexible six-step process designed to help cities and regions overcome the key barriers to financing climate adaptation by offering a structured, step-by-step approach that builds local capacity and bridges gaps between planning and implementation. The AIC works in parallel with the formation of the action plan, ensuring the choice of adaptation pathways reflects economic and financial viability, on top of urgency for cities and regions. This paper maps the steps and processes included in the AIC to the common adaptation finance barriers, namely economic, financial, awareness, behavioral, institutional and technological barriers. Furthermore, it highlights the distinct impact on both raising and leveraging financial capital to galvanize regional resilience and assesses a suite of innovative financial sources and instruments to cater to specific regional needs. We underline the importance of succinct frameworks for sub-national adaptation finance and contribute to the growing literature on levers of regional resilience.

Keywords: Adaptation Finance, Regional Resilience, Pathways2Resilience, Mission Adaptation

THE ROLE OF INTRAPRENEURSHIP IN THE ENTREPRENEURIAL ORIENTATION OF UNIVERSITIES

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Abstract
This study explores how intrapreneurship among academic staff contributes to the development of entrepreneurial orientation (EO) in higher education institutions (HEIs), with a focus on Albanian universities. Drawing on a mixed-methods approach that combines the HEInnovate self-assessment tool with in-depth qualitative interviews across six universities, the study provides a grounded, integrative perspective linking micro-level agency with macro-level institutional change. The findings reveal that intrapreneurship—defined as proactive, innovative actions by university members aimed at creating academic, social, or economic value—plays a central role in driving innovation in universities. Individuals who engage in intrapreneurial activities often navigate multiple institutional logics, balancing academic identities with entrepreneurial ambitions. These behaviors lead to the emergence of new programs, centers, partnerships, and funding mechanisms, which over time contribute to the structural evolution of universities into more entrepreneurial entities.

The study extends existing theories by showing that EO in HEIs is not uniform but dimension-specific, often shaped by contextual factors such as governance structures, incentive systems, and institutional culture. Public and private universities display different pathways to entrepreneurship, but across all cases, individual agencies remain a key driver of change. The research also contributes to identity theory by illustrating how intrapreneurial identities form gradually within academic settings, supported by leadership, peer recognition, and institutional support.

Managerial implications include the need for leadership to foster enabling environments, provide targeted incentives, and institutionalize bottom-up initiatives. At the policy level, the findings suggest that promoting entrepreneurial universities requires mechanisms that empower individual actors, not just structural reform. Overall, the study highlights that intrapreneurship is both a manifestation and a catalyst of entrepreneurial orientation in universities, particularly in resource-constrained and transitional contexts. By centering on individual agency within institutional change, the research offers new insights into how universities can adapt and innovate from within.

Key words: intrapreneurship, entrepreneurial orientation, entrepreneurial university

THE ROLE OF COACHING IN SHAPING LEADERS FOR A SUSTAINABLE WORLD

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Abstract
In an era marked by unprecedented environmental, social, and economic challenges, the demand for sustainable leadership has never been greater. Organizations across sectors are expected not only to deliver financial performance but also to integrate sustainability into their strategies and daily operations. This presentation explores how coaching can serve as a transformative process in shaping leaders who are equipped to address the complexities of a sustainable world.

Drawing upon the principles of coaching, such as active listening, powerful questioning, and reflective practice, leaders are guided to cultivate greater self-awareness, systemic thinking, and values-driven decision-making. These competencies are essential for aligning organizational priorities with the United Nations Sustainable Development Goals (SDGs). Through coaching, leaders learn to bridge the gap between personal purpose and organizational responsibility, creating strategies that balance profit, people, and planet.

Ultimately, coaching is positioned not merely as a tool for individual development but as a catalyst for systemic change. By empowering leaders to act with responsibility, inclusivity, and long-term vision, coaching contributes to shaping organizations that thrive in harmony with society and the environment. This presentation invites participants to reimagine coaching as a key enabler of sustainable leadership for the challenges and opportunities of the future.

Keywords: *Coaching, Sustainable Leadership, Sustainable Development Goals*

INTRODUCTION

The contemporary global environment is defined by climate change, resource depletion, geopolitical instability, and widening social inequalities. As a result, businesses are under growing pressure to take on responsibilities that go beyond financial success and implement sustainable practices that add value to society over the long run.

A global framework encouraging institutions to integrate economic development, social equity, and environmental protection was established by the United Nations' adoption of the 2030 Agenda for Sustainable Development (United Nations, 2015). Leadership in this

situation needs to change from focusing on short-term performance to long-term systemic responsibility.

According to Hargreaves and Fink (2006), sustainable leadership places a strong emphasis on ethical governance, stakeholder engagement, and forward-thinking mindset. Deeper developmental interventions are necessary to foster such leadership, though. To help leaders navigate complexity and match organizational objectives with sustainability principles, coaching has become an essential process. Traditional leadership models often fall short in preparing leaders for this new reality. Many leaders are trained to prioritize short-term KPIs (Key Performance Indicators)., operate in silos, or focus predominantly on operational efficiency.

However, sustainability challenges require leaders who can understand interconnected systems, reflect deeply on their impact, and navigate ambiguity. Leaders frequently express the desire to integrate sustainability but lack the frameworks, time, or guidance to do so effectively. In this paper we will explore how coaching can serve as a transformative process in shaping leaders who are equipped to address the complexities of a sustainable world.

THEORETICAL FOUNDATIONS OF SUSTAINABLE

Recent research further expands the conceptualization of sustainable leadership across diverse sectors and contexts. For example, Eliot and Massyn (2024) propose a leadership competence framework for sustainable development in manufacturing, conceptualized through the "bicycle metaphor," emphasizing balance between strategic direction, stakeholder engagement, and adaptive capacity. This framework reinforces the multidimensional nature of sustainability leadership competencies.

Similarly, visionary leadership and innovative mindset are identified as critical drivers of sustainable business development (Farhan, 2024). Key attributes of innovative leadership attitude, visionary leadership, and the five leadership methods were emphasized in their analysis. According to the study, a distinctive organizational identity that supports its differentiation and ongoing development can be created by appropriately aligning the performed leadership strategy with the current visionary leadership and inventive mindset.

Emerging evidence also highlights leadership responsibility as a central mechanism in corporate sustainability transitions. Keil et al. (2025) highlight the significance of environmentally conscious CEOs as role models who may propel businesses toward efficient sustainability management. Their study provides valuable insights into the requirements that leaders must meet in order to cultivate an environmentally conscious culture inside their companies.

Furthermore, sustainable leadership has measurable behavioral impact. Nie et al. (2025) demonstrate that by improving employees' future orientation, sustainable leadership greatly encourages pro-environmental activities. They also found that when employees are more morally aware, sustainable leadership has a greater effect on their pro-environmental actions. Also, they propose that companies can encourage employees to prioritize long-term thinking and raise awareness of sustainability concepts, especially among those with high moral sensitivity.

These contemporary contributions strengthen the argument that sustainable leadership is not merely conceptual but empirically observable across organizational systems.

COACHING AS A DEVELOPMENTAL INTERVENTION

The evolving sustainability landscape requires coaching approaches that move beyond performance optimization toward systemic impact. Renshaw and Robinson (2024) conclude that "creating leaders-who-coach who, as a result, will gradually enable a change in the underlying systemic issues" is the key to finding answers. According to the authors, "personal experience, client conversations, and research has led us to identify and highlight two critical issues where we see organizations consistently making serious errors that hold back the development of their leaders, waste money, and restrict the potential for longer term and sustainable effectiveness."

Moreover, empirical evidence suggests that coaching approaches contribute sustainably to competency development. Seemann et al. (2024) demonstrate that coaching methodologies enhance strategic thinking, responsibility awareness, and maturity among management students, indicating that coaching builds enduring sustainability-related competencies.

When integrated into executive contexts, coaching therefore becomes a mechanism for cultivating leadership competencies aligned with ESG integration, SDG implementation, and responsible governance.

ALIGNING LEADERSHIP WITH THE SUSTAINABLE DEVELOPMENT GOALS

A thorough road map for tackling global issues like climate action, responsible consumption, and decreased inequality is provided by the Sustainable Development Goals (United Nations, 2015). Strategic alignment and leadership commitment are necessary for organizations to integrate the SDGs. (Liao, 2022), (Liao, 2022; Sifat, 2019)
This integration is supported by coaching by:
Encouraging discussion of ESG priorities
Promoting stakeholder-centered thinking
Encouraging transparency and accountability
Connecting global responsibility with one's own leadership goals
Instead of viewing sustainability values as merely a matter of compliance, leaders who use coaching processes are better positioned to internalize them.

COACHING, PURPOSE, AND ETHICAL RESPONSIBILITY

Research on ethical leadership emphasizes how moral identity and integrity shape organizational culture (Brown & Treviño, 2006). By encouraging leaders to consider the wider ramifications of their choices, coaching enhances ethical awareness.
Through facilitated introspection, leaders investigate issues like:
• How will this approach affect the environment and society in the long run?
• How does this choice fit with our declared principles?
• Who are the impacted stakeholders?
In addition to strengthening sustainability as a central leadership focus rather than a side project, this reflective depth improves responsible governance.

Furthermore, there are specific coaching competencies that directly support sustainable leadership. (DiGirolamo & Tkach, 2019), (Carey et al., 2011)

First, self-awareness: leaders begin to understand their values, motivations, and blind spots.

Second, systemic thinking: they learn to see issues not as isolated problems but as interconnected dynamics.

Third, purpose-driven decision-making: they align decisions with long-term values and societal impact.

Fourth, empathy and inclusion: coaching strengthens the ability to understand diverse stakeholders.

And finally, resilience: leaders become better equipped to navigate uncertainty and complexity.

FROM INDIVIDUAL DEVELOPMENT TO SYSTEMIC CHANGE

The systemic impact of sustainable leadership is further supported by empirical findings demonstrating behavioral spillover effects. Sustainable leaders not only shape strategy but influence employee attitudes and environmental behaviors (Nie et al., 2025).
Additionally, leadership competence models emphasize balance, adaptability, and ethical direction as critical dimensions of sustainability (Eliot & Massyn, 2024). Coaching strengthens precisely these meta-competencies by fostering reflective capacity and long-term orientation.

In this sense, coaching serves as an enabling infrastructure for developing leaders capable of acting as agents of sustainable change (Keil et al., 2025).

FROM PERSONAL PURPOSE TO ORGANIZATIONAL RESPONSIBILITY

Coaching encourages leaders to clarify their personal purpose, understand their role in societal impact, align organizational goals with ethical practices, and inspire others through authenticity (Whitmore, 2017; Renshaw & Robinson, 2024). One of the most powerful effects of coaching is its capacity to facilitate deeper purpose clarification. When leaders gain insight into what genuinely matters to them, they are more likely to lead authentically and foster stronger engagement among followers (Brown & Treviño, 2006).

Furthermore, coaching supports leaders in bridging the gap between personal values and organizational expectations through reflective dialogue and values alignment processes (Grant, 2014). This alignment enhances trust, commitment, and long-term orientation toward sustainability objectives, reinforcing responsible and purpose-driven leadership (Hargreaves & Fink, 2006).

In this sense, coaching enables leaders to integrate personal identity with professional responsibility, bringing their "whole selves" into their leadership practice and strengthening the ethical and relational foundations of sustainable leadership.

RESILIENCE AND ADAPTIVE CAPACITY

Sustainability transitions unfold in volatile and uncertain environments, requiring leaders to sustain long-term commitments under pressure (Senge, 2006). Psychological resilience defined as adaptive functioning despite adversity (Luthans, 2002) constitutes a critical micro-foundation of sustainable leadership. (Dologlou, 2024) (Dologlou & Mitoula, 2024)

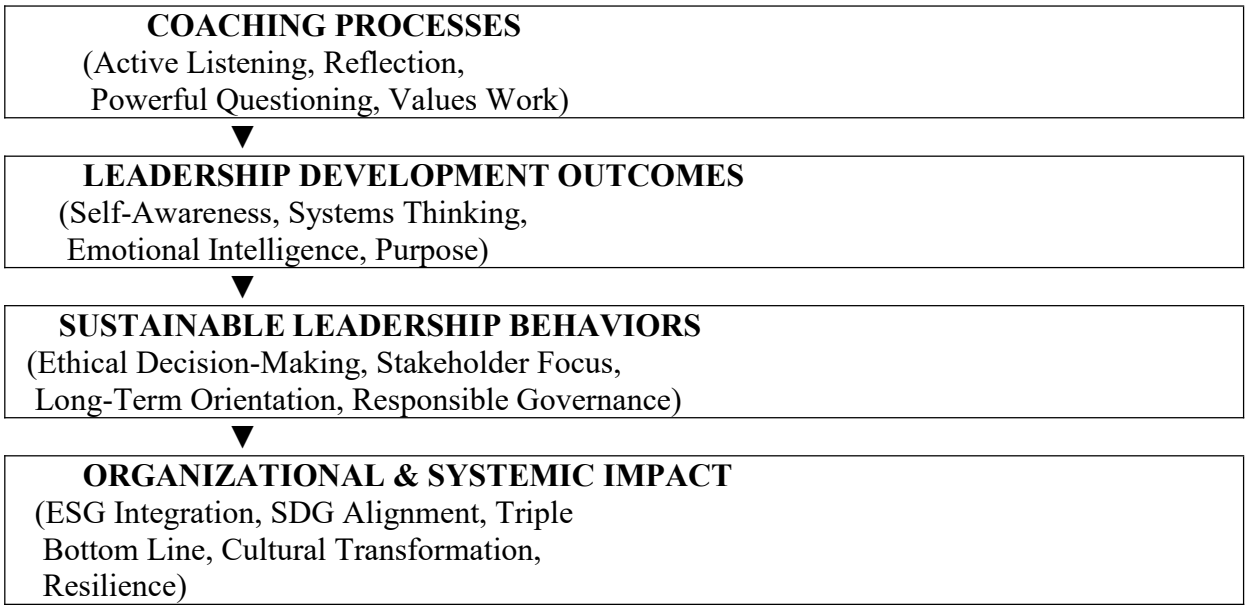
Coaching enhances resilience primarily through strengthened self-regulation and emotional management. Self-regulation theory suggests that individuals adjust behavior in alignment with internal goals and feedback loops (Carver & Scheier, 1998). Through

reflective dialogue, coaching develops metacognitive awareness, enabling leaders to regulate stress responses and maintain strategic focus (Grant, 2014).

By reinforcing emotional intelligence and constructive reframing (Goleman, 1998), coaching supports adaptive decision-making and sustained alignment with long-term sustainability objectives (Renshaw & Robinson, 2024).

Figure 1 presents the conceptual framework of this study, illustrating coaching as a developmental intervention that enhances core leadership competencies. These competencies mediate the relationship between coaching processes and sustainable organizational outcomes. The model positions coaching not merely as an individual development tool but as a systemic enabler of ESG integration, SDG alignment, and long-term organizational resilience.

Figure 1
Conceptual Model: Coaching as a Catalyst for Sustainable Leadership and Systemic Impact



Note. The model illustrates how coaching processes enhance leadership development outcomes, which foster sustainable leadership behaviors and contribute to organizational and systemic impact.

IMPLICATIONS FOR RESEARCH AND PRACTICE

The conceptual model proposed in this paper positions coaching as a mediating developmental mechanism linking leadership competencies to sustainable organizational outcomes. This framing opens several avenues for future empirical investigation.

First, quantitative research could test the mediating role of leadership development outcomes—such as self-awareness, systems thinking, and values-driven decision-making—in the relationship between coaching interventions and sustainability performance indicators. Building on findings that sustainable leadership influences employees' pro-environmental behaviors (Nie et al., 2025), future studies could examine whether coaching indirectly enhances such behaviors through leadership transformation.

Second, longitudinal designs are particularly relevant. Sustainability transformation unfolds over time; therefore, longitudinal studies could explore whether coaching produces enduring shifts in leadership orientation toward ESG integration and SDG alignment.

Third, sector-specific research is encouraged. Future research could compare how coaching supports sustainability transitions in manufacturing, services, public sector organizations, and emerging economies.

Finally, future research may develop and validate measurement instruments capturing "sustainable leadership maturity" as an outcome of coaching interventions, contributing to theoretical consolidation in both coaching and sustainability scholarship.

From a practical perspective, coaching should be strategically embedded within organizational sustainability agendas rather than treated solely as an executive development tool.

First, integrating coaching into ESG strategy enables leaders to align mindset, decision-making, and stakeholder accountability with long-term sustainability objectives. Structured coaching conversations can explicitly address ethical responsibility, systemic risk, and sustainable value creation.

Second, leadership development programs should incorporate coaching methodologies that cultivate systems thinking, reflective capacity, and purpose alignment, fostering sustainability-oriented competencies beyond technical expertise (Seemann et al., 2024).

Third, team coaching supports cultural transformation by strengthening collective ownership, cross-functional collaboration, and shared accountability for sustainability initiatives (Hawkins, 2017).

Finally, coaching equips leaders to act as agents of sustainable change by enhancing adaptability, moral courage, and long-term strategic orientation in volatile environments (Keil et al., 2025), while also contributing to sustainability-focused leadership development in educational contexts (Seemann et al., 2024).

A central contribution of this paper lies in bridging the gap between sustainability theory and leadership development practice. By positioning coaching as a systemic enabler rather than a peripheral intervention, organizations and scholars alike can reconceptualize leadership development as a foundational pillar of sustainable transformation.

The complexity of global challenges demands leaders who are not only strategically competent but ethically grounded, systemically aware, and purpose driven. Coaching provides the structured developmental space in which these qualities can emerge and mature.

CONCLUSIONS

A new paradigm of leadership, one marked by systemic awareness, ethical integrity, and long-term vision, is required due to the complexity of today's global challenges.

In order to develop these traits, coaching is essential. Coaching helps close the gap between sustainability goals and practical strategy by promoting self-awareness, coordinating values with global priorities, and enhancing adaptive capacity. Individual development is only one aspect of coaching. Systemic change is sparked by it. Leaders have an impact on strategies, structures, and culture when they change their perspective.

Coaching boosts an organization's ability to adapt to uncertainty, promotes innovation, and speeds up the adoption of sustainable practices. It encourages a more moral, resilient, and human-centered leadership style, elements that our world desperately needs.

In the end, coaching goes beyond improving individual performance. It serves as a driving

force behind organizational change and sustainable leadership, fostering the growth of establishments that can coexist peacefully with the environment and society.

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COSMETOLOGY PRODUCTS AND SUSTAINABILITY: GREEK CONSUMER'S SOCIAL AND ENVIRONMENTAL ATTITUDES AND PERCEPTIONS

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Abstract
Growing environmental degradation and social challenges have prompted both businesses and consumers to prioritize sustainability, encouraging environmentally and socially responsible practices across various industries. As a result, sustainability and ethical consumption have emerged as central areas in contemporary consumer research, attracting scholarly attention to the relationship between environmental awareness, social responsibility, and purchasing behavior. The cosmetics sector, as a dynamic segment of the global marketplace, exemplifies these challenges due to its ecological impact, ethical sourcing practices, and reliance on Corporate Social Responsibility (CSR) initiatives.

This paper examines the environmental and social attitudes and perceptions of Greek consumers in relation to cosmetology products, addressing an underexplored national context.

The study is based on a quantitative survey completed by 375 respondents aged 15–63, mostly living in the Attica region. Data were analyzed using Excel spreadsheets, with pivot tables, charts, and chi-square (χ^2) tests of independence applied to identify significant relationships.

The results demonstrate that while respondents recognize the importance of environmental and social issues, their purchasing choices are mainly shaped by practical factors such as product quality, effectiveness, and affordable prices. An important finding of the study is the clear gap between ethical attitudes and consumer behavior. Despite perceiving sustainable cosmetics as beneficial for both health and the environment, a substantial proportion of participants expressed reluctance to pay higher prices. Furthermore, the frequent uncertainty in responses points to limited consumer knowledge and insufficient corporate communication strategies. These findings highlight the need for cosmetic companies to enhance transparency, improve consumer education, and maintain affordable pricing, thereby fostering closer alignment between consumer values and market practices.

Keywords: cosmetology products, sustainability, environmental attitudes, social attitudes, consumers, Attica, Greece

THE GIG ECONOMY AND EMPLOYMENT CREATION IN THE DIGITAL ERA: EXPLORING THE OPPORTUNITIES AND FACILITATING CONDITIONS FOR POLICY CONSIDERATIONS

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Abstract
Digitalization, supported by improved Information and Communication Technology (ICT), has drastically disrupted the nature of employment, shifting from traditional long-term employment to stable employment and, more recently, towards short-term work arrangements, commonly known as the gig economy.

The gig economy has affected various sectors, including transportation, hospitality, healthcare, and education. In simple terms, the gig economy is characterized by short-term, flexible, and digitally platform-mediated work. On the one hand, the gig economy creates job opportunities; on the other hand, it raises concerns about job security, income levels, and employment rights. Both the individual and the organization should be well prepared to operate effectively in the gig economy. The potential benefits of the gig economy will be undermined without mutual preparedness. While the individual should cultivate their mindset regarding the terms and conditions of flexible work arrangements, organizations should develop short-term work practices, diverse reward strategies, and robust digitalization platforms to support the gig economy. With the rise of the gig economy, expected to reach USD 2,178.4 billion by 2034 (Business Research Insights, 2025), both individuals and organizations face a dilemma. The individual needs to reconcile stability and job security with job flexibility and autonomy. In contrast, the organization needs to strike a balance between stable work arrangements and the need to reduce costs and promote innovation. While the gig

economy is likely to grow, there is a pressing need to prepare both individuals and organizations for its opportunities and challenges.

Therefore, the objective of the paper is to explore the policy implications of the gig economy by analyzing the opportunities and facilitating conditions. The conceptual paper contributes to a deeper understanding of how stakeholders can leverage the potential of the gig economy to drive sustainable innovation and employment creation.

Keywords: Digitalization, the gig economy, organizational factors, employment creation

1. INTRODUCTION

The rapid advancement of digital technologies and the rise of innovative business models have significantly transformed traditional employment frameworks and reshaped the global labor market. The increasing digitalization of economic activities has not only created new work opportunities but has also fundamentally changed the nature, organization, and geographical distribution of labor. Digital technologies, combined with the widespread availability of high-speed Internet and online platforms, have facilitated the emergence of a borderless labor market, where individuals—especially freelancers—can offer their expertise and services on a global scale (Graham et al., 2017).

Consequently, the Internet has morphed into a vast, dynamic marketplace for labor, enabling the real-time exchange of knowledge, skills, and competencies across geographical boundaries. This transformation has redefined employment relationships, altered work arrangements, and shifted the demand for specific skill sets (De Stefano, 2016). The digital transformation of work has led to the emergence of new occupational categories and hybrid professions, while simultaneously rendering specific traditional roles obsolete. Online gig platforms allow remote workers to participate in multiple short-term projects concurrently, often supplanting the conventional model of full-time employment with a single employer. As a result, digital labor has become a prominent feature of the global economic landscape, reshaping patterns of production, consumption, and income distribution (Langley and Leyshon, 2017). Empirical evidence supports the rapid expansion of this phenomenon. The global gig economy experienced a 17.4% compound annual growth rate (CAGR) from 2018 to 2023. According to the World Bank (2023), the gig economy accounts for up to 12 percent of the global labor market. Freelancers now make up 46.6% of the workforce, compared to 39% just last year. The global freelance platform market size is projected to increase at a CAGR of 16.6% from 2024 to 2029. The global freelance platform market is expected to grow with a CAGR of 15.4% and reach $12.01 billion by 2028. The gig economy has grown 15x faster than the traditional job market. The global freelance market is expected to grow at a compound annual growth rate (CAGR) of 15% through 2026.

This consistent growth underscores the structural integration of online freelancing within both developed and developing economies. In advanced economies, digital labor enhances organizational flexibility, cost efficiency, and access to specialized skills (Manyika et al., 2016). For developing economies, digital labor serves as a crucial mechanism for economic inclusion, income generation, and integration into global value chains (Kuek et al., 2015). A significant portion of the global digital labor force resides in developing countries, where online work grants access to international markets and alleviates local labor market constraints (Graham et al., 2017).

The significance of digital labor became particularly pronounced during the COVID-19 pandemic, which acted as a catalyst for the widespread adoption of remote work and digital collaboration tools. During this period, online labor platforms emerged as critical infrastructures, enabling economic continuity for millions of workers and businesses (International Labour Organization, 2021). This crisis highlighted both the resilience and vulnerabilities inherent in digital labor markets, particularly in relation to issues of income security, algorithmic management, and social protection (Berg, 2016; Wood et al., 2019).

As the gig economy gains prominence within the digital landscape, it has transformed traditional labor paradigms, providing many workers with flexibility and independence while simultaneously posing challenges related to job quality and precariousness (Anwar and Graham, 2021). This precarity may lead to job insecurity, reduced benefits, and increased stress levels for workers, negatively impacting their satisfaction and well-being (Kuhn and Galloway, 2019). Such challenges underscore the urgent need for collective bargaining mechanisms to enhance worker protection, ensure fair treatment, and improve working conditions (Miranda Boto and Brameshuber, 2022). To address these issues, a balanced strategy is essential—one that harnesses the advantages of flexibility while mitigating the risks of job instability and precarious employment (Himani Srihita et al., 2025).

As the digital economy continues to evolve, the online labor market is poised to exert an increasingly significant influence on global employment structures, labor policies, and socioeconomic inequalities. Therefore, understanding the dynamics of digital labor is crucial for formulating policies that strike a balance between flexibility and innovation, on the one hand, and fairness and inclusivity, on the other, in the future of work.

2. SCOPE OF THE GIG ECONOMY

The gig economy is referred to as the sharing economy, peer economy, on-demand economy, and platform economy (Taylor et al., 2023). The gig economy has rapidly emerged as a form of service delivery that challenges existing business models, labor-management practices, and regulations (Healy et al., 2017). The term "gig economy" describes a labor market characterized by temporary, independent, and flexible work arrangements (Devinatz, 2019). In this context, individuals often take a project-based approach, accepting various gigs or assignments as independent contractors rather than occupying traditional employee roles within organizations (Minter, 2017). Digital platforms have significantly accelerated the gig economy by connecting workers with employers or customers seeking specific services (Soundarya and Kumar, 2025).

The gig economy has several characteristics. One of the main characteristics of the gig economy is flexibility, which it offers to workers. As individuals can choose where, when, and how much they want to work, they can balance their personal and professional lives while pursuing different income-generating activities (Lehdonvirta, 2018). Many gig workers are independent contractors who provide their services only when needed (Nadler, 2017). Therefore, they do not require long-term contracts and choose which gigs to accept (Sridhar et al., 2023). Advancements in information technology play a significant role in the development of the gig economy (Damoska Sekuloska and Erceg, 2023). This transformation is evident in the shift from local to global labor markets, from full-time to temporally flexible work, and from permanent to casual employment (Kässi and Lehdonvirta, 2018). Gig workers utilize digital platforms, including ride-hailing apps, online marketplaces, and freelancing websites, to connect with clients or employers (Ray, 2024). These platforms act as intermediaries, linking buyers and sellers. Digital platforms are the most important and necessary place for

73% of freelancers to find a job, as their dominance stems from their ability to efficiently and quickly match supply and demand, leading to a significant reduction in transaction costs (McKinsey, 2015). These platforms provide access to skills and talent worldwide, offering decent pay and greater flexibility than the regular labor market (Damoska Sekuloska and Erceg, 2023). The gig economy encompasses a wide range of work types. Gig workers are present in various sectors, including transportation (such as ridesharing drivers), deliveries, household tasks, the arts, and business (Soundarya and Kumar, 2025).

The gig economy offers several benefits to its users. Freelancing enables individuals to set their own schedules, choose tasks that interest them, and have greater control over their professional lives than in traditional employment models (Roy and Shrivastava, 2020). It provides individuals with opportunities to supplement their regular income through side jobs, which may appeal to those looking to start a business or increase their earnings (Celestin and Vanitha, 2021). Gig work also enables individuals to regularly improve existing skills or acquire new ones. This platform enables individuals to explore different sectors, gain diverse experiences, and build a portfolio of work (Kuhn et al., 2021). The benefits of the gig economy vary significantly depending on whether the user is a business, a worker, or a customer (Swetha et al., 2025). For businesses, the gig economy enables companies to reduce expenses and enhance operational efficiency (Alon et al., 2023). Employers are not required to provide a physical workplace or benefits such as paid time off or health insurance, and this expectation is generally absent. The flexibility of the gig economy allows companies to hire specialists for short-term or specialized tasks that would be costly to employ permanently (Kuhn et al., 2021). In the gig economy, a worker's work-life balance may improve compared to traditional employment models. Workers in this field enjoy greater flexibility in setting their schedules, allowing them to avoid being limited to a single employer (Lehdonvirta, 2018). Customers appreciate the flexibility and diversity the gig economy offers for hiring individuals to deliver private services (Oranburg, 2018). Many services now offer higher quality at a lower cost than before. There is a broader range of service providers, delivery options, and physical locations available to you.

3. THEORETICAL FRAMEWORK

Freelancing, commonly conceptualized as the gig economy, does not represent a novel form of employment but rather a reconfiguration of labor practices that has gained renewed prominence in the digital era. Its modern manifestation emerged in the aftermath of the Great Recession, when significant segments of the global workforce lost access to stable, long-term employment and consequently turned to short-term, task-based engagements as a means of income generation. Scholarly analyses suggest that the gig economy served as a crucial employment buffer during economic downturns, providing temporary work opportunities when conventional, full-time positions were scarce (Donovan et al., 2016).

The rise of digital labor epitomizes this structural transformation by enabling individuals to perform discrete, independent tasks—or "gigs"—without maintaining permanent employment relationships (Graham et al., 2017). Accelerated by rapid advancements in digital and information technologies, the gig economy has evolved into a widespread and integral part of the employment landscape. Increasingly, workers are voluntarily transitioning from traditional employment to independent, project-based engagements distributed across multiple employers (Chen, 2016).

The Internet and digitalization have profoundly reshaped labor markets, altering the spatial and organizational dimensions of work. This transformation has generated new

occupations while simultaneously rendering specific traditional roles obsolete. Particularly within developing economies, the digital labor market has emerged as a crucial source of livelihood, serving either as a primary occupation or as a supplementary income stream. A growing body of research identifies the gig economy as a defining feature of contemporary labor dynamics (Taylor et al., 2017), reflecting broader shifts in work culture that prioritize flexibility, autonomy, and independence, underpinned by technological innovation (Kolmar, 2022).

The expanding population of freelancers constitutes one of the most significant developments in global labor evolution. The proliferation of online work platforms (Chan and Wang, 2018; Huws et al., 2017) positions digital labor and online talent marketplaces as foundational components of the future of work. Such platforms facilitate global labor connectivity, enabling the efficient matching of employers and skilled professionals irrespective of geographical boundaries (Horton et al., 2018). The interplay between information and communication technologies (ICTs) and gig-based employment reflects three overarching trends reshaping contemporary labor markets: (1) a shift from localized to global remote work, (2) a transition from full-time to flexible employment arrangements, and (3) a movement from permanent to temporary or project-based occupations (Kässi and Lehdonvirta, 2018). In this context, online freelancing offers a viable model for flexible employment, empowering individuals to participate in diverse projects without dependency on a single employer (Gray & Suri, 2019).

A notable consequence of this transformation is the phenomenon of virtual migration, whereby employment opportunities are digitally transmitted to workers, thereby negating the need for physical relocation (Lehdonvirta, 2018; Horton et al., 2018; Braesemann et al., 2018; Melia, 2020). The World Development Report (World Bank, 2019) acknowledges this shift as an irreversible transformation in work, urging economies to adapt institutional frameworks to integrate online freelancing while addressing its associated challenges effectively.

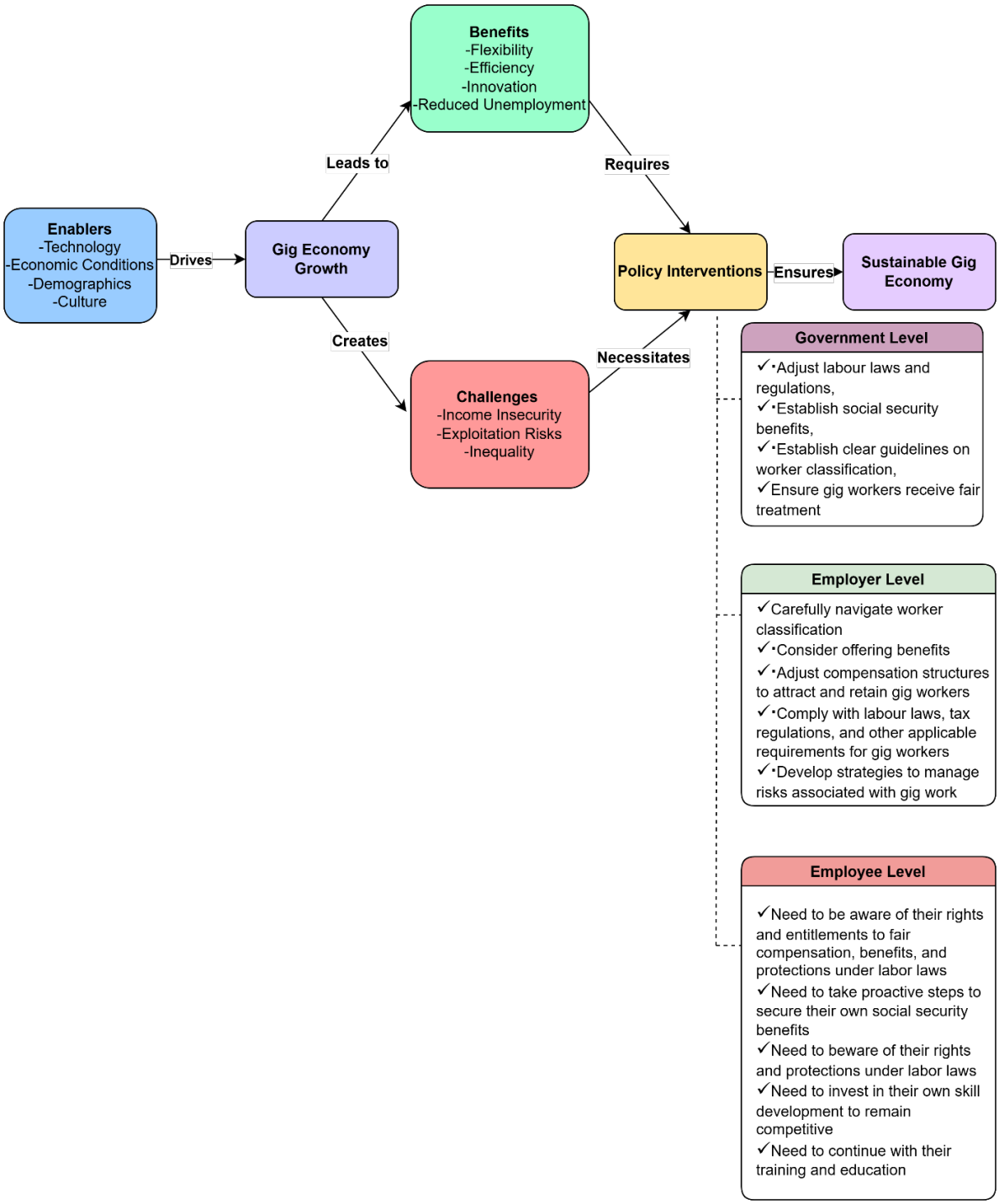
At its core, the gig economy involves the exchange of labor for monetary compensation through digital platforms that mediate interactions between service providers and clients, typically structured around short-term or task-specific engagements. These platforms have reconfigured the spatial organization of work, enabling individuals to offer services independently of their employer's physical location. This delocalization of labor mitigates local market constraints, enhances worker bargaining power, and may yield improved remuneration for specialized skills (Graham et al., 2017). Online outsourcing further generates new employment opportunities, particularly within developing economies. Empirical data suggests that while approximately 75% of freelance projects in developed contexts originate from domestic clients, nearly 90% of comparable work in developing regions is commissioned by overseas employers (Dunn, 2018). Digital platforms influence labor supply decisions primarily in two ways: first, by reducing entry barriers and enabling rapid access to income-generating activities without reliance on traditional recruitment processes; and second, by facilitating virtual labor migration, granting workers access to global opportunities beyond their immediate geographic constraints (Dunn, 2018).

These developments have profound implications for migration and socioeconomic development. Workers from regions with limited local employment prospects or skill mismatches can now participate in global digital labor markets, often choosing migration as an option rather than a necessity. As van Doorn and Vijay (2021) observe, the expansion of gig platforms as functional alternatives or extensions of existing migration infrastructures may have far-reaching economic and political implications, particularly in developing contexts.Younger generations have especially embraced the digital gig economy and are

increasingly promoted as a development strategy to enhance employment and national income in emerging economies (Heeks, 2017). For many workers, particularly in resource-constrained settings, digital gigs represent not only a primary livelihood but also a means of economic inclusion, providing access to income streams and opportunities that were previously unattainable due to the widespread adoption of digitalization and online labor platforms.

Based on the literature review and theoretical framework, we propose the following conceptual framework for researching the gig economy (Figure 1).

Figure 1. Conceptual framework for researching the gig economy



Source: authors

Key drivers of the gig economy include technological advancements, demand for labor flexibility, evolving worker preferences for autonomy, economic pressures, and changing regulations (Jain, 2024). These factors contribute to the rapid expansion and ongoing transformation of gig-based work structures across various industries, including ridesharing and freelance digital services. The rise of online platforms and mobile apps has enabled seamless matching between gig workers and clients, allowing instant access to work opportunities and streamlined workforce management (Sivapraksam and Jazil, 2025). Businesses increasingly hire gig workers to manage costs, address labor shortages, and access specialized skills without the expense of full-time employment or overhead (Kuhn et al., 2021). The appeal of flexible schedules, control over work location, and the ability to balance multiple roles or side hustles attracts diverse demographics to gig work, particularly younger workers and those seeking entrepreneurial experiences (Wu and Huang, 2024). Legislative shifts in employment status have an impact on the size and structure of the gig workforce. At the same time, cultural trends — such as increased mobility and the acceptance of non-traditional career pathways — continue to drive participation (Jain, 2024). Participation in gig work has been shown to facilitate skills acquisition, capital accumulation, and the launch of new businesses, effectively serving as a springboard for entrepreneurship, especially among first-time firm founders (Wheelahan and Moodie, 2022). A recent study concluded that gig workers are more likely to start new firms, often in industries related to their gig work, and use gig income to gain experience and capital before launching their own ventures (Denes et al., 2025). Contemporary analyses indicate that advances in digital technology, combined with business demands for scalability and workers' preferences for independence and diverse experiences, remain central to the growth of the gig economy.

Additional drivers of the gig economy include ease of entry and exit, asset requirements, flexibility and autonomy, risks and vulnerabilities, and earning potential. The gig economy's primary appeal lies in its ease of entry and exit, attracting individuals seeking immediate financial relief (Friedman, 2014). Access to platforms is influenced by prerequisites such as skills, job experience, and financial resources, as well as by recruitment processes that include document verification and interviews. In gig economies, barriers to entry are reduced as requirements are minimal. In a neoliberal economy, various stakeholders assume greater financial and operational risks beyond the company itself (Singh and Kadam, 2024). Gig platforms often require workers to own or rent essential equipment, such as cars, motorcycles, makeup kits, or outfits, before they can join and start work. Gig platforms essentially aim to offer workers flexibility in choosing their schedules and compensation. Gig workers differ from traditional employees in that they are seen as partners, sharing profits with their clients (Schwellnus et al., 2019). Gig platforms have thrived in the post-Fordist era by transferring market risk from businesses to workers. Workers face vulnerability stemming from the unpredictable aspects of their contractual relationships (Singh and Kadam, 2024). One advantage of gig work compared to traditional employment is the potential to earn based on the value of the job performed (Sharma, 2024).

On the other hand, the gig economy faces several challenges and concerns. Many gig workers have significant concerns about their economic security (Salleh et al., 2023). They experience financial insecurity due to the risk of low demand and difficulties maintaining a steady income. As independent contractors, gig workers often lack the benefits and protections provided to regular employees (Friedman, 2014). They may have difficulty accessing rights to social security and wages. Freelance workers also face challenges in accessing social safety nets, such as worker protection, disability insurance, and benefits, because the same legal frameworks that govern traditional employment are absent (Behrendt

et al., 2019). Gig workers frequently experience concerns about job security, opportunities for advancement, and income stability. To maintain consistent revenue, it is essential to regularly seek new opportunities and clients (Mwesha et al., 2025).

4. ENABLERS OF THE GIG ECONOMY

Technology as an enabler for the gig economy
Several studies have demonstrated that digitalization and globalization have contributed to the growth of the gig economy worldwide, offering alternative work arrangements that provide the advantage of flexible working hours. With the advancement in technology, people's preferences for jobs have changed from traditional ones to freelance services (Davidson and Infranca, 2016; Todolı-Signes, 2017; Jarrahi and Sutherland, 2019; Soriano and Panaligan, 2019; Jain, 2024). Numerous studies have shown that the gig economy has contributed to the development of non-standardized forms of work arrangements through digital platforms, driven by the rapid expansion of technological innovations. These platforms operate with low basic pay, job insecurity and low fringe benefits. Since the jobs are contractual and flexible in nature, they often serve as a secondary income source for most gig workers. This is often termed as on-demand jobs, digital work, just-in-time work, or the shared economy, where a short-term task is assigned to an individual for which they are contractually paid, and the platforms experience high worker turnover (De Stefano, 2016; Farrell and Greig, 2016). Contingent work is digitally mediated and can be performed remotely at the customer's location (Graham and Anwar, 2018). Extant literature has also shown that technological advancements have enabled the gig workers to grasp digital skills that have surfaced in India (Huang et al., 2018, 2020; Heeks, 2017) and digitally mediated gig work has become the need of the hour for the gig workers to work without any constraint of time and location (Gandhi et al., 2018).

Economic conditions and the uptake of the gig economy
Another crucial enabling factor for the gig economy is the state of the economy. Studies have shown that the gig economy has reshaped traditional labor markets, driving economic evolution (Farrell and Greig, 2016; Kumar et al., 2018; Jain, 2024; Zimoto, 2025). It offers alternative employment opportunities for marginalized groups, such as students, retirees, and individuals in remote areas (Katz and Krueger, 2016). This inclusivity expands the labor force participation rate and reduces unemployment rates (Benmelech et al., 2020). Moreover, the gig economy facilitates economic resilience by providing individuals with supplemental income during economic downturns (Graham et al., 2017). During periods of economic uncertainty, gig work provides individuals with a means to generate income, thereby contributing to overall economic stability (Foley et al., 2019). The gig economy represents a disruptive force that is reshaping traditional employment structures, fostering innovation, and driving economic evolution. However, it also raises important questions regarding labor rights, social protections, and income inequality. As the gig economy continues to evolve, policymakers, businesses, and stakeholders must address these challenges to ensure inclusive and sustainable growth (Jain, 2024; Shaiwalini and Patnaik, 2025)

Demographic-related factors and the gig economy
Several research works have explored the impact of demographic-related factors and the gig economy (Shekawat and Saxena, 2025; Perera et al., 2025; Choudhary and Shireshi, 2022; Cook et al., 2018). The recent work of Shekawat and Saxena (2025) has investigated the

impact of demographic characteristics on the stress level of gig workers. This study has highlighted that demographic factors, including gender, income levels, working hours, and educational backgrounds, are regarded as key stressors. The gig economy fosters worker flexibility, which is assumed to benefit women, who often bear family responsibilities (Cook et al., 2018). In a similar vein to what is depicted by Hinge et al. (2022), the number of women joining the Gig Economy has increased day by day, as it enables them to manage their own home and job. Indeed, women can balance their work and life, choosing their working hours and tasks (Hinge et al., 2022; Cook et al., 2018). Moreover, the McKinsey Report has stated that even a 10 percent rise in the gig economy workforce in India by 2025 will increase India's GDP rate by 16% (Mehata et al., 2020). As advocated by Hinge et al. (2022), the Gig Economy has led to alternative arrangements for career advancement among Millennials and the Z-generation.

Impact of culture and the gig economy

There have been ongoing research studies to investigate the significance of culture within the gig economy (Shaiwalini and Patnaik, 2025; Thomas and Baddipudi, 2022; Malik et al., 2021; Roy and Shrivastava, 2020; Vallas and Schor, 2020; Morgan and Nelligan, 2018). It has been stated that cultural norms and values are important considerations within the gig economy (Shaiwalini and Patnaik, 2025). Indeed, gig professionals must be proficient in staying organized, sustaining client relationships, and meeting deadlines for overseas clients, as well as coping emotionally when working with clients from diverse cultural and geographical backgrounds (Ashford et al., 2018). The role of digital platforms is crucial for introducing gig culture to developing countries and remote corners of the world (Roy and Shrivastava, 2020).

5. ADVANTAGES AND DISADVANTAGES OF GIG EMPLOYMENT TO EMPLOYEES

5.1. Advantages of gig employment to employees

Flexibility and autonomy

Since they are employed on contracts, gig employees have the flexibility to decide on the time of work, the duration of the contract, and the location of employment (Veluchamy et al., 2021). They can also manage their workload to cater to personal commitments (family and education). Furthermore, gig employees can work remotely from anywhere. These work arrangements relieve mandatory working hours (Lehdonvirta, 2018).

Greater independence and multiple sources of income

As gig workers choose their work/assignments, they tend to have more control over their decisions and methods. Compared to a dependent employee who seeks redistribution of profits, a gig employee describes their own boss, who seeks capital accumulation (Barratt et al., 2020). Considered micro-entrepreneurs, gig workers tend to be more entrepreneurial rather than adopting a worker-centric approach (Pollio, 2022). Moreover, they become more financially independent as they can generate income from multiple sources simultaneously. On the other hand, Mitchell and Decker (2021) note that gig workers exhibit income targeting such that they work less when they are close to their income goals.

Multi-skilling and experience from diverse sectors
Gig employment enables individuals to broaden their skills through their exposure to diverse industries and projects. The fact that they move in and out of the gig economy enables them to acquire new skills and competencies that are often transferable, which ultimately contribute to their employability and enhance wage negotiation (Kost et al, 2020). Nevertheless, the lack of intraorganizational development constrains them from developing higher-order skills, including managerial skills (Webster and Beehr, 2013).

Work-life balance and geographic freedom
The flexibility of deciding when to work and how much to engage in a project or assignment enables gig employees to structure their work by considering their personal priorities. Shahzadi et al. (2022) demonstrate that flexible work arrangements have a direct and significant influence on work-life balance. A study by Veluchamy et al. (2021) found that gig employees in India derive a high level of satisfaction influenced by the flexible working hours that improve their work-life balance compared to traditional workers. The study also concluded that the increased level of satisfaction and an improved work-life balance boost gig workers' productivity and motivation at work, such that other benefits linked to full-time employees are nullified. Moreover, the fact that gig work is generally digital and online-based broadens the opportunities for gig employees.

5.2. Disadvantages of gig employment for employees

Income, insecurity and inadequate social protection
Gig workers often face financial difficulties due to the lack of a guaranteed minimum income, unlike traditional workers (Nguyen Ngoc Thanh, 2025). According to Thomas et al. (2022), income insecurity can cause health and psychological distress. Additionally, gig workers often lack adequate social protection, as they are frequently excluded from benefits such as health insurance, paid leave, and retirement benefits (Ishaq and Darmawan, 2021).

Employment Precarity
Gig workers who are employed as independent contractors often run the risk of being laid off or having their hours reduced (Wood and Lehdonvirta, 2021), compared to permanent job holders who have solid employment protections, such as grounds for dismissal. According to Cheng and Chan (2008), employment precarity has harmful consequences, including inability to plan future employment, stress and ill health. Moreover, Wood and Lehdonvirta (2021) revealed that precarious work can be perceived as a feeling of insecurity about the future.

Limited Career Development
Gig workers typically do not receive formal training from the companies that employ them. According to Zheng et al. (2024), gig workers learn by doing or through the regular formal training provided by the online platform. The fact that gig workers are employed on short-term contracts restricts their career plans and career advancement. Since their transition is horizontal, they cannot develop higher-order skills, which restricts their propensity to be promoted to a managerial level. Gandini (2019) considers that gig workers have limited scope for personal growth and learning.

Lack of Unionization

As the gig workers are classified as independent contractors, they are generally not unionized. The fact that a formal employment contract does not bind them limits their right to associate with trade unions (Martindale et al., 2024). Their self-employed workers' status acts as a barrier to collective bargaining (Daskalova et al., 2021)

6. ADVANTAGES AND DISADVANTAGES OF GIG EMPLOYMENT TO COMPANIES

6.1. Advantages to companies

Cost efficiency
Since gig workers are employed on a contractual basis, firms are not required to incur additional fixed costs related to their employment, such as benefits, bonuses, insurance, and pension policies, as well as other fringe benefits. As higher pay rates are required to maintain a large pool of workers, lower profit margins are expected (Lian et al., 2025). Moreover, Oranburg and Palagashvili (2021) consider that the rapid growth of technology and innovation contributes to a reduction in the transaction costs associated with long-term employment.

Workforce flexibility
Gig employment enables firms to adjust their workforce size, which is often influenced by changing market conditions and seasonal demand. According to Ganapathyraman (2024), gig workers can serve as a buffer to meet unexpected fluctuations in demand and economic conditions, while Suryawanshi and Ponde (2024) enumerate the potential of gig employment to create a flexible workforce. According to Allon et al. (2023), companies benefit from labor flexibility by hiring employees on a real-time basis, i.e., employing them when needed.

Access to specialized talent
Instead of employing workers on a long-term basis, firms have the option of hiring employees as needed to meet the company's specific requirements. As the boundaryless career perspective equips employees with diverse skill sets to transition between employers, firms can easily tap into these skill sets as needed (Kost et al., 2020). Moreover, the gig economy enables firms to develop innovative talent management models by providing them with access to global talent (Satpathy et al., 2024). Additionally, firms benefit from their exposure to various settings through their short-term assignments.

Increased productivity and innovation, and a reduction in training costs
Gig workers have the potential to foster innovation based on the experiences they acquire by working in various sectors/industries. According to Talukder et al. (2025), technology-enabled integration of gig workers improves their productivity. Being self-trained and experienced, companies do not have to incur additional training costs for gig workers. Having a culture of adaptation and innovation (Celestin and Vanitha, 2023), employees invest in upskilling themselves to remain relevant and up to date (Behera and Gaur, 2022).

6.2. Disadvantages to companies

Lack of commitment and loyalty
As gig employees are not emotionally tied to the organization due to the absence of long-term employment relationships, they demonstrate low organizational commitment. According to

Aboobaker et al. (2022), gig workers generally lack a sense of organizational citizenship, which tends to result in them being less loyal towards their employers. In a similar vein, Zhang and Liu (2020) questioned the loyalty of "casual labourers," while Velimirovic (2023) emphasized the lack of commitment among gig economy workers. Moreover, it becomes difficult to standardize the performance level of gig workers who work independently.

Reduced control and coordination
Companies have less direct control over the performance of gig employees since they operate outside the traditional employment structures. Unlike workers employed in a substantive capacity, gig employees determine their own working schedules and work in various geographical locations, making quality control more challenging. Furthermore, the fact that various companies contract gig workers make it difficult to control their performance (Roberts and Douglas, 2022). Similarly, the employment of gig workers from diverse cultural and geographical backgrounds presents significant communication challenges. In a similar vein, the absence of face-to-face interactions with the employees can lead to miscommunication. However, the use of standardized IT platforms ensures consistency in communication and streamlining of processes.

Data Security Issues
As gig workers are often employed on short-term contracts and are rarely bound by strict confidentiality clauses, the risks of data breaches or sensitive data leaks are high. Since gig workers use personal devices for handling different jobs, the likelihood of data leaks and cross-contamination (that is, accidentally sharing sensitive information with third parties) exists (Adebowale and Akinnagbe, 2023)

The above challenges can affect the company's reputation, financial position and operational disruption.

7. POLICY IMPLICATIONS

This paper contributes to gig work research by theorizing the role of resource vulnerability in shaping the differential experiences of workers. As the gig economy rapidly evolves, a comprehensive policy framework is crucial for policymakers to address its multifaceted challenges and capitalize on its potential. As we have seen, while promising immense benefits in terms of innovation, work flexibility, and service provision, the gig economy also presents a host of challenges that call for a comprehensive policy approach. The policy implications of the gig economy are multifaceted and far-reaching, affecting governments, employers, and employees in distinct ways. The key considerations for multiple stakeholders are as follows:

For Governments:
- Regulatory frameworks: Governments need to adjust labor laws and regulations to address the unique challenges of the gig economy, ensuring fair treatment and protection for gig workers.
- Social security and benefits: Governments may need to establish or extend social security benefits, such as unemployment insurance, healthcare, and retirement plans, to gig workers who lack traditional employment benefits.
- Worker classification: Clear guidelines on worker classification are essential to prevent misclassification and ensure gig workers receive fair treatment.

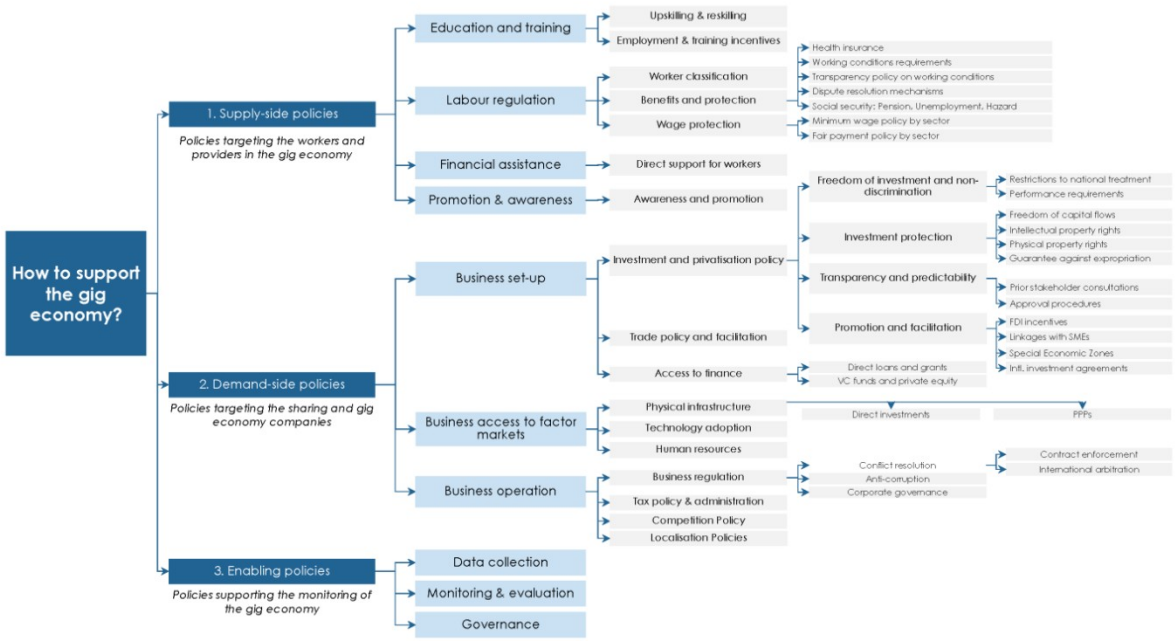
- Taxation: Governments need to develop effective taxation systems to capture income from gig work and ensure tax compliance.

For Employers:
- Worker Classification: Employers must carefully navigate worker classification to avoid misclassification issues and potential penalties.
- Benefits and Compensation: Employers may need to consider offering benefits or adjusting compensation structures to attract and retain gig workers.
- Compliance with Regulations: Employers must comply with labor laws, tax regulations, and other applicable requirements for gig workers.
- Risk Management: Employers should develop strategies to manage risks associated with gig work, including worker injuries and disputes, to ensure a safe and secure work environment.

For Employees:
- Fair Compensation Gig workers need to be aware of their rights and entitlements to fair compensation, benefits, and protections under labor laws.
- Social Security and Benefits: Gig workers may need to take proactive steps to secure their own social security benefits, such as retirement planning and healthcare insurance.
- Worker Rights: Gig workers should be aware of their rights and protections under labor laws, including the right to collective bargaining and protection against exploitation.
- Skill Development: Gig workers need to invest in their own skill development to remain competitive in the gig economy.
- Training for Gig Workers: A Systematic Review and Research Agenda by Panpan Zhang (Zhang, 2025) offers a systematic review of gig worker training, identifying competency and economic rationales behind current practices and highlighting the emphasis on skill enhancement, particularly digital proficiency, while noting gaps in addressing the impact of algorithmic management on workers' mental health and job satisfaction. Furthermore, it points out the lack of inclusive training, especially for marginalized groups such as women and immigrants.

Zhang (2025) proposes a research agenda focusing on long-term outcomes and tailored training frameworks for the gig economy, advocating for more strategic and inclusive approaches in this evolving labor landscape. Overall, the gig economy requires a coordinated response from governments, employers, and employees to ensure fair treatment, protection, and benefits for all stakeholders involved. Whiteshield's Gig Economy Policy Framework, supported by its database of global best practices, can help governments steer the gig economy to foster innovation, deliver better quality services, and provide gainful employment for their citizens (Sullivan and Homsy, 2023). As we have seen above, while promising immense benefits in terms of innovation, work flexibility, and service provision, the gig economy also presents a range of challenges that necessitate a comprehensive policy approach. Figure 2 below highlights Sullivan's and Homsy's (2023) Whiteshield's proposed policy framework, which comprises supply-side, demand-side, and enabling policies

Figure 2. The gig economy policy framework



Source: adapted from Sullivan and Homsy, 2023

8. CONCLUSION

The gig economy is a transformative force in contemporary labor markets, reshaping traditional employment structures and introducing a new model of work based on flexibility, autonomy, and digital connectivity. This shift has expanded employment opportunities and entrepreneurial pathways for a diverse range of individuals, including marginalized groups, while also enhancing economic resilience during periods of uncertainty. However, these benefits are accompanied by significant policy and social challenges, particularly regarding income instability, insufficient social protection, employment precarity, and limited career development.

To harness the benefits and address the risks of gig work, governments must develop adaptive regulatory frameworks that clarify worker classification and extend social protections to platform-based workers. Employers should innovate compensation models, support skill development, and manage the organizational risks associated with a flexible, digitally mediated workforce. For gig workers, understanding their rights, actively pursuing upskilling opportunities, and engaging in collective bargaining are crucial strategies for navigating the changing employment landscape.

The ongoing growth of the gig economy requires a multi-stakeholder approach, with coordinated efforts across policy, business, and workforce sectors to ensure fairness, security, and inclusivity. By investing in digital infrastructure, developing inclusive training programs, and promoting best practices, stakeholders can maximize the sector's potential for innovation and job creation while upholding social justice and economic sustainability. Ultimately, mutual preparedness – rooted in collaboration, forward-thinking policy, and ongoing research– will be essential for individuals, organizations, and societies to thrive in the evolving world of work shaped by the gig economy.

Ongoing research is vital; future studies should examine varied gig work experiences across regions, evaluate the long-term effects of skill development initiatives, and assess the mental health impacts of algorithmic management to better inform policy and practice. In conclusion, ensuring mutual preparedness for both individuals and organizations will maximize the gig economy's potential for sustainable innovation and job creation while minimizing its associated risks.

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BEYOND THE GREEN LABEL: ENTREPRENEURSHIP, GOVERNANCE, AND THE SUSTAINABILITY PARADOX - THE CASE OF BENGUERIR'S GREEN CITY

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Abstract
Entrepreneurship is increasingly presented as a pillar of sustainable urban and regional development, promising innovation, socio-environmental alignment, and resilience. The Green City of Benguerir in Morocco attempts to embody this ambition through a variety of flagship initiatives. As a result, the city has gained visibility on national and international stages as a knowledge-based sustainability model.

This paper investigates how entrepreneurship is mobilized in urban sustainability agendas, how it operates across scales of governance, and the way it shapes the sustainability trajectory of an emerging city. We seek to extend current debates by adopting analytical induction as our methodological stance. Beginning with the hypothesis that entrepreneurship acts as a catalyst for sustainable urban transformation, the claim is tested and refined through two complementary tools: (i) critical discourse analysis of institutional documents, planning policies, and media outputs; and (ii) the design of an Entrepreneurial Governance Matrix, assessing alignment (or misalignment) of entrepreneurial narratives and practices across local, national, and global scales.

The findings reveal a multi-scalar paradox. At higher scales, the Green City of Benguerir is promoted as a flagship model of sustainable urbanism, drawing strength from certifications, strategic branding, and institutional entrepreneurship enhancing its territorial attractiveness and international visibility. At the local scale, however, this narrative faces significant limitations, raising questions about the actual social and environmental impacts of sustainability initiatives. Such asymmetries invite a more critical reading in which institutional and entrepreneurial strategiescan strengthen or constrain urban sustainability depending on how they are governed and articulated across scales. For readers and practitioners, the intended benefit is twofold : a novel methodological framework focused on analyzing entrepreneurship in sustainable urban governance, and practical insights into how bridging global branding with local empowerment can help sustainable cities transcend performative models and advance resilient, equitable, context-sensitive transformations.

Key words: Sustainable City, Entrepreneurship, Urban Governance, Urban Sustainability, Territorial Development, Multi-Scalar Governance, Green City of Benguerir.

ENTREPRENEURSHIP AND EUROPEAN VALUES AS DRIVERS OF SUSTAINABLE INNOVATION AND DIGITAL TRANSFORMATION

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Abstract
Today, entrepreneurship can no longer be defined solely through financial metrics but must be framed within the context of the European Union's values, which establish its priorities and developmental directions. The EU's core values—democracy, rule of law, solidarity, inclusion, and sustainability—constitute essential pillars for shaping innovative and resilient entrepreneurial ecosystems. This paper examines entrepreneurship in practice through the perspective of these values, with particular focus on three strategic dimensions: sustainability, digitalization, and social impact.

Digitalization is analyzed in relation to EU policies that foster the transition toward a technology-driven, innovation-oriented, and highly connected economy. Sustainability is addressed within the framework of the European Green Deal, circular economy principles, and the obligation for companies to integrate ESG criteria into their business models. Social impact is examined in the context of advancing equal opportunities, diversity, and corporate social responsibility, which increasingly serve as criteria for competitiveness and legitimacy in the European marketplace.

The study is grounded in an evaluation of EU policies, recent reports (such as the European Innovation Scoreboard and the Global Innovation Index), and case studies from Member States that have successfully embedded EU values into their entrepreneurial strategies. The findings emphasize that EU values function as strategic instruments that stimulate innovation, foster sustainable value creation, and enhance economic resilience in the face of global challenges, rather than serving merely as normative principles. At the same time, the Republic of Moldova and other Eastern Partnership countries have the opportunity to harness these directions to recalibrate their entrepreneurial ecosystems in line with European standards and to strengthen their global competitiveness.

Key words: innovative entrepreneurship; European values; digitalization; sustainability; social impact; circular economy; economic resilience

EVALUATING THE ROLE OF AGRICULTURAL SUBSIDIES IN AGRITOURISM DEVELOPMENT: A CASE STUDY FROM ALBANIA

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This study explores the impact of Albania's national agricultural funding schemes on the development of the agritourism sector, using a qualitative, exploratory case study approach. The research focuses on up to 40 representative agritourism farms, employing semi-structured interviews with owners and managers, complemented by document analysis of funding applications and related materials. Thematic coding and cross-case synthesis are used to assess the effects of subsidies on farm expansion, productivity, sustainability practices, and overall business performance. Findings indicate that financial support has contributed to improvements in infrastructure, service quality, and operational resilience. However, systemic barriers—such as bureaucratic inefficiencies, limited access to information, and inconsistent funding flows—hinder the full realization of these benefits. The study highlights the importance of streamlining administrative processes and implementing targeted policy interventions to enhance the effectiveness of public investment in agritourism and supporting broader rural development goals.

Key words: role of subsidies, agriculture, rural tourism, rural development

LEVEL OF DISASTER PREPAREDNESS OF LINDAWAN NATIONAL HIGH SCHOOL

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Abstract
Disaster preparedness is the active process of planning, organizing and preparing people, families, community and institutions to respond to and recover. The main purpose of this research is to determine the students' level of preparedness, the benefits they gain, and their knowledge about disaster readiness. This study used a quantitative descriptive research design with 130 respondents selected through stratified random sampling at Lindawan National High School. The findings show that the overall weighted mean for the level of disaster preparedness is 3.10, indicating that students are well-prepared. The benefits of disaster preparedness obtained an average weighted mean of 3.17, which suggests that it is often beneficial for the students. Meanwhile, the knowledge on disaster preparedness has an average weighted mean of 3.0, meaning the students are often knowledgeable. In conclusion, Lindawan National High School provides proper evacuation procedures, first aid kits, and seminars to ensure student safety. The researchers recommend that barangay officials continue organizing seminars and awareness activities to further strengthen students' preparedness.

Keywords: Disaster preparedness, knowledge on disaster preparedness, awareness

COMPARATIVE ANALYSIS OF LOCAL GOVERNMENT AND CITIZEN CONTRIBUTIONS TO SUSTAINABLE WASTE MANAGEMENT (SDG 12) IN GREECE, ITALY, SERBIA AND MOLDOVA

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Abstract
The present paper coordinates a four-country comparative study on SDG 12 (waste management) that deliberately privileges flexible, qualitative, and practice-based evidence, complemented where available by secondary statistics. The paper pursues two fully independent, parallel outputs:

1.Institutional/Policy paper comparing legal frameworks, multi-level governance, implementation capacity, EU alignment, and funding mechanisms in Greece, Italy, Serbia, and Moldova.

2.Citizen/Practices paper comparing public engagement, NGO initiatives, municipal programs, and local case studies that enable (or hinder) waste prevention, separate collection, and recycling.

The paper will harmonize country profiles via a common template, ensure comparability through shared definitions and inclusion criteria, and run a light quality-assurance loop (triangulating policy documents, municipal reports, NGO outputs, and academic literature).

Keywords: cosmetology products, sustainability, environmental attitudes, social attitudes, consumers, Attica, Greece

SESSION

"Culture – Museums – Religious and Cities"

Chaired by **Assoc Prof Astara Olga-Eleni** and
Prof Papaioannou Georgios

EVALUATING THE ROLE OF MUSEUMS ON CITIES' SUSTAINABLE DEVELOPMENT: A COMBINED ANALYSISOF ATHENS AND SINGAPORE

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Abstract
The role of culture in the sustainable development of cities is undisputed, which is why Europe is oriented towards cultural tourism as a means of fostering tourism development and differentiating it as a competitive global product. Culture has a profound impact on the formation of individual identity and "culture uniqueness" of a given society. The evaluation of "cultural-economic" goods takes place in a multidimensional socioeconomic framework. In social terms, the main benefits are the social inclusion of diverse groups, the promotion of social unity, the development of diversity, the encouragement of productivity and originality, and finally, the enhancement of national cultural identity. From an economic perspective, cultural industries have a significant impact on the national GDP, gross added value, and the reduction of unemployment. At the same time, they contribute to improving the balance of payments, fostering competitiveness, and attracting businesses and investors. To this effort of cities to foster their regeneration or reconstruction, museums were an important component of culture to the development of places.

Based on our main hypothesis, regarding the major importance of culture on cities multidimensional development and in particular to role of museums, this paper, aims to examine, the dynamic connection between the role of museums and the viable development of cities as well as the salience of this interdependence. Using qualitative approach, through a combined analysis (case study, content and comparative) we examine social, economic, cultural, technological, and environmental criteria as a framework, aiming to elucidate and highlight the significance of implementing cultural policies for the sustainable development of cities in contemporary globalized societies. The correlation under investigation is revealed by evaluating and comparingthe Acropolis Museum, in Athensand the Art Science Museum, in Singapore.

Keywords: museums; cultural policy; sustainable development; museum contribution; creative cities, combined analysis

KmVert "URBAN RELIGIOUS ARCHAEOLOGY": A SUSTAINABLE SOCIO-CULTURAL VISION FOR URBAN REGENERATION

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Abstract
As part of the urban development project *"Km Vert"*, an intriguing area of investigation is Urban Religious Archaeology, which examines the transformation of sacred spaces in contemporary cities within broader socio-cultural change and urban regeneration processes. The focus lies on disused religious sites—primarily churches no longer active in liturgical functions—which have become symbols of a transition from traditional religiosity toward new forms of collective identity and spatial belonging.

While industrial ruins are often effectively reused and integrated into the urban fabric, sacred spaces present more complex challenges. Their symbolic and emotional significance, rooted in historical and community identity, can generate tensions—intensified by the acceleration of digital communication and the fragmentation of urban experiences.

The phenomenon of religious archaeology includes both abandoned churches still under the traditional ecclesiastical administration and newly built sacred spaces that often lack vitality or cultural relevance in today's society. A critical reinterpretation of these places is proposed, one that moves beyond conventional spatial logic and promotes their integration into unusual urban contexts—such as shopping centers, green infrastructures, or hybrid community spaces—capable of fostering new forms of social interaction.

This approach calls for a paradigm shift in architectural design and urban planning, where the reuse or transformation of religious spaces becomes part of a broader strategy for inclusive and sustainable urban regeneration. Demolition or repurposing must be approached with care, balancing preservation, innovation, and social cohesion.

Finally, the concept of a "biological standstill" is introduced—a deliberate pause in the design process aimed at redefining the relationships between clients, architects, and communities. This reflective interval can foster new cultural production models, reactivating religious heritage as a living resource within the evolving identity of the contemporary city.

Keywords: Urban, archaeology, urban regeneration, sacred, cultural place, religion, Km Vert

WHICH FUTURE EXACTLY? JUSTICE AND SUSTAINABILITY IN AFROFUTURIST LITERATURE AND MODERN GREEK SPECULATIVE FICTION

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Abstract
This paper will examine how justice and sustainability are portrayed in Afrofuturist literature and Greek science fiction. Greek speculative literature, often engages with themes shaped by Western experiences and contemporary national issues like economic instability and technological dilemmas as also addressing environmental problems. Afrofuturism, conversely, regularly imagines technologically advanced societies free of racial inequalities promoting ecological harmony. However, despite their different cultural and historical contexts, both genres demonstrate concerns on social and environmental issues as well as the search for a fairer and more sustainable world.

By using a comparative approach the paper examines four representative examples, two of Afrofuturist and two of Greek science fiction, portraying dystopian and utopian futures in order to reveal the universality of these issues emphasizing on social justice, environmental balance and collective identity. The analysis unveils the beneficial role of literature as a cultural product that can inspire social change. The study of such works can thus contribute meaningfully to the reconstruction of our world highlighting the role of human values as a foremost priority over a technocratic world.

Key words: justice, Greek science fiction, Afrofuturism, future, sustainability

1. INTRODUCTION

In Lewis Carroll's *Alice's adventures in Wonderland*,(1869) little Alice trying to find her way through the wondrous world she fell into, crosses paths with a Cheshire Cat and in her confusion, poses the following question: *-Would you tell me, please, which way I ought to go from here? -That depends a good deal on where you want to get to*. Cat replies. Then Alice adds: *-I don't much care where [...] so long as I get "somewhere"*(Carroll, 1869, p.89). On our journey on this Earth, we all need a sense of direction. Especially in today's world, where technological progress has permeated our lives and social and economic inequalities are intense, finding a direction that could alleviate these problems is crucial.

This reality has led international bodies and organizations to investigate the concept of justice in the age of globalization. At the same time, the pursuit of eliminating inequalities at environmental, economic, and more broadly social levels remains an active demand for ensuring the sustainability of the planet (*The Sustainable Development Goals Report*, 2025; Pikalo et al., 2022;*Addressing justice and sustainable development –UN enviroment programme*, 2019; *European environment agency, Analysis and Data, Delivering justice in sustainability transitions,* 2024; *United Nations Development Programme,* n.d.).

Contemporary discussions within international organizations treat justice and sustainability as unified objectives, emphasizing the intergenerational dimension and developing appropriate strategies towards this direction. In the same time this inseparable connection between justice and sustainability as a moral responsibility shared by all, depends on the decisions made today (*The Sustainable Development Goals Report*, 2025; Pikalo et al., 2022;*Addressing justice and sustainable development –UN enviroment programme*, 2019; *European environment agency, Analysis and Data, Delivering justice in sustainability transitions,* 2024; *United Nations Development Programme,* n.d.).

However, as these practices do not always succeed in incorporating historical or social injustices and past errors, imagination emerges as a means of giving us a new direction and offering a more radical and immediate solution. Within this realm, human beings are able to find space for the realization of their desires and to interpret life around them in alternative ways, challenging dominant narratives and claiming a space of hope or constructing of a more free and sustainable society (see also: Womack, 2013; Zipes, 2009; Sandner (Ed.), 2004). In particular, speculative literature—utopias and dystopias, as well as science fiction, with their distinctive characteristics—provides an outlet for addressing both social and environmental problems by projecting either an improved or a deteriorated form of life that differs from the one we currently experience (Imarisha, 2015; Fitting, 2010; Vieira, 2010; Bhatia, 2022; Sargent, 1994; Stableford, 2010; Hotston, 2022; Otto, 2019). These realms expose the shortcomings of the social sphere, offering critical perspectives on issues such as environmental pollution, overpopulation, and more explicitly political concerns, including justice (Imarisha, 2015; Fitting, 2010; Vieira, 2010; Bhatia, 2022; Sargent, 1994; Stableford, 2010; Hotston, 2022; Otto, 2019), thereby expanding the range of solutions that may be proposed for frequently emerging social problems or historico-political failures that continue to persist in the world today.

The present article aims to explore aspects of justice and sustainability in four literary works from the late twentieth and early twenty-first centuries: two from Afrofuturist literature and two from Greek science fiction, which is here regarded as a subgenre of speculative literature[2]. Specifically, *Parable of the Sower* (2014) by Octavia Butler and *Ιστορίες από ένα περασμένο μέλλον* [*Stories from a Distant Future*] (2023a) by Μιχάλης Μακρόπουλος [Michalis Makropoulos] focus on the concepts of justice and sustainability, placing particular emphasis on the management of environmental and social issues. Similarly, *The Deep* (2019) by Rivers Solomon and *Επιστροφή στο Λίκνο* [*Return to the Cradle*] (2023) by Ιωσήφ Μανίκης [Iosif Manikis], examine these concepts with particular attention to the issues of collective memory and identity. By adopting a comparative close reading of the selected texts, prioritizing textual analysis rather than relying on a theoretical framework, the paper investigates how these works, as examples of Afrofuturist and Greek science fiction exemplify the diverse strategies and creative practices through which speculative fiction addresses the issues of justice, sustainability.

[2] As the distinction between *speculative fiction* and *science fiction* does not constitute the primary focus of the present article, it suffices to note that there is extensive discussion in the international scholarly literature regarding these terms. It is worth noting that the boundaries between them are not rigid, and the distinction is not absolute. For further discussion, see indicatively: Canavan & Link (2019); Oziewicz (2017, March 29); Latham (Ed.) (2014); Suvin (1972, 1979), Mancuso (10 August, 2016).

2. JUSTICE AND SUSTAINABILITY IN AFROFUTURIST LITERATURE AND GREEK SCIENCEFICTION

The interaction between the Greek experience and the African American experience (as articulated through Afrofuturism), as well as Greek science fiction, is to a great extend shaped by their historical pasts and traditions, a past marked by subjugation and oppression, acknowledging the fundamental importance of equality, the pursuit of democratic freedoms and the respect for nature (see indicatively: Mawere & Mubaya, 2016; Santas & Anagnostopoulos (Eds.), 2018). Such cultural exchanges showcase the unique characteristics of different traditions and their contributions to global efforts for justice and sustainability beyond national boundaries.

Afrofuturist literature constitutes a form of expression of Afrofuturism, a term introduced by Dery (1994) in the 1990s, which has continued to develop rapidly up to the present day (Yaszek, 2013). It aims at the creation of a more just and hopeful future for the Afrodiasporic community through science fiction and technology, while foregrounding African culture in order to reconstruct and challenge the darker aspects of history—namely, the history of slavery, colonialism, and *white supremacy* (Dery, 1994; Womack, 2013; Lavender III, 2019; Yaszek, 2013; Yaszek, 2006; Carter, 2022; Eshun, 2003). This approach, extending across various art forms such as music, painting, cinema, and literature, seeks to overturn stereotypes surrounding Black identity while also projecting a more positive image of Africa (see also Elia, 2014; Tosaya, 2018; Womack, 2013; Eshun, 2003). Through Afrofuturism, an effort to redefine the present and to heal the traumas of the past is an absolute priority (Yaszek, 2013; Womack, 2013; Lavender III, 2019).

The sustainable and just future for the black race remains an enduring demand. From the plantations and the slavery period to present-day movements advocating for the human rights of Black people, such as *Black Lives Matter*, today's American cities, bearing the traumatic histories, the defeats and victories of the Black people (Hood, 2020), still reveal ongoing inequalities. Beyond the creation of new worlds, Afrofuturism seeks dignified conditions for marginalized communities and inclusive participation in sustainable environments that are not shaped by racial or colonial constraints (*Building the Future*, 2024; Dearing, 2024). The creativity fostered by Afrofuturism is expressed through projects such as those by Michelle Mlati for example, which are oriented toward the design of spaces in which the Black community can live under conditions of equality and inclusion, free from racial discrimination (Latief, 2019; *Building the Future*, 2024; Omotalade, 2023). With the aim of repositioning the Black community at the center rather than at the margins, the equitable distribution of energy, the restoration of ecological imbalances, and the struggle against environmental racism and imperialism are central to its demands (Omotalade, 2023; Schell, 2024).

In particular, Schell (2024) makes some more interesting remarks regarding Afrofuturist position on sustainability and responses to the climate crisis with notable clarity, emphasizing that a return to the past and a harmonious reconciliation with ancestral values stands in opposition to harmful practices that affect the entire ecosystem (Schell, 2024). As he notes, the emphasis placed on learning from the mistakes committed in the past, can help prevent future catastrophic consequences as well as the acceptance of the fact that humans are part of nature should lead to deeper mutual understanding beyond racist behaviors, a condition that constitutes a prerequisite for equitable and sustainable coexistence (Schell, 2024).

The Afrofuturist understanding of sustainability is not solely environmental or racial but also technological. Thus, Afrofuturism, as a collective project advocating equal access to technology and rejecting the racialized *digital divide* narrative (Nelson, 2002, p. 6), envisions

a future more closely linked to the questioning of dominant Western power structures. It maintains that technological developments should be understood as outcomes of cultural inventiveness (Schell, 2024) rather than merely as products of speculation, oriented not toward domination over nature but toward harmonious coexistence with it (Schell, 2024). As seen in the film *Black Panther*, the fictional *Wakanda* is portrayed as an advanced technological country located somewhere in Africa, rich in resources and culture, and inhabited by courageous heroes (Googler, 2018).

Despite lacking the coherence of Afrofuturism as a cultural and social movement Greek science fiction, engages also with themes of justice and sustainability in an analogous way. Grounded in the long tradition and experience of ancient Greek culture, Greek speculative thought with its origins in Lucian's *True History* (2nd century AD) continues to constitute a stable foundation of Greek literature throughout the twentieth century and beyond, emerging from Greece's historical and political developments, including struggles for democracy and equality, the World Wars, the dictatorship and the linguistic dispute surrounding the transition from *Katharevousa* to *Demotic Greek* (Pastourmatzi, 1999b; Nikolaidou, 2022a; Λάζος, 1989).

From the early twentieth century onwards, works of Greek science fiction by authors such as D. Voutyras and P. Pikros refer to utopian journeys into space and to societies of equality and freedom, while simultaneously offering sharp criticism of the capitalist and authoritarian structures of the society of their time (Pastourmatzi, 1999b; Σταθάτος, 2025). From the 1970's onwards, the genre began to spread more widely (Καλαντζής, 2022; Nikolaidou, 2022b; Λάζος, 1989), and ecological concerns were increasingly present, including environmental pollution, nuclear energy, and overpopulation, issues that preoccupied humanity more broadly during those decades, as well as reflections on technological achievements and the role of human identity or reservations regarding technological intervention (Λάζος, 1989; Μπέσσα, 2024).Nevertheless in light of historical traumas, Greek science fiction—especially in its early stages—focused on themes of loneliness and alienation (Nikolaidou, 2022a) and in contrast to Afrofuturism, it has tended to be more cautious, engaging primarily with the negative aspects of technology, with a tendency to project darker visions of social and environmental conditions (Nikolaidou, 2022a). Thus, economic crisis, refugees, and criticism of capitalist and authoritarian practices—often articulated through dystopian narratives—come to dominate, with perhaps the exception of younger writers, placing emphasis on solidarity and the hope of achieving a more just society (Nikolaidou, 2022a).

Although Afrofuturism constitutes a genre in continuous development and of central interest to the African American diaspora, Greek science fiction displays two defining characteristics. For many years, it functioned as marginal literature—often labeled *paraliterature*—with little but nonetheless significant publishing efforts (see also Σταθάτος, 2021; Λάζος, 1989; Καλαντζής, 2022; Σταθάτος, 2025; Pastourmatzi, 1999a), while adopting a hybrid identity derived largely from influences and imitations of English and American science fiction (Σταθάτος, 2025; Nikolaidou, 2022b; Nikolaidou & Pseftakis, 2022; Nikolaidou, 2022a; Λιθαρής, 2003). As a result, issues related to social change and sustainability are often linked to foreign models, since the genre has maintained a continuous relationship with Anglophone and American science fiction and its market ledding to the extensive imitation of linguistic or cultural patterns, as well as the incorporation of social concerns or other historical pathologies such as colonialism which although not entirely its own, are nevertheless transmitted through it (Σταθάτος, 2025; Nikolaidou, 2022b; Nikolaidou & Pseftakis, 2022; Nikolaidou, 2022a; Λιθαρής, 2003).

Despite the challenges it continues to face, contemporary Greek science fiction appears to be finding a balance between preserving its cultural heritage and aligning itself with the international scene of speculative literature, while at the same time engaging with its own national sociopolitical issues and articulating concerns of inclusion (Nikolaidou, 2022b; Nikolaidou & Pseftakis, 2022). A central concern for writers of speculative fiction in Greece today is the concept of justice in the era of Greece's migratory and economic crisis after 2010, writing about class inequalities in future alternative societies, with an emphasis on inclusion, and equality in society as collective demands (see also Christou, 2022; Kanari, 2022). As a crossroads of cultures and a European country, Greece produces future-oriented narratives inspired by its own contemporary socioeconomic problems, such as the refugee crisis, racism and migration, poverty, the limits and possibilities of biotechnology, and broader social inequalities, often envisioning Athens in a future era (Kanari, 2022; Αρβανίτης (Ed.), 2017; Nikolaidou & Pseftakis, 2022). The same applies to works such as that of Νίκος Ξένιος, [Nikos Xenios] entitled *Αλλοτεκοίτη, Εκεί που χάθηκε η βλάστηση* [*Allotekoiti, Where Vegetation Was Lost*] (2023), which constitute an allegory of the contemporary era exposing the consequences of the environmental crisis, including desertification of mutated ecosystems as a result of profit and capitalist interests. Others such as those N. Φερεντίνος, [N. Ferentinos] (see: *Μηνύματα από τα Ηλύσια πεδία* [*Messages from the Elysian Fields*] , 2021), as well as in the works of M. Μανωλιός [M. Manolios] (see: *Αγέννητοι Αδελφοί*, [*Unborn Brothers*], 2014) pose metaphysical and existential questions concerning human life, as well as the issue of artificial intelligence and the relationship between justice and moral consciousness.

This search for its originality gives an optimistic outlook that science fiction in Greece will have the potential to further evolve as a genre, increasingly addressing the country's social and political problems in the future (Nikolaidou, 2022b). Moreover, Σταθάτος [Stathatos] (2025) claims that signs of recovery are evident today, emphasizing the important role that Greek science fiction plays on environmental, technological and social crises seeking to avoid stigmatization a "low" or non-canonical literature (Σταθάτος, 2025).

3. NATURE, SOCIETY AND COSMOS: ENVIRONMENTAL AND SOCIAL DIMENSIONS OF JUSTICE AND SUSTAINABILITY IN "PARABLE OF THE SOWER" AND "STORIES FROM A DISTANT FUTURE"

Parable of the Sower (2014), the first book in Octavia Butler's (1947-2006) duology, stands as one of the most characteristic works of Afrofuturist literature (García, 2024; Ruffin, 2005; Choudhury, & Mukherjee, 2023), particularly revealing regarding issues of social justice and the search for sustainable practices in a collapsing world. As an author of *neo-slave narratives*, she focuses broadly on the social injustices endured both by the Black race and other minorities (García, 2024; Guerrero, 2021; Kouhestani, 2015). The story follows a young Black teenager, Lauren Olamina, the daughter of a pastor priest, who, through her diary, keeps notes of life in a dystopian California 2024 in the walled city of Robledo, where hyper-industrialization as well as the dissolution of social values are common place (Butler, 2014; Manuel, 2004).

As a person born with hyperempathy, (Butler, 2014, p.37) the ability to intensely feel the emotions of others, she is troubled by this decay and unfairness as the city of Robledo is on the brink of collapse, plagued by economic and racial inequalities and criminality (Butler, 2014): *Even in Robledo, most of the street poor—squatters, winos, junkies, homeless people in general—are dangerous. They're desperate or crazy or both.[…]. They carry untreated*

diseases and festering wounds. (Butler, 2014, p. 18). In this dystopia, Butler will show the need to confront the irrationalities of the present and its contradictory character, as the only solution for overcoming it, criticizing capitalist and racist ideologies of the postmodern world (Miller, 1998; Phillips, 2002). Lauren will resist to this catastrophe envisioning a new belief system called *Earthseed*, which would not share in the decomposition of the Western world (Dunning, 2020). The new religion will have *change* as its focus aiming at creating a society that employs critical thinking and projecting the ethical interdependence of humanity and the future: *All that you touch,/You Change./All that you Change,/Changes you./The only lasting truth/Is Change./God/Is Change.* (Butler, 2014, pp. 95-96). Her crucial message is that this religion must find its roots in the stars, showing us that escaping Earth and expanding to other worlds is what will constitute the beginning of a more just and sustainable society and will act as a counterweight to the present chaotic condition, opening up to new places like the stars where the healing of social wounds (Guerrero, 2021; Stillman, 2003).

Also, behind this search for new worlds these *post-apocalyptic geographies* (Guerrero, 2021, p. 42) as a more just and balanced choice, Butler hides the search for a new identity, free from constraints of religious and racial violence. Her work alludes also to the years of slavery while demonstrating the author's anarchic approach to building worlds outside the global, Eurocentric system (Guerrero, 2021; Dunning, 2020; Moreno, 2020). Furthermore, Butler condemns uncritical adherence to faith drawing inspiration from the relationship of African Americans with the Bible opposing the Eurocentric God of the whites who considered Black people sinners (Manuel, 2004; Choudhury & Mukherjee, 2023; Kouhestani, 2015).

On the journey to realize her vision, Lauren will begin a trip North with a few companions, and during her journey, she will help and care for people, thus showing that Acorn, the destination, is also the root of her religion's philosophy (see also: Butler, 2014, p.669). This religion, based on solidarity, the transcendence of social stereotypes, and the necessity of human action, emphasizes community's resilience in order to achieve transformation in the face of the social failures of the present (Phillips, 2002; Miller, 1998; Guerrero, 2021) but also symbolizes the collective journey towards a more optimistic future through our inevitable connection to the laws of the universe: *We are all Godseed, but no more or less so than any other aspect of the universe, Godseed is all there is—all that Changes. Earthseed is all that spreads Earthlife to new earths.* (Butler, 2014, pp. 68-69)

Basically, the future Butler proposes is based on the belief that it is not so much about something renewing and different, but rather about reshaping what already exists as adaptation seems to be the sustainable solution to the dead-end (Manuel, 2024; Dunning, 2020). She expresses both the refusal to submit to a faith that serves injustice and the will for adaptation and resilience in order to survive, offering the community a safer existence (García, 2024; Manuel, 2004; Choudhury & Mukherjee, 2023).

In this hope for a more just and consequently sustainable reality, social impasses also drive the stories of ΜιχάληςΜακρόπουλος [Michalis Markopoulos] (1965-) in *Ιστορίες από ένα περασμένο μέλλον* [*Stories from a Distant Future*] (2023a), in which social and political decline is equally intense, and with the ease of fiction, the stories move between different temporal boundaries (Αθανασέλος, 2023; Δημητριάδου, 2023). The future here reflects the dystopian present. The writer himself confirms that: *Just as I don't believe there is "historical" fiction, I also don't believe there is "futuristic" fiction. Whatever is written in an era, in one way or another, reflects its era* (Μακρόπουλος, 2023b, paras 3). Also

Περατνωνάκης [Perantonakis] (2023) remarks that: *Our Earth, [...]would nostalgically yearn for today's reality as a lost utopia, not ideal but certainly better than its projection.* (Περαντωνάκης, 2023, para. 3). Therefore, the future, as Λιναρδάκη [Linardaki] (2023) says, reflects present failures emphasizing that the stories aim to convey a lesson of humanity, encouraging awareness to promote change in the world (Λιναρδάκη, 2023). In general, writer's concerns, as expressed in other works like *The Sea* (Μακρόπουλος, 2020), which fall within the genre of climate fiction (Αθανασοπούλου, 2025) depict post-apocalyptic landscapes where the consequences of the environmental crisis, produced by governmental oligarchy, are highlighted, while simultaneously projecting the value of human bonds (Pfefferkorn, 2024; Μακρόπουλος, 2023a; Κουρούπη, 2024; Αθανασοπούλου, 2025). In *Ιστορίες από ένα περασμένο μέλλον* [*Stories from a Distant Future*] (2023a), technology plays a dominant role as people, amidst the decline, find refuge in it, while the stories are set in a future time where human existence experiences a continuous dead-end, far from any notion of happiness, with technological progress bringing not only advancement but also regression (Αθανασοπούλου, 2025; Περαντωνάκης, 2023).

In these narratives, religious and technological critiques prevail. In the short story *Ishmael* (Μακρόπουλος, 2023a, pp. 141-187), traditional God is absent while the people of a forgotten province, lacking technical knowledge, deify an old, derelict wind turbine, portraying the results of a non-sustainable society due to technological decline: *a fallen, broken God with its wings that had rolled down the hill[...] the God of plastic things, of beast-humans*. (Μακρόπουλος, 2023a, p. 174; Αθανασοπούλου, 2025). In another titled *The Earth with Two Moons* (Μακρόπουλος, 2023, pp. 119-134), economic decline, resource scarcity and overpopulation dominate: *On Earth, life was unbearable. In every corner, people were starving and giving birth. The more their hunger, the more children they gave birth to* (Μακρόπουλος, 2023a, p. 119). In such a condition, the social elite relocates to the Moon (a female-led) and Ηώ [Eos] (male-led) respectively, colonies where reproduction is carried out via artificial wombs (Μακρόπουλος, 2023a, pp. 119, 127).The plot of *The Planet with Two Suns* (Μακρόπουλος, 2023a, pp. 67-83) deals with the indictment of capitalist excess, environmental exploitation, and social injustice. In the future, planet *Kepler-1812b* produces *ballardium* ore, used by the wealthy on earth for medical purposes and time travel, and *kefe*, a drug more accessible to the poor (Μακρόπουλος, 2023a, pp. 67-69,72-73). Access to the new resources only enhances the age-old problems of social inequality and uneven access to health care (Μακρόπουλος, 2023a, pp.119-120). The pair eventually moves there where people work under harsh conditions in the *dry, hot air* (Μακρόπουλος, 2023a, p.76), until the man dies and the girl wanders off into the inhospitable planet (Μακρόπουλος, 2023a, p.83).

In *The Photographer* (Μακρόπουλος, 2023a, pp. 85-107), the story portrays a world where ecological destruction has serious social consequences. Unable to restore the natural world to its previous state, society's response is to attempt to create a virtual reality through which it hopes to provide the illusion of justice and sustainability (Μακρόπουλος, 2023a, pp. 85-107). In the story, the protagonist's job, established by a special committee, is to create more acceptable virtual representations of a crumbling world as an *unrealist* (Μακρόπουλος, 2023a, p. 86): *A temporary healing in the reality of ruins [...] a world that doesn't exist but is the one we'd like to have existed.* (Μακρόπουλος, 2023a, pp. 85,86). His actions range from *resurrecting a starving polar bear that was rummaging through garbage* (Μακρόπουλος, 2023a, p. 87) to *restoring the image of the sunken Solomon Islands* (Μακρόπουλος, 2023a,

p.93). In this universe, where social structures like schools and hospitals have collapsed, the attempt to post real photos of destruction is considered a crime, pursued by the *unliners* (Μακρόπουλος, 2023a, pp. 85-107,99). The story emphasizes the cost of confronting the systemic decline as Lene, a girl with anorexia, dares to upload illegal photos that capture reality as it is, but the story ends with her dying, while the protagonist, having fallen in love with her, secretly uploaded unreal images portraying her as a healthy person (Μακρόπουλος, 2023a, pp. 106-107, 95).

The fundamental question posed by these works is, in essence, the aftermath of a world in dissolution and collapse, particularly how humans will find their balance, and what role justice plays in such a fragile world. Butler creates, ex nihilo, a new, hopeful status where creative adaptation and community support are the guarantees for a just and sustainable coexistence. On the other hand, Μακρόπουλος [Makropoulos], while showing the importance of human relationships as a transformative factor for a more sustainable society, focuses on the futile attempt of humanity to escape the conditions that imprison them, as in this post-apocalyptic world, justice is unattainable while the lack of sustainability has led to social and environmental decay.

4. NAVIGATING JUST AND SUSTAINABLE FUTURES: COLLECTIVE MEMORY AND IDENTITY IN "THE DEEP" AND "RETURN TO THE CRADLE"

In the work *The Deep* (Solomon, 2019) by queer writer Rivers Solomon[3] (1989-), with Daveed Diggs, William Hutson, and Jonathan Snipes[4], is a novella where sustainability and justice are intertwined with collective memory and the acceptance of past trauma. The work, another example of Afrofuturist literature, echoes the traumatic historical event of the transatlantic slave trade and the broader context of slavery, when pregnant Black women were thrown overboard and murdered at sea while their descendants survive as mermaids known as wajinru in an underwater city. This future emerging from a painful past is in line with wider Afrofuturist perspectives of a hopeful tomorrow and quest for the equitable and harmonious living of black populations. The novel deals with central issues concerning Black history, such as that of the trauma of the Transatlantic revisited through the lens of counter-memories, projecting the voices of the oppressed and enabling both the confrontation of historical trauma and the envisioning of healing (Kannan, 2022; Dawn & Alan, 2025; Er, 2023; Jenson, 2022; Calvo-Pascual, 2024). For wajinru, life beneath the surface of the ocean becomes crucial for their survival. Even though as Solomon emphasizes, this ocean city is utopian, a space where there are no misfortunes, inequalities, economic hardship, nor properties depriving the financially weak of housing rights (Solomon, Nov. 2019) legacy of suffering still torments this world. The Ocean presented as a transitional space between individual identity and

[3] The designation fae/faer is the most appropriate for the queer Rivers Solomon, as she herself states on her website (Solomon, n.d.).

[4]The work, and especially the idea of an underwater society and beings that originated from the transatlantic slave trade, comes from the creations of the electronic music group *Drexciya* and their album "The Quest" (1997), and later from the hip hop band *clipping* (2017), consisting of Daveed Diggs, William Hutson, and Jonathan Snipes. See also: *Drexciya* - 01 Intro (2021)

collective memory, the space of transition from death to rebirth represents a sense of belonging, but also a space where Black and queer identity emerges (Dawn & Alan, 2025; Xausa, 2025; Er, 2023; Patrizi, 2023; DeLoughrey, 2022).

Inside this watery landscape, the society of the wajinru is one of forgetfulness: *Their memories faded after weeks or months—if not through wajinru biological predisposition for forgetfulness, then through sheer force of will.* (Solomon, 2019, pp.15-16) and this inability to remember perpetuates injustice making the wajinru society powerless to heal itself (Solomon, 2019, p.22). The historian, Yetu, keeps wajinru's memories alive, bringing them back in the annual ceremony of "Remembrance" making sure that the past is neither forgotten or erased (Solomon, 2019, pp.19-22). As Dawn & Alan (2025) emphasize, Solomon, through the non-human and hermaphroditic form of Yetu, projects a polyphonic dimension onto the historical perspective, while negating the Western separation between life and death, incorporating the wajinru who exist in a continuum of life-death (Dawn & Alan, 2025, p. 7). Within that frame the work highlights the restoration of the traumatic past and collective memory as the only means of shaping a more just and sustainable future but also the difficulty of such an endeavor without personal cost. Yetu, unable to bear the weight of all the memories and torn between her personal desires and the responsibility she has to her community, faces a serious existential crisis (Solomon, 2019, pp. 14,22, 56-57, 71-72). Deciding to travel to the surface in order to confront her own experiences and memories she meets Oori, a *two-leg*, whose lack of traumatic past helps Yetu's emotional healing and leads to the restoration of her own justice too (Solomon, 2019, ch. 5, pp. 110-158): *"I know who I am now. All I knew before was who they were, who they wanted me to be," said Yetu. "And it was killing me. It did kill me. I wasn't Yetu. I was just a shell for their whims.* (Solomon, 2019, pp. 157-158). Nevertheless, the memories and concern for the wajinru feel like a storm of waves, forcing her to return to them and face her demons (Solomon, 2019, ch.9). Having overcome her loneliness, she finds meaning in reconnecting with her community as this appears to be a more balanced choice: *Could it really be that there was a version of the world where everything would be eradicated? Gone?[...] If it was a choice between the History and emptiness, maybe Yetu wanted the History.* (Solomon, 2019, pp. 206, 237-238).

In the political fantasy novel by ΙωσήφΜανίκης [Iosif Manikis], *Επιστροφή στο Λίκνο* [*Return to the Cradle*] (2023), we follow the journey of four cosmonauts from a suffering Earth, to the planet Λητώ [Leto] in 2060 with the spaceship *Αργώ*[*Argo*](Manikis, 2023). The discovery of the planet had filled humanity with hopes for an encounter with new life forms or the possibility of colonization (Μανίκης, 2023, pp. 78-81). However, the planet is inhospitable and the cosmonauts return to Earth after seventy years, only to find out that Earth has recovered with significant advancements in all sectors (Μανίκης, 2023). This just and sustainable condition has been achieved through a return to the roots, which constitutes a rebirth. It is this return that has brought ecological and social balance, as well as the restoration of historical and social injustices. Now Earth is trying to become *the bright home of all humanity, without distinctions and limitations* (Μανίκης, 2023, pp. 205-206) and the dream of a better world appears to have been fulfilled in the Cradle instead of a distant planet. Having expanded into new colonies inside the solar system such as the *Uranian State* composing an autonomous ecosystem, this utopia shows environmental flourishing in harmony with technology, with core values of communal ownership and respect for property (Μανίκης, 2023, pp. 207, see also ch.1, pp. 205-214, ch. 4, pp.226-232). Solutions to

environmental issues are drastic, indicating a utopia in progress with clear optimistic future prospects (Μανίκης, 2023, ch. 2, pp. 245-256). On a political and social level, peace, the abolition of borders, and the elimination of state oversight over citizens have shaped a society of justice with *absolute freedom of thought and action* (p. 207). People are all equal, following the Enlightenment model, with an emphasis on diversity (Μανίκης, 2023, pp. 209-210) and participation in democratic processes (Μανίκης, 2023, pp. 210-211, ch.1, pp. 205-214).

Here, the issue of the return to the *Cradle*, which is Earth, constitutes the author's main concern, along with the anxiety about its future as well as its origin and evolutionary path (Μπρίκος, 2025). The changes occurring in various parts of Earth are given in detail, thus projecting the wealth of Greek cultural heritage, but also the explosion of natural wealth and beauty encountered in places like the Amazon, etc., a place ideally sustainable and just (Μανίκης, 2023, pp. 132-138; Ζηλιασκοπούλου, n.d.), emphasizing the image of a utopia through the presentation of characters who symbolize real figures of world History and more broadly with political references but also in everyday moments (see also Μπρίκος, 2025; Ζηλιασκοπούλου, n.d.).

The book has existential and philosophical dimensions, raising questions about humanity's place in the Universe and the value of collectivity and our connection to the universe, while the issue of experience and memory, transferred to the inner world of the protagonists, transcend here, as in Solomon (2019), the concept of time and its linear perception (Αθάνατος, 2025). The cosmonauts recall their memory upon their return and, having come face to face with the past, they also seek a new beginning, while their connection to the universe projects the Global destiny as that element which knows no geographical boundaries (Αθάνατος, 2025). The author's message about the value of collectivity for achieving a better and more hopeful future (Αθάνατος, 2025) leads him to a novelistic synthesis that, as he poses questions, also answers them. As he himself says: *[the work] raises reflections and poses questions, with the main one being: Is utopia an unattainable dream or can it become practice, can it become eutopia, the good place, the feasible dream?* (Μανίκης, 2024).

In the societies of Solomon and Μανίκης [Manikis], justice is achieved through memory and the reclamation of the past. In Solomon's case, justice is identified with the recovery of history, of the forgotten past, while in Μανίκης [Manikis], it is achieved when humanity connects with its original homeland, its roots, thus rectifying its mistakes or injustices. This existential dimension of justice and the emphasis on collective identity as hope for its restoration are complemented by the idea of sustainability. In the case of *The Deep* (2019), remembering the past and confronting the trauma could help the submarine wajinru society to better survive in the future. Similarly, in Μανίκης [Manikis's] work, reuniting with the environment, nature, is what helps in the recovery of humanity and leads to a more sustainable future.

5. CONCLUSIONS

The above analysis highlighted four forms of justice and sustainability in four corresponding literary works. Through the comparison of these concepts from two literary traditions which, even if they exhibit differences, present significant points of convergence, the importance of

redefining values such as humanity, collectivity, and cultural identity is highlighted as solutions for a just and sustainable life, pointing out that that technology and science alone is not sufficient to resolve these issues. The study of such works can thus contribute meaningfully to the collective movement toward a more just and equitable future portraying fiction's role as a powerful tool for reflexion on ethical and ecological preoccupations. In that sense these narratives not only raise awareness of these notions but also invites us to imagine future where, perhaps, the *Wonderland* is no longer just a bad dream, as Alice experienced it, but a place we've managed to reach, *the place* as she would say, *we've finally arrived at*.

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MARINE PARKS & CULTURAL SUSTAINABILITY: THE ROLE OF IONIAN AND SOUTH AEGEAN NATIONAL MARINE PARKS IN PROMOTING MARITIME CULTURAL HERITAGE AND ISLAND RESILIENCE

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Abstract
This study investigates the contribution of the Ionian and South Aegean National Marine Parks to the promotion of maritime cultural heritage and the sustainable development of island regions. Traditionally perceived as environmental protection zones, marine parks are increasingly recognized as strategic spaces for the integrated preservation of both natural and cultural capital, especially in island ecosystems vulnerable to climate change. The research is grounded in a multidisciplinary theoretical framework that combines cultural ecology, sustainable cultural tourism, and resilience studies. It draws on critical analysis of official management plans, legislative frameworks, and interpretative strategies that frame marine parks as hybrid infrastructures, simultaneously ecological, educational, and cultural.

The literature review highlights successful international cases where protected marine areas contribute not only to biodiversity conservation but also to the transmission of intangible heritage, such as traditional navigation, mythologies, local coastal rituals, and vernacular seascapes. Particular emphasis is given to the role of marine parks in supporting place-based narratives and fostering eco-cultural tourism as a vehicle for economic revitalization and intergenerational learning. Expected outcomes of the study include the identification of best practices for embedding cultural dimensions into marine spatial planning and the proposal of policy recommendations that position marine parks as drivers of green, inclusive, and culturally informed island development. In the context of the climate crisis, this approach underlines the importance of integrating cultural sustainability into regional resilience strategies.

Keywords: marine parks, cultural heritage, island sustainability, climate resilience, maritime identity.

MUSEUMS AND SUSTAINABLE GREEN DEVELOPMENT: THE CASE OF GREECE

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Abstract
The relationship between museums, sustainable development, and green development is complex and multidimensional, underscoring the role of museums as institutions with distinct social, cultural, and educational responsibilities. Within the broader framework of sustainable development, museums are increasingly aligned with the United Nations Sustainable Development Goals (SDGs), particularly those addressing social inclusion, economic viability, and environmental responsibility. In parallel, the concept of green development emphasizes the need for museums to actively reduce their ecological footprint by adopting practices such as energy efficiency, renewable energy integration, sustainable construction methods, and waste reduction strategies. Climate change further intensifies the urgency of these commitments. On the one hand, museums face direct risks from extreme weather events, rising global temperatures, and the gradual deterioration of cultural heritage assets. On the other hand, museums possess a unique capacity to contribute to climate change awareness by interpreting scientific knowledge, translating it into culturally resonant narratives, and engaging diverse audiences in dialogue and collective action.

This paper presents the preliminary results of an ongoing research project that investigates current realities and prospects of the relationship between museums and sustainable green development in Greece. Methodologically, the study relies primarily on semistructured interviews with key stakeholders, including individuals and institutional representatives. It is conducted as a collaborative initiative between the University of West Attica and the Ionian University. Early findings suggest that the Greek case demonstrates an intersection of environmental, social, economic, and cultural dimensions, all of which influence how museums address sustainability and green development. The research further highlights the need for institutional reform and open, inclusive dialogue aimed at developing coherent strategies and policies. Ultimately, the study argues that museums can act as mediators between science, policy, the economy, and society, adopting a future-oriented stance that promotes resilience and fosters environmentally conscious communities.

Keywords: Museums, Sustainable Development, Green Development, Climate Change, Cultural Heritage, Environmental Responsibility, Social Awareness

SUSTAINABLE CULTURAL DEVELOPMENT THROUGH AN INTERPRETATIVE APPROACH WITHIN THE FRAMEWORK OF THE CLIMATE CRISIS - A MATHEMATICAL MODEL AND FIELD RESEARCH: THE CASE OF DELPHI

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Abstract
Sustainable cultural development is not merely a "goal" for a city or a region; it constitutes a fundamental element of mediation between memory, history, the economy, and the environment. The theoretical approach, together with the empirical cultural orientations of this study, takes into account the 2030 Agenda and the Sustainable Development Goals, as well as the "Faro Convention," through which states commit to safeguarding cultural heritage and citizens' rights of access and participation, while UNESCO's policies on the sustainable management of World Heritage monuments are also imposed.

Delphi is one of the World Cultural Heritage Monuments recognized for its high aesthetic value, universal historical significance, and outstanding artistic importance, as the center of the ancient world where the Temple of Apollo and the sanctuary of oracles were located. It is noteworthy that for nearly a thousand years Delphi hosted rulers, emperors, and ordinary people who flocked to the site seeking guidance and the power of the god's priestess.

From our investigation of the Delphic landscape, it is acknowledged as both a common and contested good, requiring further interdisciplinary methods of protection and participatory management. In this context, Delphi offers an exceptional opportunity to link culture with environmental protection and sustainable cultural regional development.

In brief, the Delphic landscape is not limited to the archaeological site but extends to the broader cultural ecosystem, stretching from the steep foothills of Mount Parnassus to the Pleistos valley and the historic olive grove of Amfissa, reaching the maritime gateway of Itea and the naval past of Galaxidi. The interaction of these elements shapes a unified cultural geography in which cultural heritage may serve as a catalyst for inclusive, green, and sustainable cultural development.

Therefore, in this study, the promotion of Delphi constitutes a comprehensive paradigm of sustainable regional development policy, in which culture interweaves with nature, the knowledge economy, social cohesion, and respect for the ecological limits of local communities. At the same time, Delphi is among the most emblematic cultural landscapes of the planet, where history, ancient memory, the natural environment, and contemporary socio-economic dynamics interact within a complex web of spatial, cultural, and environmental relations. In this regard, an attempt is made to develop a holistic model in which culture could function as a driver of sustainable cultural development, a "living laboratory of cultural heritage."

Furthermore, the analysis encompasses historical, geophysical, and climatological elements, as well as current challenges (climate change, seismicity, carrying capacity, seasonality of demand, and infrastructure pressures). Critical questions are raised as to whether Delphi, through strategic interventions and dynamic management practices, could overcome the climate crisis.

Simultaneously, this research outlines a set of fundamental principles governing sustainable cultural development, aiming to enable green transition management toward sustainable growth, social cohesion, and the well-being of local residents within a diachronic model shaped by the climate crisis. To this end, both a mathematical model and field research were employed.

Keywords: Delphi, UNESCO World Cultural Heritage Site, climate change – crisis, mathematical model, field research, sustainable cultural development

VALUING UNDERWATER CULTURAL HERITAGE AS RESOURCE FOR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF BANTRY BAY HARBOUR

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Abstract
Maritime cultural heritage is increasingly recognized as a valuable resource for sustainable development and the well-being of local communities. A critical aspect of this is Underwater Cultural Heritage (UCH), which includes any trace of human existence with cultural, historical, or archaeological significance that has been underwater for at least 100 years. These sites, ranging from shipwrecks to ancient settlements, provide unique insights into human history, technological development, and the long-standing relationship between coastal communities and the sea. In Ireland, research on UCH remains limited, with a primary focus on shipwrecks as a means of cultural memory or legal protection. This study seeks to bridge this gap by evaluating UCH in Bantry Bay not only as a heritage asset but also as a driver for biodiversity protection and community engagement. By integrating cultural, ecological, and social dimensions, the research demonstrates the broader significance of Bantry Bay's maritime underwater cultural heritage for environmental protection and sustainable local development.

Keywords: underwater cultural heritage, sustainable tourism, marine protected areas, blue economy.

INTRODUCTION

Beneath the waters of Bantry Bay lies a hidden world where history, culture, and nature converge. This being said, maritime cultural heritage is recognized as a valuable resource for sustainable development and the well-being of local communities around the world. An increasingly studied aspect of maritime cultural heritage is underwater cultural heritage (UCH). Under the UNESCO 2001 Convention on the Protection of the Underwater Cultural Heritage, underwater cultural heritage includes any trace of human existence with cultural, historical, or archaeological significance that has been underwater for at least 100 years, such as shipwrecks, submerged archaeological sites, and ancient settlements. These sites provide unique insights into human history, technological development, and the long-standing relationship between coastal communities and the sea.

This study aims to highlight the value of Bantry Bay Harbour's maritime cultural heritage, with a focus on submerged underwater cultural heritage, including shipwreck sites such as *La Surveillante*, as a case study. It explores the potential creation of a marine protected area to safeguard these cultural sites, promote marine biodiversity, and ensure long-term conservation. The research also investigates the possibility of sustainable tourism development through active participation and engagement of local communities, as well as the intentional formulation of new UCH sites by contemporary actors. By integrating cultural, ecological, and social dimensions, the study demonstrates the broader significance of Bantry

Bay's maritime underwater cultural heritage for heritage preservation, environmental protection, and sustainable local development.

AIMS, OBJECTIVES, AND RESEARCH QUESTIONS

This research project is driven by three primary aims: to assess the value of Underwater Cultural Heritage (UCH) in Ireland through a case study on Bantry Bay, Cork; to explore how UCH can be incorporated into marine spatial planning and marine protected area (MPA) frameworks, ensuring that cultural, ecological, and community values are considered together in sustainable marine management; and to explore the potential of UCH to support sustainable tourism, including options such as underwater cultural heritage museums or heritage trails and diving tourism in the area. To achieve these aims, the study is structured around several core objectives, including determining the cultural, historical, ecological, and socio-economic value of UCH in Bantry Bay through archival research, literature review, and interviews with state officials from the Ministry of Culture and underwater heritage authorities. Furthermore, the project seeks to evaluate the potential of marine protected areas and coastal/maritime zoning as tools for protecting and managing UCH by analyzing existing GIS data to map the geographical and socio-economic zones of Bantry Bay, particularly in relation to the shipwreck site near the working harbour. Finally, it aims to examine existing policy frameworks and stakeholder participation in the governance of UCH in Ireland by reviewing existing legislation, conducting interviews with relevant stakeholders, and organising workshops with the local community as it relates to existing but also future UCH.

These objectives are guided by three central research questions:

1. Is it feasible to utilize underwater cultural heritage in Bantry Bay sustainably, following established international best practices, and to what purposes?
2. To what extent does UCH in Bantry Bay align with the objectives of the EU Blue Economy, including sustainable development, marine conservation, and community benefit?
3. How feasible are policy and governance changes to formally incorporate UCH into a marine protected area (MPA) framework in Bantry Bay, and what would be the implications for maritime activities and local stakeholders?

LITERATURE REVIEW AND STATE OF THE ART

Foundational frameworks, such as UNESCO's 2001 Convention and the ICOMOS Principles, provide the international context for protection and sustainable management of UCH. Additionally, studies from southern Europe (e.g., Pérez-Reverte Mañas et al., 2021; Koutsi & Stratigea, 2019) demonstrate how UCH has been successfully integrated into Blue Economy strategies, particularly through sustainable tourism and participatory spatial planning, offering models for adaptation to the Irish context. However, recent scholarship (Kyvelou & Chiotinis, 2022) emphasizes the need to reconnect cultural and natural capital, reinforcing the proposal's aim to situate UCH within broader socio-ecological systems. In Ireland, research on UCH remains limited, with most attention focused on shipwrecks as cultural memory (Delaney, 2018) or on legal mapping and protection (Kelleher et al., 2025). To date, little consideration has been given to their socio-economic or tourism potential as well as socio-ecological implications. This proposal builds directly from these contributions, proposing to evaluate

UCH in Bantry Bay not only as a heritage asset but also in the contexts of sustainable local development, biodiversity protection, and community engagement.

This project advances the state of the art by critically examining successful paradigms of underwater cultural heritage (UCH) management from Southern European contexts to Ireland, where integration of UCH into sustainability strategies remains limited. Existing Irish research has focused on documentation of shipwrecks, cultural memory, and legal protection, but has not addressed UCH's potential socio-economic, ecological, or tourism value (Delaney, 2018). Similarly, work on legal mapping and protection highlights important frameworks but leaves open questions on sustainable reuse and local engagement (Kelleher et al., 2025). By situating Bantry Bay Harbour as a case study within the EU's Blue Economy framework, this project tackles this gap, demonstrating how UCH can be mobilised not only as a heritage asset but as a driver of sustainable development and biodiversity protection. Theoretically, the project also contributes by reconnecting cultural and natural capital, answering calls by Kyvelou and Chiotinis (2022) to bridge heritage and ecology. The concept of "reconfiguring ruins" underscores that cultural ruins are not inert remains but active sites shaping identity, resilience, and future imaginaries (DeSilvey & Harrison, 2020). This perspective is particularly relevant for submerged heritage, which has often been overlooked in broader debates about cultural and environmental futures. By applying this lens, the project reframes UCH as part of socio-ecological systems, rather than as isolated artefacts, thereby advancing debates in heritage studies and sustainability science.

Furthermore, the project engages with emerging critiques of the Blue Economy's ambiguity and risks of exclusion. Recent work highlights the need to embed justice, equity, and community voices at the centre of blue economy initiatives, cautioning against exploitative "blue growth" models that privilege economic gains over ecological or social sustainability (Germond-Duret et al., 2022). By foregrounding local participation, stakeholder engagement, and inclusive governance, this research responds directly to such critiques, proposing a model for a just and sustainable integration of UCH into environmental and development policies. The timing of this project is particularly advantageous, as it engages with Bantry Bay before emerging demands and uses around underwater cultural heritage intensify. By proactively exploring sustainable management and community engagement, the research aims to anticipate potential conflicts and support equitable, forward-looking strategies for heritage and ecological protection. In sum, the project contributes new empirical evidence for Ireland, extends theoretical debates by positioning UCH within justice-oriented and interdisciplinary sustainability frameworks, and provides practical tools for policymakers. It ensures that Irish scholarship not only aligns with but extends European and international best practice by demonstrating how heritage, biodiversity, and community well-being can be co-advanced.

RESEARCH DESIGN AND METHODOLOGIES

This research employs an interdisciplinary design that synthesizes perspectives from geography, ecology, maritime archaeology, and tourism management. The study utilizes a mixed-methods approach, combining qualitative and quantitative data to assess the diverse values associated with Underwater Cultural Heritage (UCH) in Bantry Bay and to evaluate the feasibility of regional sustainable tourism. The framework further bridges theoretical and practical dimensions by examining relevant policy structures alongside the perspectives of stakeholders, including national and local cultural authorities, Cork County Council, and the local community.

The methodology is structured into the following key components:

Theoretical Analysis
During the doctoral research, core concepts and theoretical frameworks serviceable to Irish UCH will be identified, evaluated, and applied. A comprehensive literature review will examine existing research on UCH in Ireland, specifically focusing on Bantry Bay. Archival sources, including the Irish National Monuments Service, the Shipwreck Inventory of Ireland, and the Underwater Archaeology Unit, will be accessed alongside local libraries and digital databases to investigate the shipwreck *La Surveillante*. This investigation will cover the circumstances of its discovery, archaeological studies to date, and its current status within heritage management frameworks. Additionally, participatory research will be undertaken to highlight and anticipate other existing or emerging typologies of UCH in Bantry Bay.

GIS-Based Spatial Analysis
Spatial analysis will be conducted using Geographic Information System (GIS) data for Bantry Bay obtained from the INFOMAR and GeoHive databases. INFOMAR provides high-resolution seabed mapping, including bathymetry, sediment types, and shipwreck locations, essential for identifying and analyzing UCH sites (Quinn, R. et al,2002). GeoHive offers critical terrestrial spatial data, including coastal zones, land use, infrastructure, and maritime activity areas.

Integrating these datasets within a GIS platform enables the research to:

- Study and map the precise location of UCH in the Bantry Bay area.
- Assess the spatial relationship between UCH sites, coastal zones, and various maritime activities.
- Support the strategic planning of Marine Protected Areas (MPAs) and sustainable tourism initiatives.

This combined approach ensures a holistic understanding of both ecological and human factors relevant to the conservation and management of UCH in the region.

Interviews and Questionnaires
To explore the sociological and economic dimensions of underwater heritage, questionnaires will be distributed to recreationists and tourists in Bantry Bay during the spring and summer months to assess interest in the shipwreck as a cultural and tourism attraction (Khater, M. *et al*, 2024). Furthermore, semi-structured interviews will be conducted with key stakeholders to capture a wide range of institutional and community perspectives:

- **Cork and Bantry County Councils**: To understand institutional perceptions of the shipwreck's value and the willingness to invest in its protection and sustainable use.
- **Non-governmental Organizations (NGOs)**: To assess the impact of the shipwreck on marine biodiversity and evaluate existing conservation measures.
- **Local Tourist and Harbor Businesses**: To evaluate the potential economic benefits derived from the utilization of the shipwreck.

This multifaceted approach ensures a comprehensive understanding of community attitudes and institutional perspectives, directly supporting the development of robust, sustainable management strategies for UCH in Bantry Bay.

RESEARCH RISKS AND CONTINGENCY FRAMEWORK

In this research project, the foundational phases involving the literature review and GIS analysis present minimal risks, significantly contributing to the overall feasibility of the study. The primary potential challenge lies in securing sufficient participation from local stakeholders, recreationists, and tourists during the empirical data collection phase. To mitigate this, a robust contingency plan has been established to ensure the timely completion of all research objectives. For the theoretical and archival components, if access to specific primary databases is restricted, alternative sources such as open-access repositories and university archives will be utilized to maintain comprehensive coverage. Given that GIS data for Bantry Bay are predominantly open-access via INFOMAR and GeoHive, these reliable spatial datasets provide a stable technical foundation. Regarding qualitative engagement, participants will be contacted in advance to secure informed consent, and should the initial sample of recreationists prove insufficient, outreach will be expanded through local organizations and digital travel groups to ensure a robust dataset.

DISCUSSION

The integration of Underwater Cultural Heritage (UCH) into the maritime spatial planning of Bantry Bay presents a transformative opportunity to bridge the gap between cultural preservation and environmental sustainability. By applying the "Alonissos Paradigm," this research suggests that shifting UCH from a state of static legal protection to an active socio-economic resource can catalyze local development while simultaneously enhancing biodiversity. Submerged sites, such as the *La Surveillante*, function as more than archaeological artifacts; they are active components of a socio-ecological system that shape community identity and resilience (DeSilvey & Harrison, 2020). However, the feasibility of this model in an Irish context requires navigating complex challenges, including the current lack of a formal national Marine Protected Area (MPA) definition and potential conflicts with established industrial activities in the harbor. Moving toward a justice-oriented Blue Economy requires that local participation and inclusive governance remain at the center of development policies to avoid exploitative "blue growth" models (Germond-Duret et al., 2022).

CONCLUSION

In conclusion, valuing UCH as an integral part of the Blue Economy offers a just and sustainable pathway for coastal governance in Ireland. This research moves beyond traditional documentation to propose a framework where heritage preservation, biodiversity protection, and community well-being are co-advanced (Kyvelou & Chiotinis, 2022). By utilizing GIS-based spatial analysis and interdisciplinary stakeholder engagement, the study provides practical tools for policymakers to anticipate and mitigate conflicts before industrial demands on marine spaces intensify. Ultimately, the transition toward a UCH-integrated MPA in Bantry Bay ensures that Ireland's hidden maritime history becomes a visible driver for long-term regional resilience and environmental stewardship. By reconnecting cultural and natural

capital, Irish scholarship can align with and extend international best practices, demonstrating that heritage sites are not inert remains but active assets for a sustainable future.

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URBAN EXPANSION AND THE "OTHER" CITY IN CINEMA. THE URGENT NEED FOR A SUSTAINABLE CITY.

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Abstract
Since 2008, the global urban population has exceeded the rural population for the first time in human history. Urban sprawl and the population movements it entails, are gradually eliminating any meaning of dipoles such as city-countryside or center-periphery, which were developed in an effort to understand space. Urbanized space extends to infinity and disappears on the horizon, while slums have become a reality that is fully integrated into ever-expanding megacities.

The reality of the "other" city as a social symptom, as well as, an urban experience, was captured on film. The choice was primarily spatial, as a shot of the slums can raise our awareness much more than any political declaration. Starting from the neorealism of harsh everyday life, it focuses on recording poverty, on protest, and social analysis, combining fiction with documentation and social recording in aesthetic terms. Ultimately, connecting emotion with reflection, energy with consciousness. After all, cinema does not have the right to ignore life; it must see, hear, and question...

Camera records, in a process of re-sensitization, the relationship between residents and the urban environment of the slum. The urban image interacts with the city passerby, developing a dialectical relationship between image and movement, where each sequence of images becomes an object of reflection. This is a reflective cinema, marking the transition from the aesthetic of poverty to the aesthetic of dream, the only right that cannot be denied. Nowadays, migration, economic and humanitarian crises, as well as the recent pandemic, constitute the social dynamic of the city, which determines cinematic writing. Cinema, as an art in motion, captures urban life in its dynamic unfolding, highlighting the social phenomena that constitute this dynamic for a sustainable city.

Keywords: urban expansion, "other" city, sustainable, cinema, reflection

1. THE "OTHER" CITY

Today, urban expansion and the population movements it entails constitute the expression of a new era for humanity. This process progressively abolishes any meaning in dipoles such as city–countryside or center–periphery, which were developed in an attempt to understand space.

Indeed, the deprived populations of this world are now accumulating in slums, barrios, favelas, and bidonvilles of megacities, which are undergoing an uncontrolled demographic explosion. As early as 2008, and for the first time in the history of humankind, the global urban population surpassed the rural population, as more than half of the planet's 6.7 billion inhabitants lived in cities. Many of these new city dwellers are poor, while the place where they seek residence or are born is the slum.

The global urban population is expected to have doubled by 2030, when 5 billion people will live in urban centers - a population that is constantly growing and expected to increase dramatically. Specifically, since 2017, 55% of the world's population resides in urban centers, while by 2050, it is expected that 65% (approximately 6.5 billion people) will live in cities. In other words, the increase in city residents will be the trend with the greatest impact on development in the 21st century.

In this world, most of the urban poor will be youth under the age of 25. Almost all of humanity will choose to live in an entirely artificial environment, where behind the storefronts of shopping centers and skyscrapers, vast slums will extend. These "other" cities, growing rapidly by one million people per week, are "suffocating" the large urban centers of Africa, Asia, and Latin America.

Today, one in three city residents' lives in a slum. It is characteristic that in the Dharavi slum, in the center of Mumbai, one million people live literally on top of each other, as the ratio of population to area corresponds to 4.5 people per square meter.

The UN, in its reports, defines slums as poor areas with makeshift dwellings that lack access to potable water or other basic infrastructure. It uses the term "slum household" to describe a group of people living under the same roof in an urban area who lack one or more of the following:

- Permanent residence
- Adequate space
- Access to clean water and sanitation facilities

In Latin America, and specifically in Brazil, at least 1/3 of the country's urban population resides in informal settlements, self-managed communities, and favelas that signal the transition from "housing" to "shelter". These are clusters of low-income housing, makeshiftly constructed from improvised materials, where low-income individuals reside. It is simultaneously considered a dangerous place and a situation regarded as unpleasant and disorganized.

Image 1:Morumbí favela, one of the largest slums in São Paulo.

Specifically in Rio, their population exceeds one million, accounting for nearly 20% of the city's population.

A large part of the responsibility for the existence of favelas is attributed to state power, given that effective housing solutions for the urban working classes never existed. This lack of policy produced fewer homes for the poor in urban centers, limiting opportunities to improve their lives and resulting in the direct expansion of slums.

The favelas, as phenomena of self-housing, took place on occupied lands of reduced value, highlighting the state's lack of care for the poor. However, they also revealed the power of the need for survival of a population that literally had nowhere else to stay. Resourceful adaptation, as a privilege of the weak, created the social culture of the favela, with self-managed communities in informal settlements that implemented alternative housing practices.

In these poor neighborhoods, levels of solidarity exist that are unknown to the wealthy suburbs. They constitute spaces where different cultures mix, often functioning as communities of creation that feed new movements in the arts. Indicatively, the favelas in Rio always produce forms of cultural expression that define the identity of the city. In the past, they gave birth to samba, and many of its important singers still live there, as the samba schools are headquartered there. More recently, "funk carioca" emerged primarily in the favelas before eventually being assimilated by other social classes through the media.

Whatever is produced there eventually becomes integrated into the rest of the city and gives its residents a unified identity. As a kind of response to the intolerance of the state and the city towards the favelas, the residents create what is later launched as the "face of Rio". In any case, popular culture is not what is called "folklore" in technical terms, but what is called, in the language of the people, permanent historical change.

2. THE CINEMA OF THE "OTHER" CITY

The "other" city as a social symptom, but also as an urban experience, has been uniquely captured in cinema, as the only right that cannot be denied is the dream. The path for the cinema of the "other" city was opened in the 1940s by Italian Neorealism, which echoed an aesthetic of the poor, utilizing amateur actors, documentary techniques, and lightweight equipment to create a cinema that was lean in technical means but rich in imagination.

Later, the ethics of Italian Neorealism were grafted with the aggressive aesthetic of the French Nouvelle Vague, for a cinema "*based on the means at our disposal, with low cost and in a short time… a political cinema that aims to inform not through logic, but through poetry*," according to the pioneering Brazilian creator G. Rocha. This is a cinema that neither distorts nor embellishes the particularly unequal political, social, and cultural conditions in the slums of the "Third World". Specifically, G. Rocha pointed out that *"an economically* underdeveloped country does not mean it must also be artistically underdeveloped"; all that was needed was "a camera in hand and an idea in the head".

This movement is Cinema Novo, which initially developed in Brazil - with most of its films shot in Bahia - defining the cinematic landscape of Latin America by extending its aesthetic to the social life of the slum. It is a cinema of immediate recording of an ominous social reality, which imposed itself through the truth of its images and sounds; for if a place looks its true face in the eye, there is a chance to escape underdevelopment. This independent cinema of the "other" city, often self-funded by its creators, used the aesthetic of poverty to reveal something that many people had every reason to ignore, even though it existed right next to them.

In the cinema of the "other" city, social deadlocks dominate, highlighting a city unable to integrate its "heroes," who live trapped under conditions they did not cause themselves. This cinema records the relationship between residents and the urban environment. Urban expansion and continuous construction are depicted in cinematic images that map spaces and record their social coordinates. Those forced into marginalization live on the fringes of the city. As P. Sorlin (2004) characteristically describes, they "belong between capitalism and the proletariat, between exploitation and petty theft - that is, they live in the Third World". The periphery becomes a gathering place for the poor; the rupture with the city is a fact - it is no longer made to their measure, it is no longer theirs.

Image 2: *The roof*, V. De Sica, 1956

In 1956, V. De Sica dared to show the suburbs of Rome with dwellings built from bricks and corrugated iron in the film *The Roof* (*Il Tetto*), and to name the streets of the shantytown of his young protagonists in the film *Miracle in Milan* (1951) as Joy Street, Hope Street, Solidarity Street, and even 2x3=6 Street for the young leads to learn mathematics.

Image 3: *Miracle in Milan*, V. de Sica, 1951

Within this neorealist climate, the surrealist L. Buñuel - paradoxical as it may sound - directed *The Forgotten* (*Los Olvidados*) in 1950 while exiled in Mexico. Set against the backdrop of slums on the outskirts of Mexico City, it remains one of the first and most significant films to capture the reality of the shantytown.

Image 4: *The forgotten*, L. Buñuel, 1950

Cinematic slums have an autonomous existence and recognizable characteristics. They are primarily intermediate spaces, anarchically "structured" areas with poorly built huts. These cinematic shacks are far from the center and lack the vital road that would offer a window to the outside world. People are constantly moving via motorcycles, tricycles, or on foot. The route to the center has been replaced by local dealings. Movements and chance encounters give way to an intense communal and yet harsh life, determined by the degree of tolerance and coexistence. Unemployment or temporary labor is a given, resulting in abundant free time for wandering. This continuous mobility, combined with communal life, forms significant social networks.

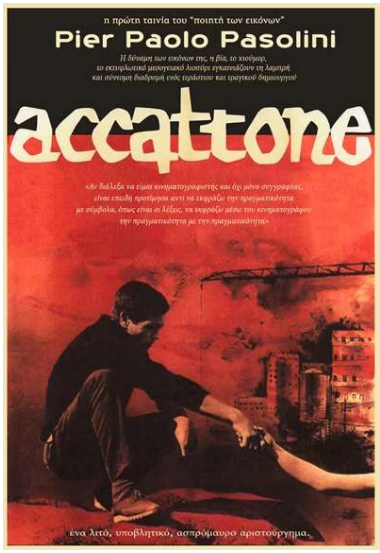


Image 5: *Accattone,* P.P. Pasolini 1961

P. Pasolini, with his films *Accattone* (1961) and *Mamma Roma* (1962), focuses on the forms, faces, and needs of the socially vulnerable residents of the slum.

Images 6 & 7: *The Constant Gardener,* F. Meirelles, 2005

In the films *The Constant Gardener* and *Tsotsi*, both released in 2005, the camera reveals the misery and degradation in the slums of the African continent. In G. Hood's *Tsotsi*, racial discrimination in the Soweto slum of Johannesburg has been replaced by equally intense social divisions and spatial schisms.

Image 8: *Bus 174*, J. Padilha, 2002

Slums are now an urban experience and a social symptom, fully integrated into the ever-expanding megacities. This fact is highlighted in the introductory aerial shots of the urban fabric of Rio in the documentary film *Bus 174* (2002) by J. Padilha.

Image 9: *City of God*, F. Meirelles, 2002

In *City of God* (*Cidade de Deus*, 2002), based on the novel by Paulo Lins and real events, F. Meirelles denounces with a raw, deeply realistic gaze the deterministic vicious cycle of poverty and crime that plagues Brazil even today, making violence almost the sole option for survival. The peculiar structure of the film is akin to the relatively new hybrid genre of docu-fiction. Contributing factors include amateur actors, the narration, nervous editing, and a penetrating internal rhythm. Documentary elements are inventively incorporated into

fiction, and this chosen heterogeneity gives the narrative a kind of agency expressed in degrees of freedom. *City of God* is not the story of a person, but of a place, which started in the 60s as a housing project for the poor and ended up in the 80s as one of Rio's most dangerous favelas. Filmed frantically and breathlessly, *City of God* will chase you if you run to escape; if you stay, it will devour you.

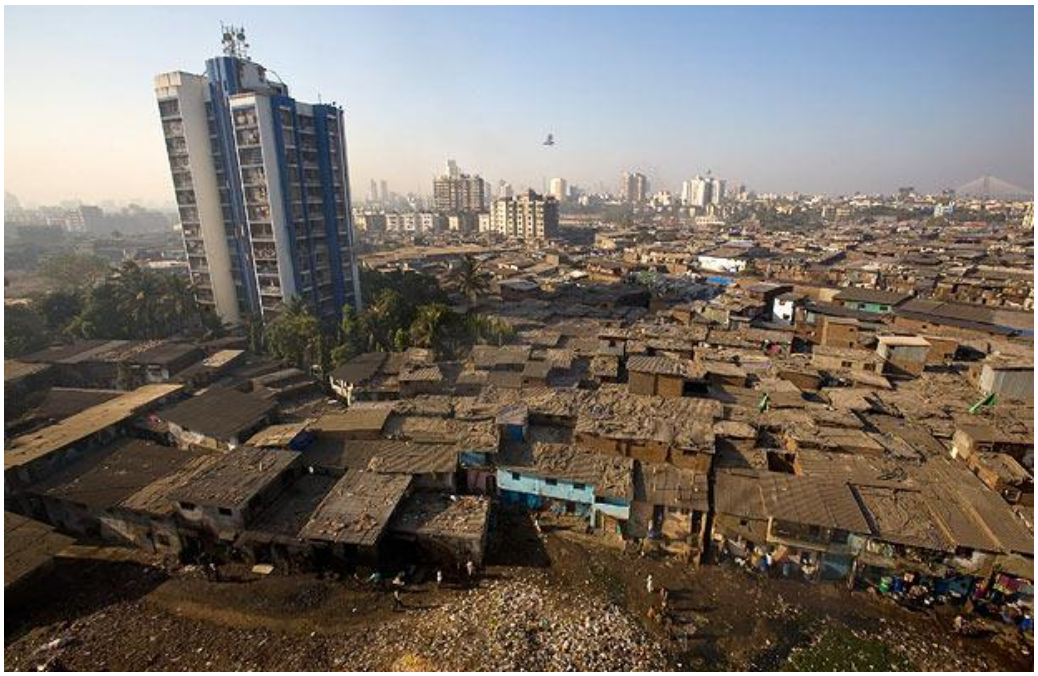
J. Padilha follows a similar style in his Berlin Festival award-winning film *Elite Squad* (*Tropa de Elite*, 2007). With a handheld camera, he wanders through Rio's poor neighborhoods and records violence and death, as the mechanisms of suppression know no limits in corruption and authoritarianism in their attempt to "clean up" the city of "scum".

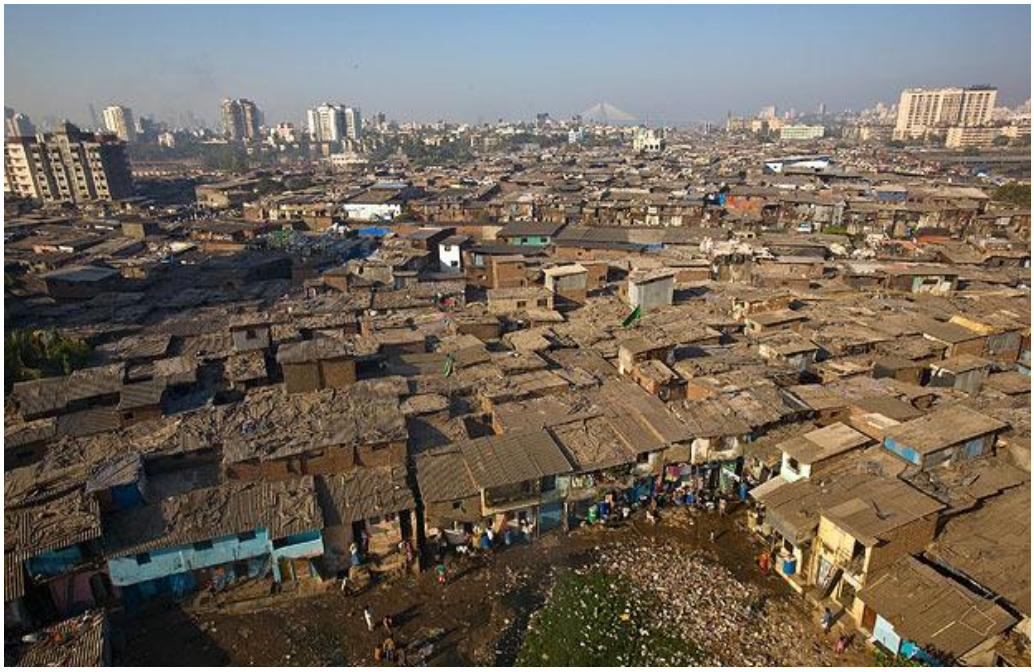
Image 10: *Elite Squad*, J. Padilha, 2007

Finally, the Oscar-winning film *Slumdog Millionaire* by D. Boyle (2009) records life in the Dharavi slum in the center of Mumbai, India - one of the largest slums in South Asia - with fast shooting and nervous editing.

Image 11: The Dharavi slum in Mumbai, where N. Boyle's film *"Slumdog Millionaire"* was shot in 2009.

The division between the center and the periphery no longer exists, and the cinematic camera depicts an urbanized space that extends to infinity and is lost on the horizon. The sole dissonance: the slum.





Images 12 & 13: The Dharavi slum in Mumbai, where N. Boyle's film *"Slumdog Millionaire"* was shot in 2009.

2.1 Towards a reflexive cinema on the path to a sustainable city

The cinema of Third World countries is no longer the poor relative of Hollywood. Instead, it produces the majority of fiction films worldwide, as it includes large film industries from countries such as India (Bollywood), Nigeria (Nollywood), Iran, Brazil, Mexico, and others. Through these films, the slum is elevated from a signified of the urban lifestyle to a signifier.

This is a cinema that, through a reflexive process, marks the transition from the aesthetic of poverty to the magical realism of the aesthetic of the dream. Creators begin from the

neorealism of harsh everyday life and, with the immediacy of their art, communicate their new vision. Moving from the recording of destitution to protest and, finally, to social analysis, they establish a reflexive cinema. They exploit the possibilities of technology, filming even with mobile phones and drones. The existence of creative communities in self-management, distribution, and screening also contributes to this.

In this cinema, issues of production methods, politics, and aesthetics are intertwined. With a spirit of collaboration between crews and creators, the authenticity of the unique culture of the shantytown is highlighted. It is another way of life, with different values and different valuations of material possessions, nature, and human relationships. A transition between the real and the imaginary, the conscious and the unconscious. A peculiar mix of realism and symbolism. A third space for negotiation on "third world" terms.

Using the aesthetics of poverty to document underdevelopment and utilize small, flexible crews, with limited time and a low budget, a cinema of high aesthetic quality and imagination was produced. Elevating cinematic art into an integral part of a culture subject to interactive relationships with socio-historical data, as it sufficed to express its own aesthetic with a spirit of reflection, the aesthetic of the dream.

The themes of shantytown cinema revolve around the daily problems of the human condition, depicting a social dynamic that tends to transcend the stereotypes it is forced into. Today, migration, the economic-humanitarian crisis, and the recent pandemic all constitute this social dynamic of the shantytown, which dictates cinematic writing. Cinema as an art in motion captures urban life in its dynamic unfolding, highlighting the social phenomena that drive this dynamic.

Today, most cities are characterized by significant inequalities, both economic and social, as well as living conditions. Informal settlements, such as shantytowns, which are the most intense manifestation of inequality, continue to emerge as a characteristic of the urban landscape and to expand. Especially in our era, where various types of crises (humanitarian, economic, social, pandemic, etc.) plague urban society, the need to protect its viability by strengthening its urban resilience is more evident than ever. That is, the capacity of residents, communities, institutions, businesses, and urban structures to survive, adapt, and evolve regardless of the chronic pressures and emergencies they may face (Urban Resilience Framework, Arup/ Rockefeller Foundation 2014) on the path to a sustainable city.

Image 14: Poster for a theatrical performance inspired by V. De Sica's film *Miracle in Milan*

Now, the great stake of the city of the homeless and immigrants is jeopardized in the areas of disruption, in the interstitial spaces, in the urban voids, in the degraded zones, in the suspended spaces of otherness in the center and on the periphery of the city. Cinema fulfills humanity's profound need to see and hear without intermediaries, as it presents these places as they are and us in relation to them. Places that the eye has learned to avoid. Cinema cannot but represent what is at stake in these areas. Developing a dialectical relationship between image and movement, where each sequence of images becomes an object of reflection. These are now urban images with identity, interacting with the city's passersby.

For the art of cinema is not concerned with the studio city, a sterile, flawless image of the city, which goes hand in hand with technological progress and sympathizes with the planning of distance, in contrast to any idea of immediacy. Cinema has no right to sideline life; it must see, hear, and doubt...

As an example, director W. Wenders advocates for a city that is not just sustainable, but livable: "Create authentic places for the children of tomorrow... Do not just build buildings but create open spaces that preserve the void/ emptiness, allowing unimpeded vision and rest." This calls for a new design on the scale of the city, one that can embody resistance to superficial change, acceptance of the documentation of the city's cultural memory, enhancement of the value of public space, and a dialogical relationship with the environment that brings about essential changes in the relationship between public and private space. In this context, today more than ever, the "game" of the city is played out in urban regeneration projects. These are essentially actions of urban renewal, which will be characterized by:

- Integrated regenerations: Extensive interventions in entire areas with respect for the natural environment and the goal of economic and social revitalization.
- Cultural sensitivity: Considering the history, cultural heritage of a place, as well as its social composition and identity.
- Targeted interventions: Small-scale actions focusing on specific buildings or blocks.
- Temporary uses as a regeneration tool: Utilizing vacant spaces for cultural or social activities.
- Participatory processes: Involvement of residents and stakeholders for sustainable and accepted solutions.
- International best practices: Examples from European cities where regenerations have strengthened urban resilience on the path to a sustainable city.

Local interventions for the transformation of the urban landscape, combined with the formation of a collective interest, a cultural consensus among the factors contributing to their implementation, constitute the important first steps. Cinema can initiate this collective interest by focusing on the relationship between itself and the city as a living social reality.

In such a context, cinema embodies the concept of the boundary, on the threshold between acceptance and resistance, in its representation of the underdevelopment of impoverished settlements and shantytowns. The choice is primarily spatial, as a shot of a shantytown can sensitize us infinitely more than any political declaration. This is cinematography that can combine social documentation with aesthetic terms, while the boundaries of representation are determined by the relationships between the real-imaginary and fiction-documentary.

Analytically, considering the language of cinema as an editing of two different, seemingly opposite, but essentially complementary shots, spoken and written words, then the former is a natural, open, and direct shot of a documentary film, and the latter is the disciplined and constructed one of fiction. Today, interest is now focused on the dialectical relationship that develops between a specific way of speaking and a specific type of writing

throughout time. A feedback loop, as the movement of the handheld camera disrupts the disciplined movement of the modern Steadicam, incorporating into technically perfect writing the orality that was initially proposed.

Image 15: *Central Station*, W. Salles, 1998

In films like the anthropocentric fiction "Central Station" (Central do Brasil, 1998) by W. Salles, the writing is not merely a direct transcription of spoken language, but primarily a complementary, overlapping form, another way of expression, nurtured by speech and in turn feeding it back. In the film, a retired teacher earns her living by writing letters for the illiterate. She is led to the arid hinterland, moving against the tide of internal migration. The camera records in a process of re-sensitization, just as it vociferously demanded in the past. As Brazilian film critic J. Avellar (2006) states, "Today we write because we spoke yesterday. We speak a common language of our own." A language defined reflectively, as it combines writing with speech, fiction with documentary, and connects emotion with reflection, action with consciousness, resistance with social analysis.

After all, as Ch. Vakaloppoulos pointed out, "the best films are those that succumb to the miracle of existence, those that defend less themselves, their city, and more the human being." It is cinema "...for a world where good morning will truly mean good morning!", as stated at the end of Vittorio De Sica's film "Miracle in Milan" (1951).

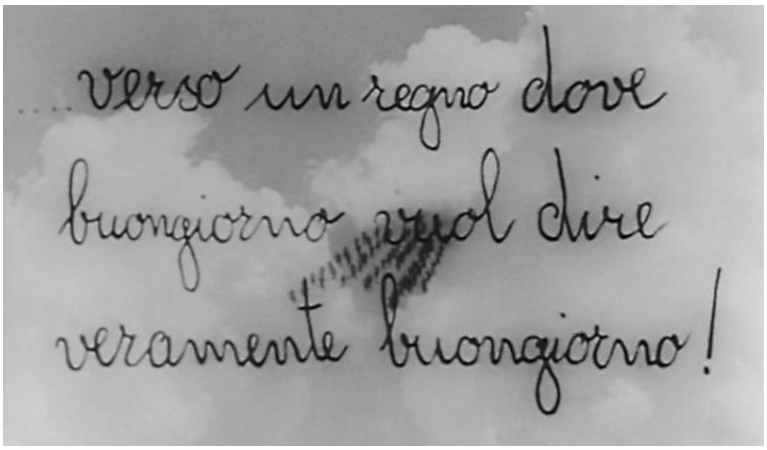


Image 16: *Miracle in Milan*, V. De Sica, 1951

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PROPOSAL FOR A CULTURAL ROUTE IN THE RUSSIAN MONASTERIES OF MOUNT ATHOS

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Abstract
Cultural routes are one of the most popular categories of the tourism industry and are enjoying rapid growth. The role of cultural routes is very important, on the one hand for the management of the cultural heritage of a place and on the other hand for their connection with the tourism sector. They seem to guarantee specific results and promise successful tourism development while seeing them as complex cultural products, they can add value to each local culture by transforming local historical-cultural elements into a set of networks of economic resources.

Cultural Routes are emerging today as an important management and useful tool for the promotion of cultural resources and the further promotion of cultural tourism in a region. Through a marked route, the visitor could experience the history and culture of the area and get to know its special physiognomy.

The present paper refers to the Russian monasteries of Mount Athos and comes up with a specific proposal for a cultural route, which is depicted on a map. The approach to the cultural points of the area is based on the criterion of the concentration of the specific monuments in a geographically limited area and the peculiarity of the Russian influence both in the architecture of the buildings and in the liturgical, religious and daily life of the monastic brotherhoods that live today in these monuments.

Keywords: Cultural routes, cultural characteristics, cultural heritage, Mount Athos, Monasteries, Russia, religious tourism

SESSION

"Promoting Sustainable Cities"

Chaired by **Prof Angelidis Minas** and
Dr Prof Koutsoumpos Leonidas

RETHINKING THE ECOLOGICAL NETWORK PROJECT CONSIDERING - NEW QUESTIONS RAISED BY URBAN COMPLEXITY

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Abstract
Discussing environmental integrity and continuity in a constantly evolving and transforming territorial context is now essential for promoting sustainable territorial development oriented towards ecological transition.

While countering the fragmentation of natural spaces and ecosystems, reducing diffuse naturalness and preserving biodiversity levels remain essential conditions, today a further step forward is required in territorial planning and ecological network design to promote ecosystem services, limit or mitigate the effects of climate change and respond to the new needs of the community.

The opportunity to experiment with an integrated and complex approach brought to light the need, felt by our research group, to re-read and re-interpret the constituent elements of the ecological network project in an innovative way.

This need has also become evident considering the interest shown by the municipal administration of Mantua in revising the territorial governance instrument (PGT) and the ecological network plan, currently in force since 2012.

The research is proposed as an exploratory and experimental activity aimed at verifying, fifteen years after the first experience, how the complexity of the territory, new environmental challenges and renewed awareness can provide an opportunity to give new substance and renewed visibility to the ecological network project. This critical analysis highlights five questions that are relevant to the ecological network project, including the need to:

- Orient the project towards defining strategic guidelines for sustainable and resilient development, understood as a possible response to the need to adapt to and mitigate the effects of climate change.
- Strengthen the identity of landscape and local characteristics, promoting community involvement in the design, development and management of a network of infrastructure and places capable of responding to the diverse needs of the territory.
- Stratify heterogeneous elements within the territory, promoting the rooting and coexistence of different elements in the ecological project.

- Interfacing diverse elements to build green infrastructures capable of connecting, through multifunctional connections, ecological values to community activities.
- Crossing territorial fragmentation through the integration of contrasting elements to strengthen ecosystems, promote the conservation and improvement of biodiversity, valorise the landscape perception.

Key words: ecological network, ecological transition, continuity, multifunctional connections, renewed challenges, landscape, identity

THE CITY AS STAGE: SOCIALLY ENGAGED PERFORMANCES IN THE PUBLIC SPACES OF ATHENS

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Abstract
The proposed paper explores how performative art can introduce and engage with the concept of space through the analysis of six socially impactful performances presented in the public spaces of Athens. It establishes a theoretical framework encompassing the concepts of space, the body in the city, and performativity, which serves as a foundation for the case studies.

The research focuses on site-specific performances from recent years, with a detailed examination of three selected examples. Interviews with key participants involved in these performances provide insights into their creative processes and artistic intentions.

The study concludes with an open-ended questionnaire designed to foster dialogue among stakeholders engaged in such productions. This aims to identify the benefits, challenges, and unique characteristics of performing in public urban spaces. Finally, the research presents its conclusions based on the findings and analysis.

Key words: public spaces, city, theatre, site-specific performances

THE CONTRIBUTION OF LOCAL GOVERNMENT TO THE PROMOTION OF SUSTAINABLE DEVELOPMENT – THE CASE STUDY OF THE MUNICIPALITY OF AMAROUSSION AND OF THE SYGGROU FOREST

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Abstract
The role of local government in promoting sustainable development is of crucial importance, as only municipalities have a deep understanding of local characteristics, comparative advantages, and opportunities for innovative actions, as well as the size, geomorphological, developmental, and cultural particularities of each city and community.

The UN 2030 Agenda recognizes the potential of Local Government Authorities to transform, through a bottom-up planning, the urban and rural environment and contribute to improving sustainability conditions globally. Sustainability as an ongoing commitment should be an integral part of the functioning of local government and the basis for social, environmental and economic sustainability.

This paper aims to highlight the results of the research conducted as part of my Master's Thesis, as well as to present the related recommendations and conclusions. The purpose of the research conducted in the context of my Master's Thesis is to capture the current situation in terms of strengthening innovation, strategy, implementation and prioritization of sustainable urban development actions of the Municipality of Maroussi and the protection of the Syggrou Forest, as well as to identify the areas in which further initiatives could be developed, with an emphasis on the environmental, social, economic, and governance dimensions of sustainability.

Key words: Sustainable urban development, innovation, local government, Municipality of Amaroussion, Syggrou Forest

1. INTRODUCTION

Capital, land, labor and entrepreneurship, with the contribution of science and technology, become factors of production, when they are used for production. These traditional of production are no longer sufficient to ensure sustainability, that is, to maintain a steady state in the resources available for the production of goods or services. Environmental Management is added as a crucial pillar of sustainable development. Sustainable development[5] is considered to be the kind of development that meets present economic, social, and

[5]As defined in the 1987 Brundtland Report of the World Commission on Environment and Development, *"Our Common Future."*

environmental needs without endangering the ability of future generations to meet their own needs.

Climate change and the energy crisis, depletion of natural resources and ecosystem degradation, inflation, structural shifts in the labor market, and demographic deadlock are some of the challenges faced by modern economies. Modern economies are called upon to address environmental management issues in the short, medium, and long term, and to implement policies that promote outward-looking production models based on the sustainable management of natural resources.

Effectively addressing these challenges necessitates targeted policymaking and data-driven planning of smart, sustainable and resilient cities and communities, where a high quality of life, social cohesion, a decent standard of living, ample green and recreational spaces, and the overall well-being of citizens are guaranteed.

The interdisciplinary and holistic approach to issues concerning the three dimensions of sustainable development (social, environmental, and economic), as well as the integration of all dimensions of sustainable development into sectoral policies and legislative frameworks, is a prerequisite for achieving the 17 Sustainable Development Goals (SDGs) and the 169 targets of the United Nations by 2030 (2030 Agenda for Sustainable Development). Regarding the progress toward the 17 Sustainable Development Goals, a UN report is published every year, based on the global indicator framework and on data produced from national statistics as well as information collected at the regional level.[6]

In Greece, local government consists of first-level Local Government Organizations, whose sole authority is the Municipality, and second-level Local Government Organizations, whose authority is the Region. The number of administrative Regions in Greece amounts to 13, the number of Regional Units to 74, and the number of Municipalities to 332.

The sustainability actions implemented in the Municipality of Amarousion - with an emphasis on green spaces, the protection of the Syggrou Forest, and the areas in which innovative "Smart City" and green transition initiatives could be integrated, as a contribution to sustainable development and as a way to improve citizens' quality of life, are the issues addressed in this case study.

The selection of this case study is justified both by the challenges the city faces in relation to sustainable development and by the apparent existence of a clear sustainability strategy.

As part of the qualitative research, the concepts of sustainable development, environmental, social, and economic sustainability, as well as their interconnection with local government, were explored through a literature review.

The quantitative research was conducted on a random sample of 84 residents of the Municipality of Amarousion, focusing on the following key questions:

- ✓ The level of awareness of the Municipality's citizens regarding sustainable development issues.
- ✓ The contribution of the local government to the protection of the Syggrou Forest.
- ✓ The obstacles identified as inhibitory factors for the sustainable management of the Syggrou Forest.

Six elected members of the local government of the Municipality of Amarousion also participated in this quantitative research. They completed a questionnaire aimed at capturing

[6] United Nations 2023 "Times of Crisis, Times of Change: Science for Accelerating Transformations to Sustainable Development", Global Sustainable Development Report 2023 https://sdgs.un.org/sites/default/files/2023-09/FINAL%20GSDR%202023-Digital%20-110923_1.pdf

their views on sustainable development, the management of the Syggrou Forest, and the role of institutional partnerships.

An interview was also conducted with the President of the Board of Directors of the Institute of Agricultural Sciences, with the aim of recording the perspective of the institutional body responsible for managing the Syggrou Forest.

2. THEORETICAL BACKGROUND

The three components of sustainability, which can be defined as economic efficiency or economic capital, social equity or social capital, and environmental preservation or environmental capital, are a commonly accepted notion in the international literature.[7] They exhibit coherence and indivisibility, as none of them can exist independently. A fourth dimension has been added to the three pillars of sustainability – the adherence to the principles of good governance or governance capital.

The origins of the concept of the "three pillars" of sustainability are attributed to the Brundtland Report of the World Commission on Environment and Development, to Agenda 21,[8] and to the 2002 World Summit on Sustainable Development.[9] In 2015, the 193 member states of the United Nations deemed it necessary to establish 17 Sustainable Development Goals to address poverty and ensure the planet's sustainability, with the commitment that these goals would be universal and indivisible.[10]

Environmental sustainability focuses on maintaining the environmental system as a fundamental prerequisite for supporting life. For any resource-based system that aims to become sustainable, three main approaches are followed: **efficiency**, which addresses the question, "What do we really need and why?", **consistency**, which addresses the question, "How can we minimize resource use in production and consumption?" and **sufficiency**, which addresses the question, "How can we design what we need in a sustainable way?". These approaches aim to reduce resource consumption. However, none of them can reduce environmental impacts to zero, when applied in combination, though, they can significantly enhance the sustainability of a resource-dependent system. With the main goal of maintaining social justice and peace, the concept of **social sustainability** is closely linked to the 17 United Nations Sustainable Development Goals (SDGs) (No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Reduced Inequalities, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace, Justice and strong Institutions, Partnerships for the Goals).[11]

In summary, we can mention that the pillars of sustainability are as follows:

- ✓ **Environmental**: concerned with the preservation of the natural environment.
- ✓ **Economic**: related to economic development and resilience.
- ✓ **Institutional**: refers to governance and resource management.

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[7] Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability Science*, 14(3), 681-695. https://doi.org/10.1007/s11625-018-0627-5

[8] **UNCED (1992). Agenda 21: *programme of action for sustainable development, Rio Declaration on Environment and Development*. New York: United Nations.**

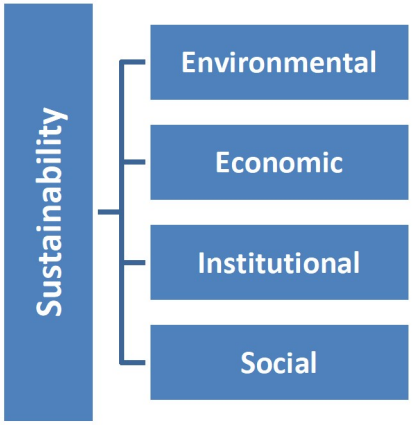
[9] Moldan B, Janoušková S, Hák T (2012) How to understand and measure environmental sustainability: indicators and targets. Ecol Indic 17:4–13. https://doi.org/10.1016/j.ecolind.2011.04.033

[10] United Nations (2015c), Transforming Our World: The 2030 Agenda for Sustainable Development, New York, NY. https://sustainabledevelopment.un.org/post2015/transformingourworld)

[11] Fischer et al., (2022) Sustainable Business Managing the Challenges of the 21st Century, Springer Briefs in Business. 10-11 & 19-20. https://doi.org/10.1007/978-3-031-25397-3_2

✓ **Social**: focuses on the well-being and cohesion of society.

Figure 1: The pillars of sustainability



Sustainable development[12] is defined as development that meets the economic, social and environmental needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable development is governed by:

(a) The **principle of normativity**, as it is linked to regulations that very depending on the cultural context and the specific historical period.
(b) The **principle of equity**, as it takes into account both present human needs and those of future generations.
(c) The **principle of indivisibility**, as it aims to harmonize economic, environmental and social objectives.
(d) The **principle of dynamism**, as it balances multiple parameters within a constantly changing environment.[13]

As a development policy, sustainable development is highly ambitious, as it aims to take into account both current and future conditions across all regions of the world, in a way that ensures prosperity in the short, medium and especially the long term.

For the formulation of the theoretical framework, a review of the literature related to the investigation of the topic was conducted. Starting from 1987, the year in which the Brundtland Report of the World Commission on Environment and Development entitled *"Our Common Future"* was published, the concept of sustainable development was established and acquired a universal and multifaceted character.[14]

Through the European Green Deal, the Investment Plan of the European Union and the Just Transition Mechanism, within the framework of good governance, the sustainable course of Europe is pursued by transforming the way we produce and consume, with the ultimate goal of achieving climate neutrality by 2050.

[12] As defined in the 1987 Brundtland Report of the World Commission on Environment and Development, *"Our Common Future"*
[13] Gibson, B., Hassan, S., & Tansey, J. (2013). *Sustainability assessment: criteria and processes*. Routledge.
[14] Satterthwaite, D. (1999) "The Earth scan reader in Sustainable cities", London: Earth scan. Sneddon, C., Howard, R.B. and Norgaard, R.B. (2006). "Sustainable development in a post-Brundtland world", Ecological Economics, 57, 253-268.

At this point, it is worth noting that energy constitutes a field of geopolitical power for all countries and Europe, within the framework of a complex balancing process, must ensure energy sufficiency, prevent price surges and at the same time pursue gradual decarbonization. Aiming at energy security and stability, the recent agreement between the United States and Greece for LNG imports from the U.S. and investments in the Greek energy market highlights the prominent role of the East Mediterranean in the strategy for a sustainable Europe.

The International Monetary Fund shares the United Nations' objectives and formulates proposals concerning sustainable development. [15] The Organization for Economic Co-operation and Development (OECD) intends to provide technical support to its member countries to achieve sustainable and inclusive growth.[16]

The progress in implementing the 17 Sustainable Development Goals in monitored by the World Bank through the indicators of the "World Development Indicators" database and the "Atlas of Sustainable Development Goals" platform. [17]

In the Greek legal system, the concept of the city as a spatial entity – geographically and administratively defined and considered suitable for promoting the vaguely defined goal of sustainable development – was adopted within the framework of urban and spatial planning in the late 1990s.[18]

After the 1990s, the concepts of the sustainable city and urban sustainability dominated the discussion and were reflected in policies, international agreements and global networks.[19]

On 26 June 2024, the Directors-General on Urban Matters (DGUM) validated the ex-ante assessment for the two priority themes of Water-Sensitive City and Building Decarbonization, focusing on integrated renovation programs and local heating and cooling strategies. On 16 May 2025, the Directors-General on Urban Matters (DGUM) adopted the Ex-Ante Assessment (EAA) on Compact Cities – Sustainable Urban Planning and Sprawl Mitigation, thereby progressing the establishment of a new Thematic Partnership under the Urban Agenda for the EU (UAEU). In a joint declaration adopted at their informal meeting of 21 May 2025, EU ministers in charge of cohesion policy, territorial cohesion and urban matters highlight that cities of every scale, along with their functional areas, play a pivotal role in competitiveness and innovation, driving economic growth and fostering social and cultural development. Between 14 April and 26 May 2025, the European Commission held a call for evidence on the new EU policy agenda for cities, aimed at developing a more formal and structured framework. The consultation drew significant input from local and regional stakeholders. The Council of European Municipalities and Regions (CEMR) notes that the

[15] Fabrizio, M. S., Garcia-Verdu, M. R., Pattillo, M. C. A., Peralta-Alva, A., Presbitero, A., Shang, B., Verdier, G., Cammilleri, M.-T., Washimi, K., Kolovich, L., Newiak, M., Cihak, M., Otker, I., Zanna, L.-F. & Baker, M. C. L. (2015). *From Ambition to Execution: Policies in Support of Sustainable Development Goals*. International Monetary Fund.

[16] OECD (2016). "Better Policies for 2030. An OECD Action Plan on the Sustainable Development.

[17] ATLAS of Sustainable Development Goals https://datatopics.worldbank.org/sdgatlas/

[18] Athanasiou, E. (2001). *The concept of the sustainable city in the context of crisis.* Topos: Review of Spatial Development, Planning and Environment, Issue 2 (47).

[19] The "Lille Action Programme", 2000; Rotterdam Urban Acquis, 2004; The Bristol Accord 2005 (EU Urban Policy); Leipzig Charter, 2007; Marseille Declaration, 2008; Toledo Declaration on urban development, 2010; EU Territorial Agenda 2020 - *Cities of Tomorrow*, 2011. https://ec.europa.eu/regional_policy/en/information/publications/_communications/2011/territorial-agenda-of-the-european-union-2020; Urban Agenda for the EU (UAEU) 'Pact of Amsterdam', 2016. https://ec.europa. eu/futurium/ en/urban-agenda/; The New Leipzig Charter-The transformative power of cities for the common good, 2020. https://ec.europa.eu/regional_policy/whats-new/newsroom/12-08-2020-new-leipzig-charter-the-transformative-power-of-cities-for-the-common-good_en; The Territorial Agenda – A future for all places 2030, 2020; The 2021 Ljubljana Agreement;

Urban Agenda for the EU has not reached its full potential, citing constrained political involvement, inadequate financial resources and the absence of integration within the EU's wider multiannual policy framework. European Regions Research and Innovation Network (ERRIN) emphasizes that the future EU agenda for cities must focus on three core priorities to empower urban areas as central actors in driving the green and digital transitions. As a network encompassing over 200 cities and regions dedicated to advancing sustainable urban development, ICLEI Europe formally welcomes the Commission's initiative aimed at reinforcing the EU's strategic ambitions for cities and sustainable urban development in the coming years. METREX Network of European Metropolitan Regions and Areas frames metropolitan regions and areas as integrated territories that include urban cores, peri-urban zones and surrounding municipalities. Metropolitan governance must be recognized as a strategic layer to effectively address challenges ranging from competitiveness and climate resilience to housing and mobility. The debate on the future EU urban agenda has been revitalized by the Commission's call for evidence on a new policy agenda for cities The Commission's July 2025 proposals for the 2028-2034 budget envisage 27 national and regional partnership plans (NRPPs), combining cohesion funding and agricultural subsidies under a unified planning and implementation framework.[20]

Local authorities in many municipalities are committed to sustainable development goals and demonstrate a willingness to exchange knowledge and experiences at the inter-municipal level. In the international literature, numerous studies can be found analyzing the reasons why the contribution of local government to sustainable development is necessary[21]. However, clarifying the conditions under which local authorities can contribute to sustainable development requires further investigation.[22]

In smart, sustainable and resilient cities (SSRC) in order to ensure sustainability and social cohesion, technologies of the Fourth Industrial Revolution (Industry 4.0) are utilized, such as: the Internet of Things (IoT) – sensors for monitoring and managing resources; Artificial Intelligence (AI) – data analysis for process optimization; Big Data Analytics – for understanding trends and improving policies; Smart Grids – for managing energy systems; Renewable Energy Sources (RES) – for achieving energy autonomy and Blockchain – as a decentralized digital transaction system aimed at ensuring transparency and reliability in management.

Smart, sustainable and resilient cities focus on the following:

- ✓ **Environmental Sustainability:**
  - • Management of natural resources (e.g., energy, water)
  - • Application of technologies to reduce CO_2 emissions
  - • Development of green spaces and infrastructures
- ✓ **Smart Governance:**
  - • Transparency in decision-making
  - • Citizen participation
  - • Support through e-Government and other digital tools

[20] EPRS European Parliamentary Research Service (2025) A new urban policy agenda for the EU: Addressing cities'
Current challenges. Author: Vasilis Margaras. Members' Research Service PE 777.938 – October 2025, 3-10. https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2025)777938

[21] Georgakellos, D., Alexandropoulou, A. (2021). Sustainable Urban Development: The Key Role of Local Government. E-journal of the Institute of Local Government, 7 July 2021, available at: https://www.ita.org.gr

[22] Wang, Xiaohu & Van Wart, Monty & Lebredo, Nick. (2014). *Sustainability Leadership in a Local Government Context*. Public Performance & Management Review. 37, 339-364. DOI:10.2753/PMR1530-9576370301

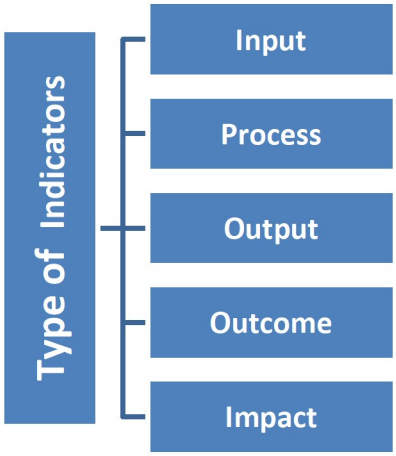
- ✓ **Social Well-being:**
  - Access to education and healthcare for all
  - Reduction of social inequalities
- ✓ **Smart Economy:**
  - Support for innovation and entrepreneurship
  - Digital transformation
- ✓ **Culture and Quality of Life:**
  - Preservation of cultural heritage
  - Enhancement of citizens' safety and well-being
- ✓ **Social Cohesion and Resilience:**
  The concept of a smart sustainable city is not limited to the use of technology but extends to the creation of socially resilient and equitable communities.
- ✓ **Regional Development:**
  The concept of smart regions connects cities with surrounding settlements, promoting integrated development through regional cooperation.[23]

One of the most comprehensive classifications and analyses of indicators for smart, sustainable and resilient cities is presented below. Indicators are classified according to their stage of development or implementation:

<u>Type of Indicators</u>

Input: Resources introduced into the system (for example funding, infrastructure)
Process: Activities and actions that are carried out.
Output: Products or services that are produced.
Outcome: Short- or medium-term changes.
Impact: Long-term effects on society, the economy or the environment.

Figure 2: Type of Indicators



[23] Parr, J. B. (1999). "Growth-pole strategies in regional economic planning: A retrospective view."*Urban Studies*, 36(7), 1195-1215.

Input indicators measure the quantity and quality of human, financial, material and political resources required for the implementation of smart interventions and the provision of smart services.
Process indicators deal with the activities and actions undertaken to ensure the proper development of smart cities and the delivery of smart services.
Output indicators refer to the products or actionsimplemented as smart city interventions. For example, the number of electric buses in operation compared to the total bus fleet.
Outcome indicators are difficult to determine, as they measure the extent to which objectives have been achieved in the medium term. An example could be the change in the percentage of people using electric buses.
Impact indicators measure the long-term contribution of smart city interventions.

Urban Sectors /Dimensions

The main sectors evaluated include**:**
Ecology: Quality of the natural environment.
Built Environment: Infrastructure and urban design.
Water Management and consumption of water resources.
Energy: Consumption and efficiency of energy resources.
Waste: Waste management and recycling.
Mobility: Transportation and accessibility.
Economy: Innovation, employment and economic development.
Education: Access to Education and quality of educational services.
Quality of Life: Health, safety and well-being.
Social Structure: Equality and social cohesion.
Governance: Transparency and decision-making.
Information and Communication Technology: Digital infrastructure and intelligence.

The following can be identified as capacities for achieving a city's resilience: planning, absorption, recovery, adaptation, robustness, stability and flexibility. The following can be identified as characteristics of resilient cities: resourcefulness, coordination capacity, redundancy, diversity, foresight capacity, self-organization, collaboration and equity.

The framework mentioned above provides the tools for monitoring and improving the performance of cities at a global level.[24]

In order to support the institutions that develop sustainable development strategies, UN member states voluntarily submit their national reports, applying 231 indicators to measure progress on the 17 Goals and the 169 sub-targets of sustainable development. In the context of the OECD's theoretical and empirical analysis of the 17 SDGs, with a focus on governance and comparative analysis among countries, a 'Sustainable Development Report' has been published by the UN Sustainable Development Solutions Network in recent years. This report is prepared by the research team led by professor Jeffrey Sachs. The authors of the report attempt to identify potential synergies and divergences among the Sustainable Development Goals and they propose global-level cooperation as well as a re-examination of the

[24] United Nations (2015c), Transforming Our World: The 2030 Agenda for Sustainable Development, New York, NY. https://sdgs.un.org/2030agenda; OECD (2018). *Environmental Performance Reviews.* IPCC (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability*; Rockefeller Foundation (2014). *100 Resilient Cities Initiative*; UN-Habitat (2016). *World Cities Report.*

relationship between markets and governments within the framework of implementing the following six parameters for sustainable development:

1. Education, gender and inequalities.
2. Health, well-being and demography.
3. Energy, decarbonization and sustainable industry.
4. Sustainable food systems, land, water and oceans.
5. Sustainable cities and communities.
6. The digital revolution.

According to the authors of the report, governments must intervene in the economy, promote public investments – primarily in infrastructure – ensure a low-emission economy, advance social justice through the redistribution of income from economically stronger to economically weaker citizens and regulate industry with the aim of safeguarding environmental and social sustainability.[25]

The same research team created an index ranging from 0 (lowest performance) to 100 (highest performance) in order to assess the progress countries have made toward achieving the UN's 17 Sustainable Development Goals. Greece ranks 29th among 193 countries and has been scored 78.7. In other words, Greece's achievement rate regarding the UN Sustainable Development Goals stands at 78.7%.[26]

The UN's 17 SDGs have been incorporated into the strategy of all European Union institutions, including the European Commission. The European Commission conducts an assessment based on Eurostat's measurements, which apply 100 indicators aimed at measuring the progress of the EU member states.[27]

According to the data from the European Commission's voluntary review[28] presented at the United Nations in 2023 regarding the progress of the implementation of the 2030 Agenda for Sustainable Development at the European Union level, the Goals on Climate and Energy show stagnation, despite the fact that ecosystems and biodiversity in certain areas have been negatively affected and given that the strategy for achieving the SDGs in the European Union incorporates most of the goals into the European Green Deal.

3. LOCAL GOVERNMENT AND SUSTAINABLE DEVELOPMENT

Improving the performance of local government in sustainability requires reforms, with clear targeting and coordination, at the level of central government – national and regional – as well as on the part of municipalities, civil society, enterprises and the scientific community.[29]

[25] Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N. and Rockström, J. (2019). "Six Transformations to achieve the Sustainable Development Goals". Nature Sustainability, 2: 805-814. https://doi.org/10.1038/s41893-019-0352-9

[26] Sachs, J.D., Lafortune, G., Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Paris: SDSN, Dublin: Dublin University Press. https://ae4ria.org/directory2/greece-ranks-29th-in-the-2024-sustainable-development-report/

[27] Trantas, N. (2021). Assessment of the Implementation Progress of the Sustainable Development Goals: Towards a More Informed and Political Content. *Review of the Hellenic Evaluation Society*, Issue 8, June 2021. https://www.hellenicevaluation.org/

[28] European Union (2023). EU Voluntary Review on progress in the implementation of the 2030 Agenda

[29] Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N. and Rockström, J. (2019). "Six Transformations to achieve the Sustainable Development Goals". Nature Sustainability, 2: 805-814. https://doi.org/10.1038/s41893-019-0352-9

From the perspective of municipalities, sustainability must be addressed not as a marketing, but as a strategic transformation with an emphasis on multi-level governance, accountability and measurable outcomes.

For managing the complexity of modern urban systems and achieving the goal of an Intelligent Sustainable City, cooperation of multiple scientific disciplines is required (Environmental Economics, Urban and Regional Planning, Economic and Regional Science, Bioeconomy, Computer Science, Statistics, Mathematics, Engineering, Urban, Regional and Environmental Law, Public Law, Administrative Science, Social and Humanitarian Sciences, Health and Life Sciences):

Urban and Spatial Planning

- Spatial planning for balancing the built and natural environment.
- Scientists specializing in the sustainable management of space and the creation of functional, resilient and green urban areas.

Environmental Sciences and Engineering

- Addressing challenges such as climate change, air quality, waste management and renewable energy sources.
- Scientists who design technologies to improve energy efficiency and promote a circular economy.

Computer Science and Engineering

- Development of smart technologies such as the Internet of Things (IoT), Big Data and Artificial Intelligence (AI).
- Applications for smart automation of city services and enhancing decision-making efficiency.

Economics and Management

- Economists who assess the costs and benefits of investments in smart technologies.
- Management scientists engaged in creating public-private partnerships (PPPs) and optimizing resource management.

Social Sciences and Law

- Political scientists and legal experts for shaping regulatory frameworks and participation policies.
- Sociologists, anthropologists and psychologists studying citizen behavior and social cohesion.

Transportation and Accounting

- Transport planners and experts in smart mobility, such as sustainable public transportation, electric vehicles and autonomous systems.

Health and Public Hygiene

- Public health specialists focused on disease prevention, as well as the maintenance and promotion of citizens' health (for example, through access to urban green spaces and clean air).

For the period 2021-2027, the European Commission, serving the policy objective 'A Europe closer to its citizens', actively supports sustainable urban development by increasing funding, embracing the primacy of local government, local authorities and civil society on city-related issues and launching the European Urban Initiative to upgrade cities through capacity building, innovative solutions and cohesion policies.

According to the findings of a 2022 survey conducted by the European Investment Bank[30], which covered 744 municipalities in the Member States of the European Union, there appear to be significant gaps in the knowledge, skills and competencies of local government employees. Municipalities highlight the difficulty they face in finding specialized personnel, particularly mechanical engineers and technicians in the fields of 'Environment' and 'Climate Change'.

Findings from a recent study [31]on the effectiveness of municipalities in Greece, examining resource efficiency and the alignment of their actions with the existing legal framework, indicate that the majority of municipalities do not systematically maintain data related to sustainability indicators.

Aiming at sound financial management, transparency, integrity and accountability to citizens, as well as improving environmental, social and corporate governance, a recent legislative act introduced the evaluation of the performance of Local Government Organizations and established a dedicated online platform for monitoring their progress. According to the Greek legislative framework,[32] the performance evaluation data of municipalities and their legal entities are published annually through the digital platform **deiktesOTA.gov.gr** and are categorized into 12 axes: Financial Data, Investments and Utilization of Real Estate, Quality of Life – Sports – Culture, Environment – Waste, Education and Early Childhood Care, People with Disabilities – Social Protection, Civil Protection, Management of Stray Companion Animals, Infrastructure – Energy Consumption, Human Resources, Smart Cities and Demographics and other data.

The table below attempts to map the above evaluation axes to the 17 UN Sustainable Development Goals (SDGs).

Table 1: Mapping the evaluation axes of Greek Municipalities to the 17 UN SDGs

Municipal Evaluation Axes	**17 UN Sustainable Development Goals (SDGs)**
Financial Data	8 (Decent Work and Economic Growth), 10 (reduced Inequalities), 11 (Sustainable Cities and Communities), 17 (Partnerships for the Goals)
Investments and Utilization of Real Estate	11 (Sustainable Cities and Communities), 17 (Partnerships for the Goals)
Quality of Life – Sports – Culture	11 (Sustainable Cities and Communities), 17 (Partnerships for the Goals)
Environment – Waste	6 (clean Water and Sanitation), 11 (Sustainable Cities and Communities), 13 (Climate Action), 14 (Life below Water), 15 (Life on Land), 17 (Partnerships for the Goals)
Education and Early Childhood Care	4 (Quality Education), 17 (Partnerships for the Goals)
People with Disabilities –	3 (Good Health and Well-Being), 11 (Sustainable Cities

[30] The state of local infrastructure investment in Europe EIB Municipalities Survey 2022-2023 © European Investment Bank, 2023. https://www.eib.org/en/publications/20230043-eib-municipalities-survey-2022.

[31] Saravakos, K., Plymakis, I., Mantas, Chr., Kalantzakis, G., Chena, R., Vallianos, I., Ulkeroglou, A., Pletsa, D., hood Stathopoulou, M. (2023). *Municipal Effectiveness Index 2023*. Center for Liberal Studies & Center for International and European Political Economy & Governance, University of the Peloponnese (Department of Political Science and International Relations). Athens, December 2023.

[32] The provisions of articles 33 and 52 of Law 5056/2023 (A' 163) as well as article 1 of Decision No. 105203/2023 (B' 7094) of the Deputy Minister of the Interior.

Social Protection	and Communities), 17 (Partnerships for the Goals)
Civil Protection	11 (Sustainable Cities and Communities), 17 (Partnerships for the Goals)
Management of Stray Companion Animals	11 (Sustainable Cities and Communities), 17 (Partnerships for the Goals)
Infrastructure – Energy Consumption	7 (Affordable and Clean Energy), 9 (Industry, Innovation and Infrastructure), 12 (responsible Consumption and Production), 17 (Partnerships for the Goals)
Human Resources	4 (Quality Education), 5 (Gender Equality), 8 (Decent Work and Economic Growth), 10 (reduced Inequalities), 11 (Sustainable Cities and Communities), 16 (Peace, Justice and strong Institutions), 17 (Partnerships for the Goals)
Smart Cities	11 (Sustainable Cities and Communities), 17 (Partnerships for the Goals)
Demographics and other data	1 (No Poverty), 2 (zero Hunger), 3 (Good Health and Well-Being), 5 (Gender Equality), 8 (Decent Work and Economic Growth), 10 (reduced Inequalities), 16 (Peace, Justice and strong Institutions), 17 (Partnerships for the Goals)

Source: Author's own elaboration based on the Ministerial Decision No. 105203/2023 (Government Gazette B' 7094) and the 2030 Agenda for Sustainable Development.[33]

More than 6 in 10 municipalities are not satisfied with their investments in climate change adaptation and 4 in 10 municipalities are dissatisfied with their investments in digital transformation infrastructure, However, digital transformation is progressing more rapidly compared to the green transition. At this point, it should be noted that local government is the first to demonstrate, at the international level, numerous good practices for achieving the goal of sustainable urban development.

Municipalities in Greece are intensifying their actions to reduce carbon dioxide emissions, improve the energy efficiency of buildings and promote the circular economy. Greece has undertaken multiple pilot initiatives at the municipal level, demonstrating how local authorities can effectively align with sustainability goals. For example, some municipalities have introduced community recycling and composting programs that prioritize citizen engagement and awareness campaigns. These programs have contributed to reducing the use of landfills and enhancing environmental awareness, thus aligning with the broader EU guidelines on waste management.

Another area of best practice concerns sustainable tourism development in regions such as Crete and the Cyclades islands. Local authorities cooperate with enterprises, non-governmental organizations and local communities to implement measures that safeguard natural ecosystems and promote cultural heritage tourism. Through proactive management of visitor flows and the development of infrastructure, these municipalities aim to balance economic growth with environmental and social well-being. These best practices demonstrate the ability of local authorities to negotiate complex interests and maintain a balance between development objectives and environmental protection goals.

[33]United Nations (2015c), Transforming Our World: The 2030 Agenda for Sustainable Development, New York, NY. https://sustainabledevelopment.un.org/post2015/transformingourworld)

The cooperation between public and private entities for crisis prevention and management aims to create an Intelligent, Sustainable and Resilient City that functions as an ecosystem capable of adapting to future challenges.[34]

Managing water scarcity in an Intelligent, Sustainable and Resilient City involves Smart Water Resource Management, which can be achieved through:

- The use of IoT sensors to monitor water quality and quantity and to detect and repair damages in water supply networks (for example, leaks) through automated systems.
- Recycling and reusing water through technologies for the treatment and utilization of greywater and liquid waste.
- Collecting rainwater through green infrastructure (for example, green roofs, rainwater harvesting tanks).
- Raising awareness and informing citizens about the use of applications that promote water-saving practices.

Earthquake prevention and mitigation can be achieved through:

- Vibration monitoring systems for the early detection of dangerous cracks.
- Networks of seismographs that provide warnings before the main tremor.
- Smart, high-strength building structures and self-repair technologies as well as citizen training and education.

Fire prevention and mitigation can be achieved, as far as possible, through:

- Satellite monitoring (drones for detecting smoke and fire sources).
- Temperature sensors in forests and urban areas.
- Green zones that limit the spread of fires.
- Robotic fire suppression systems and smart water supply networks.

Flood prevention and mitigation can be achieved through:

- Sensors for monitoring the water levels of rivers and canals.
- Early warning systems for citizens.
- Information systems with real-time flood risk mapping.
- Smart dams and pumping stations that adapt to water flow.
- Urban green areas that absorb water.
- Tree planting to reduce erosion and absorb water.

Maroussi has the potential to emerge as an Intelligent Sustainable City and this direction significant steps have already been taken through a focus on green and technologically innovative policies.

4. THE CASE STUDY OF THE MUNICIPALITY OF MAROUSSI AND THE SYGGROU FOREST

The Municipality of Maroussi is located in the northeastern part of the Athens metropolitan area. Historically, it was an agricultural region that gradually transformed into a suburban settlement and later became an important economic center. This transformation is attributed to

[34]Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., ... & Portugali, Y. (2012). Smart cities of the future. The European Physical Journal Special Topics, 214, 481-518

various factors, including urban expansion, infrastructure development and the relocation of business and commercial activities from central Athens to its outskirts.[35]

Although Maroussi is administratively part of the greater Athens area, it possesses unique characteristics, such as relatively high elevation, proximity to major road axes and a mix of purely residential areas alongside zones hosting large shopping centers and major businesses. These features place Maroussi at the crossroads of intense urban development pressures and opportunities for sustainable governance.[36]

The Municipality of Maroussi is administratively part of the North Athens Regional Unit within the Region of Attica, according to the "Kallikratis Program" (Law 3852/2010, Government Gazette 87/A/2010). The Municipality of Maroussi covers an area of approximately 13.330.971 m². The population of the city of Maroussi amounts to 72.227 inhabitants. The governing bodies of the Municipality consist of the Mayor, the Municipal Council and the Municipal Committee.[37]

Over the past decades, the Municipality has sought to balance rapid commercial development with the preservation of local and cultural characteristics, including older neighborhoods, parks and cultural institutions. Nevertheless, pressures to accommodate multinational companies, shopping centers and large infrastructure projects – as evidenced by the presence of prominent complexes and the Olympic Stadium (built for the 2004 Olympic Games)-have significantly impacted the municipality's natural and socio-economic landscape.[38]

Maroussi has a rich cultural heritage, is connected to the history of ancient Greece and dates back to 3000 B.C., the year of its founding by Cecrops. The patron deity of Maroussi was Artemis Amarysia, the goddess of the hunt, who was worshiped in the area and whose sanctuary served as an important religious center. The city possesses features that can significantly contribute to its urban environmental sustainability, enhance the quality of life for its residents and preserve its cultural heritage.

The map below illustrates the natural and cultural environment of the Municipality of Maroussi.

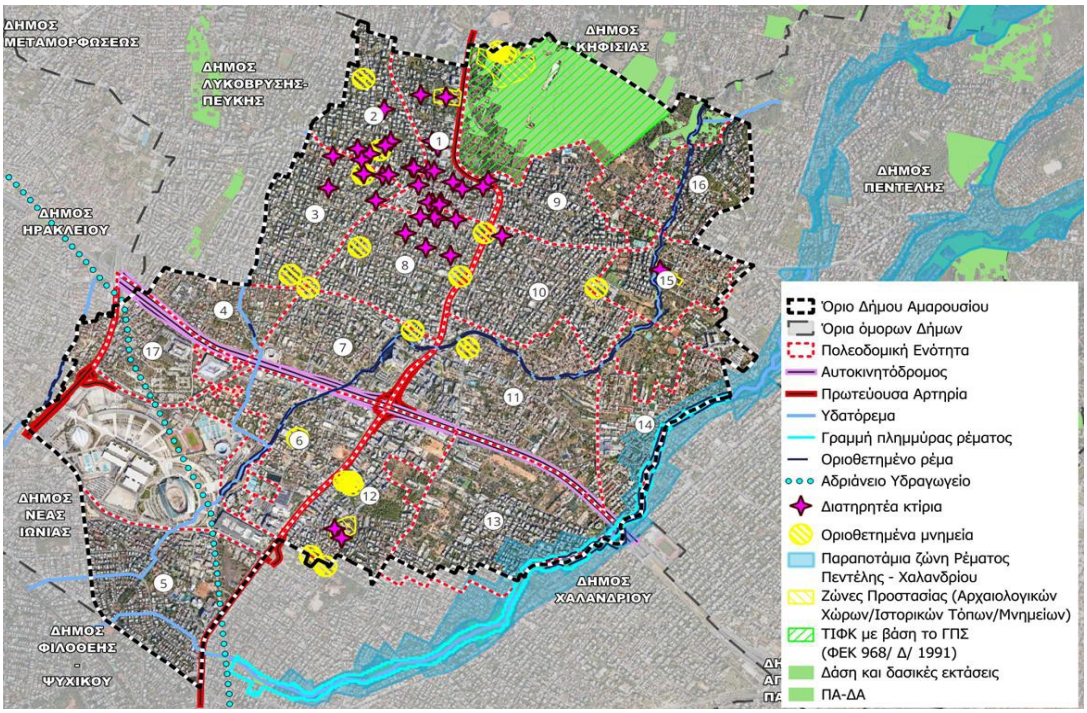
Map 1: Natural and Cultural Environment of the Municipality of Maroussi

[35] Chorianopoulos I., Pagonis T., Koukoulas S., Drymoniti S. (2010). Planning, competitiveness and sprawl in the Mediterranean city. The case of Athens Cities 27 (4), 249-259.

[36] Wassenhoven, L. C. (2022). *Compromise planning: A theoretical approach from a distant corner of Europe*. Springer Nature.

[37] Hellenic Republic, Ministry of the Interior, May 2024. *Structure and Operation of Local and Regional Democracy, Greece 2024, p. 17*. *Structure and Operation of Local and Regional Democracy, Greece 2024*, p. 17. https://www.ypes.gr/wp-content/uploads/2024/06/STRUCTURE-OPERATION-LRD-GREEK-VERSION-2024.pdf

[38] Chorianopoulos I., Pagonis T., Koukoulas S., Drymoniti S. (2010). Planning, competitiveness and sprawl in the Mediterranean city. The case of Athens Cities 27 (4), 249-259.



Source: Elaboration of the study for the Local Urban Plan of the Municipality of Maroussi, p.7[39]

Legend

Municipal boundary of the Municipality of Maroussi	
Boundaries of neighboring municipalities	
Urban Planning Unit	
Motorway/Highway	
Primary arterial road	
Watercourse/Stream	
Flood flow line	
Delineated stream	
Hadrian's Aqueduct	
Protected buildings	
Designated monuments	
Riparian zone of the Penteli-Chalandri stream	
Protection zones (archaeological sites/historic areas/monuments	
Value according to the Local Urban Plan (GG968/D/1991)	
Forests and wooded areas	
PA-DA (retained as original code)	

[39]Technical Chamber of Greece. Study Team: Joint Venture "ERATOSTHENES S.A. – Anastasia Lagoudaki – TOPODOMIKI S.A.-MSM Consulting – Seeman Environmental – Dimitrios Argyriou" (2025). *Elaboration of the study for the Local Urban Plan of the Municipality of Maroussi.*

As illustrated on the map above the Municipality of Maroussi is bordered by the Municipality of Penteli to the northeast, Kifissia to the north, Lykovryssi-Pefki to the northwest, Nea Ionia to the west, Filothei-Psychiko and Neo Iraklio to the southwest, Chalandri to the south and Vrilissia to the northeast.

Ancient Infrastructure and Cultural Monuments: The Hadrianic Aqueduct is one of the most important ancient waterworks in Attica. It was constructed during the Roman period, around 140 A.D., under the supervision of the Roman Emperor Hadrian. This aqueduct constituted an extensive water supply system, providing water to Athens and the surrounding areas for over 1.800 years. It originates in the region of Parnitha, specifically from the Tatoi spring and passes through several areas of the northern suburbs of Athens, including Maroussi. It ensured the water supply to the city of Athens.

Traditional Architecture and Urban Redevelopment: The traditional architecture of Maroussi featuring neoclassical buildings, can contribute to environmental sustainability through proper restoration and preservation of these structures.

Urban Planning: 10% of the Municipalityof Maroussi falls under protection (these areas have their own legal status).

The areas presented in the table below are subject to the same legal framework

Table 2: Areas of the Municipality of Maroussi with their own legal status

Type	**Area (m^2)**	**% of the total municipal area**	**Comments**
Total area of the Municipality	13,330,971	100%	
Forests and lands governed by forestry law	723.763	5,43%	Part of it overlaps with Syggrou Forest, the protection zones of the Penteli stream and the protection zones of archaeological sites/historic areas/monuments
Syggrou Forest which is designated as a Landscape of Exceptional Natural Beauty in the General Urban Plan of Maroussi	936.796	7.03%	A part of it overlaps with forested areas and the Protection Zones of archaeological sites/historic areas/monuments
Zone A of the Penteli-Chalandri Stream Protection Area	64.091	0,48%	A part of them overlaps with forested areas
Zone B of the Penteli-Chalandri Stream Protection Area	281.200	2,11%	
Protection Zones of archaeological sites/historic areas/monuments	146.429	1,10%	Parts of them overlap with forested areas and the Syggrou Forest

Source: Elaboration of the study for *the* Local Urban Plan of the Municipality of Maroussi, p. 3

The detailed urban plans of different areas of the Municipality of Maroussi which cover 76.2% of the municipality's total area, were approved at different periods between 1921 and 2018, as presented in the table below

Table 3: Applicable urban planning framework

Period of legal Enactment	% of the municipality's area with an approved Urban Plan
1920-1940	33,1%
1940 – 1960	8,1%
1960 – 1980	16,8%
1980 – 2000	32,3%
After 2000	9,7%
Total	**76,2%**

Source: Elaboration of the study for the Local Urban Plan of the Municipality of Maroussi, p. 3

A comprehensive approach to the urban organization of the Municipality of Maroussi as a whole was carried out later with the approved General Urban Plan (Government Gazette 968/D/1991) and with subsequent amendments in 1993, 1994, 1997 and 2019.

On July 2, 2025, at the Maroussi City Hall the presentation of the three alternative spatial development scenarios for the city was held, which are part of Stage A of the study for the Local Urban Plan of the Municipality of Maroussi. Stage B of the study for the Local Urban Plan of the Municipality of Maroussi will follow, which will constitute the final proposal for the urban redesign of the city of Maroussi. The Local Urban Plan of the Municipality of Maroussi is being prepared within the framework of the National Urban Reform Program 'Konstantinos Doxiadis'. Local Urban Plans are implemented by the Ministry of Environment and Energy with the support of the Technical Chamber of Greece and financed by the Recovery and Resilience Fund.

Green Spaces and Urban Biodiversity: Maroussi has numerous green areas, parks and groves that can be expanded and enhanced to improve urban biodiversity. These green spaces contribute to better air quality, temperature reduction and provide recreational areas for residents.

Promotion of Sustainable Cultural Events: Maroussi has a tradition of hosting cultural events, which can be designed to focus on environmental awareness.

Civil Protection: The rapid increase in vehicles, the reduction of open spaces and the climate crisis (fires, floods etc.) constitute a harsh reality for modern cities. The Municipality of Maroussi places particular emphasis on civil protection, leverages technology (artificial intelligence, sensors, thermal cameras, digital risk maps) and has installed the ANANIAS system, an intelligent and fully automated thermal-camera system for timely and effective fire detection.

Social Participation and Education: Preserving Maroussi's cultural heritage can serve as a foundation for educating residents, especially young people about the importance of environmental protection.

The historical and cultural background of Maroussi is not only a treasure of the past but also an opportunity for a sustainable future. With appropriate strategies that integrate tradition and innovation, Maroussi can serve as a model city, leveraging its cultural capital to enhance its environmental sustainability. The Syggrou Forest covers 700,000 m² of a total area of approximately 950,000 m². It is the only natural forest remaining in the Metropolitan Region of Athens and is designated as an Urban Green Space of supra-local importance, as it exceeds the criteria for size and tree canopy density. In view of rapid urban expansion, environmental

pressures and evolving social needs, the Municipality of Maroussi is undertaking sustainability-oriented initiatives (infrastructure projects, community participation programs and strategic partnerships with other municipalities, national agencies, private companies and civil society organisations). The impetus for such initiatives arises not only from local needs - such as mitigating traffic congestion or preserving green spaces – but also from global and European policy frameworks that support resilient urban environments.

5. THE E-PARK AS A MODEL OF SUSTAINABLE AND INNOVATIVE RECREATION

The creation of the e-Park constitutes a good practice in developing a model green and active recreation space that incorporates elements of technological innovation, energy self-sufficiency and environmental sustainability. Before the construction of the e-Park by BAT Hellas in cooperation with the Municipality of Maroussi, the residents of Psalidi area in Maroussi had repeatedly submitted to the Municipal Authority their request for the upgrade of 'Degleri Square' and the creation of a green space. In the same area there was a lack of modern infrastructure, green space and facilities for physical activity.

The need for sustainable development, safe and accessible public spaces for all and an improvement in residents' quality of life was urgent. The existing infrastructure was insufficient to meet the growing demands of modern urban life and both the square itself and the surrounding area presented a marked appearance of neglect.

The area has been designated as a purely residential zone. It has been burdened by rapid and intense urbanization, resulting in the exhaustion of the area's urban carrying capacity and the deterioration of residents' quality of life. Outdated methods of lighting and energy consumption were no longer sustainable, creating the need for the implementation of innovative, green technologies. The construction of the first e-Park in Greece combines environmental sustainability with technological innovation. The aim was to upgrade 'Degleri Square' in the Psalidi area of Maroussi and transform it into a modern, sustainable and technologically advanced public space.

e – Park

Source: BAT Hellas

The e-Park leveraging the achievements of technology and 'smart' equipment, includes solar lighting poles, smart solar benches and tables, a specially designed area with electric vehicle charging stations and a smart irrigation system – features that ensure the space's complete energy self-sufficiency. It attracts visitors from all over Attica and serves as a reference point for the green transition, the utilization of renewable energy sources, the use of innovative technologies and sustainable urban development. This park represents a good practice of Public-Private Partnership, Corporate Social Responsibility, as well as volunteer engagement. Visitors to the e-Park have the ability to access free wireless internet, connect their portable devices via Bluetooth for music or information playback and charge their mobile devices wirelessly or via cable, while complete energy self-sufficiency is ensured through the use of solar panels.

6. METHODOLOGY

The findings of this research which is part of my Master's thesis, came from a wide range of secondary sources, as well as from primary field research. The methodology is based on the development of a case study, incorporating both quantitative and qualitative research. From the literature review, it can be concluded that local government and especially municipalities can make a significant contribution to promoting sustainable development, as they possess knowledge of local characteristics, comparative advantages and the developmental opportunities of cities. Three structured questionnaires were used, which were specifically designed for the needs of the present research.

The first survey question is addressed to residents of the Municipality of Maroussi and includes questions related to: (a) the level of awareness among citizens of the Municipality of Maroussi regarding sustainable development issues, (b) citizens' evaluation of the Municipality's policies and actions for sustainable development and the protection of Syggrou Forest and (c) citizens' perceptions of factors that constitute obstacles to the sustainable management of Syggrou Forest. The second survey question is addressed to elected officials (municipal councilors and deputy mayors) and aims to capture their perceptions of the Municipality of Maroussi's policies and actions that focus on sustainability and the protection of Syggrou Forest. The third survey question is addressed to the President of the Board of Directors of the Institute of Agricultural Sciences. The Institute of Agricultural Sciences is the managing authority of Syggrou Forest. The interview focused on issues related to administrative functioning, financial sustainability, the implementation of sustainability initiatives, the challenges faced by the Institute and proposals for strengthening the protection of Syggrou Forest.

In the context of the present research, the following working hypotheses are formulated. These hypotheses seek to examine statistical relationships between key variables related to sustainable development, the contribution of the Municipality of Maroussi to sustainability and the protection of Syggrou Forest.

Hypothesis 1

- Null hypothesis (H0): The level of citizens' awareness regarding sustainable development and the protection of Syggrou Forest is not statistically significantly related to their educational level.
- Alternative hypothesis (H1): Citizen's educational level is statistically significantly related to their level of awareness regarding sustainable development and the protection of Syggrou Forest.

Hypothesis 2

- Null hypothesis (H0): The perceived contribution of local government to sustainable development and the protection of Syggrou Forest is not statistically dependent on its financial autonomy.
- Alternative hypothesis (H1): The perceived contribution of local government to sustainable development and the protection of Syggrou Forest is statistically dependent on its financial autonomy.

Hypothesis 3

- Null hypothesis (H0): The lack of financial resources, bureaucracy and insufficient specialized personnel do not constitute significant obstacles to the contribution of local government to sustainable development and the protection of Syggrou Forest.
- Alternative hypothesis (H1): The lack of financial resources, bureaucracy and insufficient specialized personnel constitute significant obstacles to the contribution of local government to sustainable development and the protection of Syggrou Forest.

7. FINDINGS

Profile of the citizens of the Municipality of Maroussi who participated in the Survey

Demographic Data

Gender and Age Distribution

Eighty-four (84) residents of the city of Maroussi participated in the survey. The distribution of survey participants by gender shows a clear majority of women, with 67.9% (57 citizens) being women and 32,1% (27 citizens) being men. Regarding age, 34.5% (29 citizens) belong to the 46-55 age group, while the age groups "up to 35 years" and "36-45 years" are evenly distributed, each accounting for 21.4% (18) of the respondents. The "56 and above" age group represents 22.6% (19 citizens).

Educational Level and Marital Status

Regarding educational level, a high percentage of participants are university graduates, accounting for 42.9% (36 citizens). Holders of a Master's degree represent 39.3% (33 citizens), while only 7.1% (6 citizens) hold a doctoral degree. High school graduates make up 10.7% (9 citizens) of the survey respondents.

Concerning marital status, the majority of respondents, 53.6% (45 citizens), are married. Single participants account for 21.4% (18 citizens). Those with children, either minors or adults, represent 10.7% (9 citizens). The remaining participants are divorced, 2.4% (2 citizens) or widowed, 1.2% (one citizen).

Employment Status

With regard to the employment of the survey participants, it is evident that the majority are private sector employees, accounting for 45.2% (38 citizens). The percentage of self-employed professionals is 27.4% (23 citizens), public sector employees account for 15.5% (13

citizens), and retirees represent 7.1% (6 citizens). Pupils/students account for 1.2% (one citizen), while homemakers represent 3.6% (3 citizens).

Municipal Residency of Participants
The overwhelming majority of the survey participants, 82.1% (69 citizens) are residents of the Municipality of Maroussi, while 17.9% (15 citizens) are not residents.

Duration of Residence and Reasons for Settling in Maroussi
The majority of survey participants have lived in Maroussi for over 20 years (66.7%, 56 citizens), while 13.1% (11 citizens) have lived there for 6-20 years and 7.1% (6 citizens) for 1-5 years.
Regarding the reasons for settling in Maroussi, the largest group of participants (42.9%, 36 citizens) resides in Maroussi because it is their birthplace. A further 21.4% (18 citizens) chose it for acquiring permanent residence, 20.2% (17 citizens) selected it because it is the location of their workplace, 9.5% (8 citizens) for the high quality of life and a small percentage, 6% (5 citizens) settled there because of the choice of their husband or wife.
The distribution of survey participants across the 17 Urban Planning Units (UPUs) of the Municipality of Maroussi is as follows:

Table 2: Distribution of survey participants across the 17 Urban Planning Units of Maroussi

Urban Planning Units (UPUs)	**Number of participants**
UPU-1 "Center"	14 citizens
UPU-2 "Agios Nikolaos"	3 citizens
UPU-3 "Neo Terma"	4 citizens
UPU-4 'Psalidi (Pelika)"	22 citizens
UPU-5 "Nea Filothei"	3 citizens
UPU-6 "Agios Thomas"	4 citizens
UPU-7 "Ergatikes Polykatoikies"	2 citizens
UPU-8 "Agioi Anargyroi"	2 citizens
UPU-9 "Vorre"	4 citizens
UPU-10 "Kokkinia"	4 citizens
UPU-11 "Soros-Lakka Kottou"	5 citizens
UPU-12 "Paradeisos"	2 citizens
UPU-13 "Polydrosso"	2 citizens
UPU-14 "Sismanogleio – Neo Maroussi"	3 citizens
UPU-15 "Karpathiotika-Ipirotika-Dodoni-Studio Alpha"	3 citizens
UPU-16 "Nea Lesvos – Anavryta – Angelopoulou"	5 citizens
UPU-17 "ASPAITE"	2 citizens
Total	**84**

The Contribution of the Municipality of Maroussi to Sustainable Development
When asked about their knowledge of the concept of sustainable development, 11.9% of respondents reported being highly familiar with it, while 70.2% indicated that they have a clear understanding of its meaning.

Regarding the question of whether participants are familiar with the 17 United Nations Sustainable Development Goals (SDGs), 4 respondents answered "very much", 41 answered "much", 15 answered "moderately", 10 answered "little" and 14 answered "not at all".

When asked about the sources of their knowledge regarding the 17 United Nations Sustainable Development Goals (SDGs), 45.2% of respondents reported acquiring it through participation in educational programs, 42.9% through studying relevant texts and 11.9% through involvement in local initiatives.

Survey participants were asked to assess the extent to which the actions of the Municipality of Maroussi are linked to the 17 United Nations Sustainable Development Goals (SDGs) and contribute to sustainable development. The results, ranked from highest to lowest mean score, are as follows:

- ✓ LIFE GRIN model green space (Sustainable Cities and Communities: 3.40.
- ✓ H020 Socio Bee research and innovation project (Climate Action/Environmental Protection): 3.36.
- ✓ Energy-autonomous park (Affordable and Clean Energy): 3.35.
- ✓ Recycling and waste management initiative (Climate Action): 3.24.
- ✓ Water supply and sewage management initiative (Clean Water and Sanitation): 3.23.
- ✓ Programs supporting the elderly: 3.23.
- ✓ Environmental Volunteer Charter (Sustainable Cities and Communities): 3.17.
- ✓ Action supporting institutional functions and ensuring transparency (Peace, Justice and Strong Institutions): 3.14.
- ✓ Maroussi Digital Academy (Decent Work and Economic Growth): 3.11.
- ✓ Geospatial information platform (Partnerships for the Goals): 3.11.
- ✓ Flood monitoring and early warning initiative (Sustainable Cities and Communities): 3.08.

The survey results highlight the important role that Syggrou Forest holds in the daily lives of the residents of the Municipality of Maroussi. Visitor rates are particularly high (89.3%), confirming the Forest's significance as a place of recreation and well-being for the local community. The majority of participants visit it regularly, either for walking (31%) or exercising, running, cycling (23.8%), while many people combine activities such as social gatherings, playtime with children and relaxation.

Additionally, 13.1% of the respondents stated that they combine walking with social activities (such as meeting friends or attending children's celebration) during their visit to the forest, highlighting its role as a social gathering point. Finally, 3.6% of the respondents reported combining walking with nature observation, playing with their children, picnicking or visiting the Natural History Museum.

In response to the question regarding the frequency of their visits to Syggrou Forest, 45.2% of the participants stated that they visit the forest on a weekly basis. A further 23.8% reported visiting Syggrou Forest a few times per year, 19% indicated that they visit it a few times per month, while approximately 11.9% stated that they visit the forest rarely.

The survey reveals a strong recognition of the Forest's contribution to improving quality of life, with 82.1% of respondents stating that it contributes very much.

With respect to respondents' satisfaction with the organization, planning and maintenance of Syggrou Forest, the majority (56%) reported being moderately satisfied, while 13.1% stated that they are very satisfied and 22.6% indicated that they are somewhat satisfied.

Regarding how informed participants feel about the Municipality of Maroussi's sustainability actions-and specifically its initiatives for the protection of Syggrou Forest – the findings indicate that 41.7% of respondents feel adequately informed, while 17.9% stated that they feel very well informed. 25% stated that they feel only minimally informed.

An impressive 92.9% of respondents express a positive willingness to participate in volunteer activities for the protection of Syggrou Forest, highlighting the strong social awareness and the residents' commitment to contributing to the forest's preservation and protection.

Regarding the need for further initiatives to enhance and protect Syggrou Forest, survey participants expressed their opinions and priorities. The control of the harmful plant *Ailanthus* received a high mean score of 4.60%, suggesting that participants view this action as very important for forest protection (M=4.60, SD=0.762). Strategic planning for the protection of Syggrou Forest received the second-highest mean score of 4.54 (M=4,54, SD=0.813), indicating that participants consider this need very important. Tree planting and the care of green areas are viewed as important for the preservation and regeneration of natural vegetation, with a mean score of 4.25 and a standard deviation of 0.557. Concerning educational programs for the residents of Maroussi and school students, the mean score is relatively high, reflecting that participants perceive a strong need for such initiatives (M=4.13, SD=0.597).

The majority of survey participants, 88.1% recognize the significant role of the Syggrou Forest in promoting sustainable urban development in the Municipality of Maroussi. An even higher percentage, 95.2% of respondents, consider the cooperation between local government and volunteer organizations to be extremely important and crucial for the protection of the Syggrou Forest.

The survey participants express a positive assessment of the Municipality's ability to adapt and respond to unpredictable situations and emergency events.

Respondents gave a positive evaluation of the Municipality of Maroussi's "smart" management, which refers to the use of technologies and innovations to achieve objectives and serve citizens. They noted that there are still aspects that could be improved.

Regarding actions that should be intensified to improve urban environmental sustainability in the Municipality of Maroussi and to protect Syggrou Forest, the survey results are as follows:

The adequacy of financial resources ranks highest with a mean score of 4.79 (SD=0.561), emphasizing the need for sufficient funding.

Prevention and management of natural disasters received an exceptionally high mean score of 4.77 and a low standard deviation (SD=0.499).

The adequacy of specialized staff received the third highest mean score, equal to 4.73 and a standard deviation of 0.588, indicating that participants consider the presence of qualified personnel to be critical.

The control of the harmful tree-of-heaven (Ailanthus altissima) received a mean score of 4.68 and a standard deviation of 0.604, indicating that participants consider this action to be very important for the health of Syggrou Forest, while forest cleaning scored a mean of 4.30 (SD=0.636).

The use of solar energy achieved a mean score of 4.52 (SD=0.736), confirming that renewable energy forms are a high priority. The expansion of recycling and waste management.

The development of smart applications and infrastructure for a "Smart City" received a high mean score of 4.52 and a standard deviation of 0.814, highlighting the need for the use of innovative technologies in the management of the city and the forest.

Waste management and recycling received a mean score of 4.35 and a standard deviation of 0.611, highlighting the importance of sustainable waste management for environmental protection.

The conservation of the natural and native biodiversity of Syggrou Forest is also ranked highly (M=4.35, SD=0.549).

Energy conservation is also ranked highly among the issues that participants consider very important for the urban environmental sustainability of the Municipality of Maroussi and the protection of Syggrou Forest (M=4,33, SD=0.665).

The expansion of green spaces received a high mean score of 4.30 (SD=0.617), indicating that participants recognize the importance of increasing urban greenery to enhance city quality.

Air pollution follows with a similarly high mean score of 4.26 and a standard deviation of 0.661.

Similar results were observed for the improvement of access infrastructure for people with mobility challenges (M=4.25, SD=0.656).

Strengthening citizen awareness, education and engagement actions also received a high mean score (M=4.21, SD=0.561).

The promotion of volunteer activities in Syggrou Forest was positively evaluated, though with somewhat lower relative priority (M=4.14, SD=0.624).

Improvements in climate governance were also positively evaluated (M=4.13, SD=0.724).

8. INTERPRETATION OF RESEARCH HYPOTHESES

Hypothesis 1

The analysis conducted using the Kruskal-Wallis test to examine the relationship between educational level and the degree of awareness among residents of the Municipality of Maroussi regarding issues of sustainable development and the protection of Syggrou Forest did not reveal any statistically significant differences (p=0.610). The null hypothesis – that the level of citizens' awareness regarding sustainable development and the protection of Syggrou Forest is not statistically significantly related to their educational level-was confirmed.

To investigate this relationship, the independent variable used was the educational level, as recorded in the demographic section of the questionnaire. The dependent variable was defined as an awareness index, which was derived from the calculation of the mean score of participants' responses to questions related to: their knowledge of the concept of sustainable development, their knowledge of the 17 UN Sustainable Development Goals and their assessment of the necessity of specific environmental initiatives undertaken by the Municipality of Maroussi. Therefore, environmental awareness appears to be more broadly distributed and is not exclusively dependent on citizens' educational level.

Hypothesis 2

The correlation between the Municipality'sfinancial adequacy and its contribution to sustainable development (Spearman's $\rho=0.429$, $p<0.001$) was statistically significant and positive. Therefore, the null hypothesis is rejected and the alternative hypothesis is confirmed, indicating that the Municipality's financial autonomy, as perceived by citizens, is related to its

effectiveness in matters of sustainability and environmental protection. Consequently, a statistically significant association was identified between citizens' perceptions of the Municipality's financial adequacy and its contribution to environmental policy, reinforcing the view that citizens directly link available financial resources with the effectiveness of local governance.

Hypothesis 3

The third research hypothesis focuses on examining how citizens evaluate potential obstacles to the Municipality of Maroussi's contribution to sustainable development and the protection of Syggrou Forest. Specifically, it investigates whether these obstacles are considered equally important or whether some of them are perceived by citizens as more significant than others. For this purpose, four key issues were selected:

- ✓ The improvement of climate governance,
- ✓ The securing of additional financial resources, combat the invasive
- ✓ The actions to combat the harmful plant *Ailanthus* in Syggrou Forest
- ✓ The enhancement of access infrastructure to the Syggrou Forest for individuals with mobility difficulties.

The Friedman test revealed statistically significant differences in the way citizens evaluated the four obstacles to local government action ($X^2 = 72{,}947$, $p < 0{,}001$). The paired comparisons indicate that participants consider the lack of financial resources and the presence of harmful plant Ailanthus in Syggrou Forest to be more significant obstacles compared to general climate governance and the accessibility infrastructure of the Syggrou Forest for individuals with mobility difficulties. According to the views of the survey participants, the financial autonomy of municipalities constitutes a fundamental prerequisite for the effective implementation of sustainability policies.

9. RESULTS OF THE SURVEY CONDUCTED WITH ELECTED OFFICIALS OF THE MUNICIPALITY OF MAROUSSI

Six (6) officials who were elected in the municipal elections participated in the survey. The analysis of the responses of the elected officials of the Municipality of Maroussi reveals a positive attitude toward the Municipality's strategy for sustainable development and the protection of Syggrou Forest. The survey participants are familiar with the 17 United Nations Sustainable Development Goals (SDGs). This knowledge is mainly derived from institutional and professional frameworks of information, as well as from their participation in educational programs.

The elected officials' perception of sustainable development is multidimensional, incorporating issues such as environmental protection, quality of life and green infrastructure into a unified framework for action. Rather than prioritizing a single isolated objective, there is a clear preference for the need for integrated interventions that enhance both the ecological and social functions of the city. At the same time, the elected officials of the Municipality of Maroussi recognize that urban environmental sustainability requires not only environmental management but also the availability of adequate financial and human resources, staff training, technological innovation and the active participation of society.

Syggrou Forest is universally recognized as a highly significant environmental, social, cultural and educational resource. The elected officials of the Municipality of Maroussi view Syggrou Forest as a multifunctional public space that meets a wide range of residents' daily and institutional needs. Its contribution to the promotion of sustainable urban development is

assessed very positively, as is the importance of cooperation between local authorities and volunteer organizations for its protection. They identify areas where further strengthening and strategic planning are required, particularly with regard to securing financial resources, training municipal employees, integrating innovation, further enhancing citizen information and participation and implementing targeted interventions that ensure the effective management of the area.

The unanimous agreement on the need for additional initiatives, as well as the full willingness to participate in volunteer actions, demonstrates a politically active and environmentally aware core of elected officials who are willing to contribute both institutionally and practically to the long-term protection of Syggrou Forest.

10. ANALYSIS OF THE INTERVIEW WITH THE PRESIDENT OF THE BOARD OF DIRECTORS OF THE INSTITUTE OF AGRICULTURAL SCIENCES

According to the legal framework, the Institute of Agricultural Sciences is the body responsible for the management of Syggrou Forest, which has been designated as a Landscape of Outstanding Natural Beauty and an area where archaeological finds have been identified. The Institute of Agricultural Sciences has been implementing agricultural education programs for over 120 years. It offers thematic seminars of one hundred (100) hours' duration in fields such as beekeeping, aromatic plants, olive cultivation, pest and rodent control.

The President of the Board of Directors of the Institute of Agricultural Sciences acknowledges that improvements should be made for the benefit of trainees and visitors to Syggrou Forest. He also states that the financial resources derive from the Institute of Agricultural Sciences' own revenues.

With regard to the priorities of actions for the protection of Syggrou Forest, he identifies the following as very important: strategic planning; strict surveillance and protection of the forest from fires; securing financial resources through European programs; the use of smart technologies; improvement of trainees' practical training; control of the harmful tree-of-heaven (Ailanthus altissima); Protection of biodiversity; Information and education of citizens; Organization of cultural events; cooperation with environmental organizations and improvement of infrastructure (e.g. maintenance of trails).

The association "Friends of Syggrou Forest" is committed to the protection of Syggrou Forest. According to the assessment of the President of the Board of Directors of the Institute of Agricultural Sciences, cooperation between the Institute and the Municipality of Maroussi, as well as with volunteer organizations and environmental associations is very important for the protection of Syggrou Forest. Syggrou Forest is affected by the climate crisis and additional resources – both human and financial-are required to ensure its effective protection.

11. CONCLUSIONS

The following conclusions are confirmed by both the primary and secondary research:

Achieving a sustainable, safe and resilient city in the face of the impacts of the climate crisis and social inequalities appears to be a challenging path, closely linked to: (a) financial autonomy and the capacity to invest in technology and innovation and (b) four types of capabilities: (1) strategic capacity, (2) data management capacity, (3) organizational capacity and (4) collaborative capacity.

The above-mentioned conditions do not guarantee, but rather support, the effectiveness of sustainable development policies at the local government level.

To address economic, environmental, climatic, demographic and social challenges in urban areas, the following are necessary: coordination in the implementation of sustainability actions; the existence of city networks and synergies among the Government, Regions and Municipalities with the support of social stakeholders, civil society, enterprises and the scientific community.

To strengthen the operational capacity of cities, upgrading the skills of the human resources employed in Local Government Organizations is of great importance, with the aim of taking initiatives that will contribute to sustainable development.

For Maroussi to become a smart, sustainable and resilient city, the following are required:

- **Strategic Planning**: A sustainable development plan with the active participation of citizens.
- **Investment in Technology**: Sensor networks for traffic, energy and environmental monitoring, as well as the development of smart infrastructure.
- **Resource Management:**Recycling and waste reduction and the use of renewable energy sources in public buildings.
- **Partnerships:** Cooperation with universities, research centers and the creation of "smart neighborhoods" as pilot initiatives.
- **Education and Awareness:** Informing and engaging citizens in sustainable practices.

If technologically innovative policies are promoted in Maroussi in a consistent and long-term manner and emerging technologies such as artificial intelligence, robotics and big data are fully leveraged, the city could emerge as a "development hub" and function as a "sustainable enclave", creating added value at the economic, technological and social levels.

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INTEGRATED URBAN AND ENVIRONMENTAL STRATEGIES FOR CLIMATE RESILIENCE IN THE ATHENS METROPOLITAN AREA

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Abstract
The Athens Metropolitan Area constitutes the largest urban region in Greece and ranks among the most extensive metropolitan regions in Europe. Despite its significance, the region is currently burdened by severe urban and environmental challenges, including chronic traffic congestion, inadequate transportation infrastructure, elevated levels of air and noise pollution, and heightened vulnerability to climate-related hazards such as heatwaves, wildfires and flooding. Moreover, pressures from overtourism and an increasingly unaffordable housing market further exacerbate the degradation of urban living conditions. Although ongoing initiatives—such as the expansion of public transit networks, implementation of smart city technologies, development of green and cooling infrastructure, and climate resilience planning—are in place, these efforts remain insufficient in addressing the growing complexity of urban stressors.

This study proposes an integrated urban and environmental design strategy for the Athens Metropolitan Area, aimed at enhancing mobility systems, mitigating climate impacts, and improving bioclimatic conditions, with a strong emphasis on ecological sustainability and human well-being. The proposed interventions concentrate on strategic zones, particularly the Eleonas district and the Egaleo mountain range, while promoting new intermodal connections and upgrades to existing arterial routes, including their transformation into higher-capacity motorways or highways. The design framework seeks to achieve multiple outcomes: improved air quality, urban heat island mitigation through temperature reduction, decreased greenhouse gas emissions, enhanced stormwater drainage capacity, minimized flood risk, and overall urban sustainability enhancement.

Key words: urban planning, environmental design, Athens Metropolitan Area, climate resilience

1. INTRODUCTION

The Athens Metropolitan Area is the biggest and most crowded urban region in Greece and one of the most extensive metropolitan areas in Europe. As the main political, economic, and cultural center of Greece, Athens is indispensable to both regional and national development. On the other hand, the city's urban systems, which are less and less able to withstand the increasing structural, environmental, and socioeconomic pressures, are still heavily burdened by this centrality.

Traffic congestion, which is a direct consequence of the steadily growing use of private cars, is the first most serious problem of the Athens metropolitan area. Public transport systems are less attractive, less reliable, and less efficient due to the existence of several gaps and inefficiencies in the transport infrastructure. Consequently, Athens records very high

levels of noise and air pollution almost throughout the year, thus causing a decline in environmental quality, public health, and general urban livability.

Meanwhile, prolonged droughts are making the occurrence of wildfires in the nearby forest areas more likely, and higher temperatures and frequent heatwaves are intensifying the urban heat island effect in Athens. Furthermore, heavy rainfalls combined with insufficient stormwater management facilities, especially in the most densely populated areas, cause flooding. The climate situation affects the most vulnerable groups of people, and the resources of the local government are also in danger.

Social issues have become more severe because of overtourism and the rapid changes in the housing market. On the other hand, the rising number of visitors puts more pressure on public areas, infrastructure, and local services. All these factors deepen social inequality, cause displacement, and decrease the overall standard of living in cities.

A wide range of planning measures and policy initiatives have been put in place to counter these problems. Among them are the creation of green spaces and cool, down infrastructure, modernizing and expanding public transport systems, implementing smart city technologies for better urban management, and developing comprehensive climate adaptation and resilience plans. Nevertheless, these measures are not enough to tackle the scale and complexity of the changing urban stressors in Athens, although they are well, intentioned and yield some incremental benefits. Hence, a more integrated, long, term, and socially inclusive approach is necessary to ensure the sustainable and resilient future of the metropolis.

2. INTEGRATED URBAN AND ENVIRONMENTAL DESIGN STRATEGY FOR THE ATHENS METROPOLITAN AREAS

The redesign of the Athens Metropolitan Area throughout this study incorporates a multi, scalar and integrated framework of the city. This is mainly aimed at the production and maintenance of an urban environment that is ecologically sustainable, socially resilient, and inclusive. Based on the principle that urban systems form a network of interconnections, the strategy attempts to cohere the city`s spatial planning, infrastructures development and environmental management to solve the intricate problems that the city has.

The proposed approach presents an integrated urban and environmental design strategy for the Athens Metropolitan Area, focusing on:

- Enhancing mobility systems and intermodal connections
- Mitigating climate impacts and improving bioclimatic conditions
- Prioritizing ecological sustainability and human well-being

Interventions are localized around mainly strategic zones that have a high potential of being radically changed, among which the Eleonas district and the Egaleo mountain range stand out the most. These places are considered the most important nodes of a wider urban network, being able to hold new ways of movement, natural recovery and urban regeneration. The proposal facilitates the innovation of new intermodal connections that are in line with public transport, active mobility and regional networks, while at the same time the major arterial routes are being enhanced. These routes, by means of redesign and reprogramming, are changed into high capacity, multi, functional corridors which, apart from the fact that they meet mobility requirements, also have green infrastructure and climate, adaptive design features integrated into them.

The study, through the application of this integrated framework, aspires to bring about quantifiable and lasting advantages for the Athens Metropolitan Area. Some of the goal

outcomes consist of cleaner air, decreased urban heat stress, diminished greenhouse gas emissions, increased stormwater management capacity, and a substantial lowering of flood risk. In aggregate, the positive changes make Athens a metropolitan region that is cleaner, more resilient, and environmentally friendly, which is in line with the city's move to a more balanced and future, oriented urban model.

Enhancing Mobility systems and intermodal connections

One of the significant changes envisaged by the strategy to achieve these goals is the introduction of four new major transport connections that span the Athens metropolitan area. With the help of these measures, the business district, city centers, and local communities in the region are to be better connected to each other and to the surrounding areas. Furthermore, the new transit services will increase the capacity of the present networks and foster the harmonious interlinking of the urban, suburban, and regional mobility systems.

Western Corridor

This scheme envisions a new corridor, connecting Athinon Avenue with Egaleo Ring Road. After extending the east-west connection to the western industrial sector, the corridor becomes a very efficient way of rerouting the traffic between the western suburbs and Thriasio Plane reducing travel times and pressure on overloaded roads.

Central Axis

The Central Axis creates a change of course that directly connects the east side of Athinon Avenue with Chamosternas Avenue. This link consolidates the flow of the network inside the city, making traffic circulations less heavy and solving the problem of traffic queues at the most congested intersections. Apart from the car flows, the axis is designed as a multimodal transport route, which can be combined with public transport and non, motorized forms of transport.

Southern Corridor

This corridor establishes a fresh strategically west-south connection that links Kifissos Avenue to Vouliagmenis Avenue. The main purpose of the intervention is to ease the heavy traffic that has been going on for a long time along the routes that run parallel to each other, to make it easier for people to move across the city through the urban core and to improve the connection between the western and southern districts.

Southeastern Extension

The Southeastern Extension envisions a new corridor connecting Vouliagmenis Avenue with Varis-Koropiou and Lavriou Avenues. The link facilitates the flow of traffic to the Athens Riviera, the eastern metropolitan zone, and the airport area, thus, it is a great tool for economic growth, tourism expansion, and area integration.

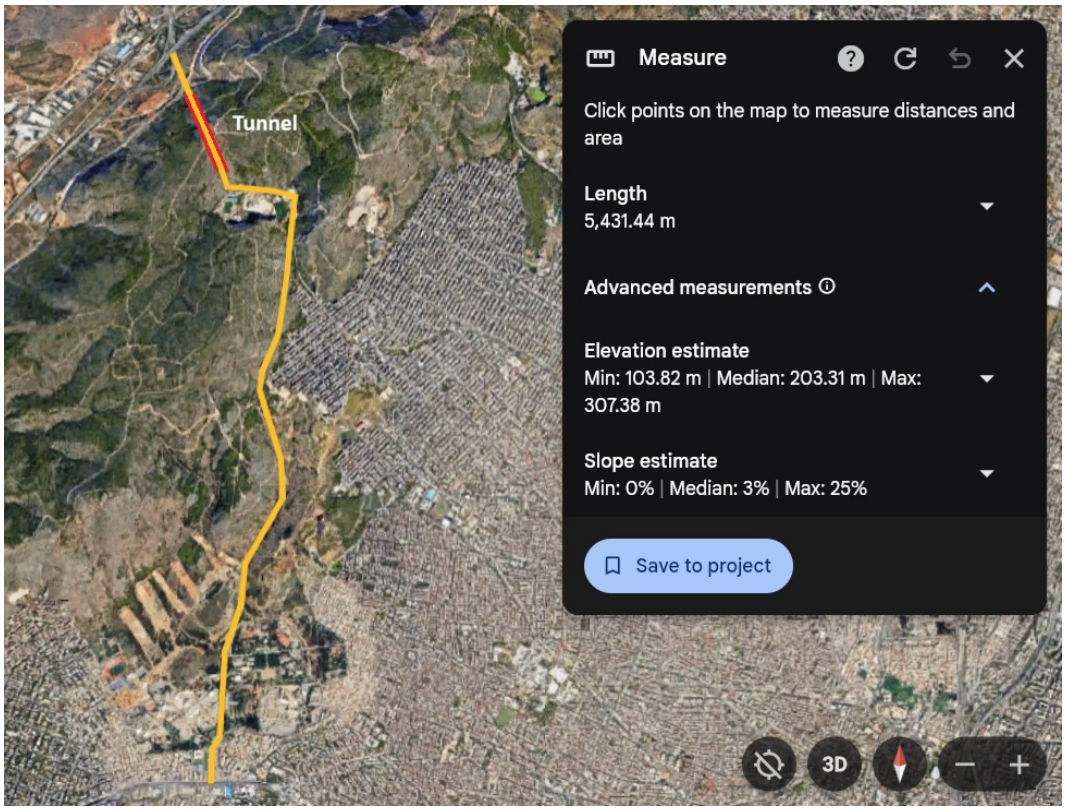
Western Corridor – Athinon Avenue to Egaleo Ring Road

Project Characteristics

The length of the proposed infrastructure intervention is about 5.5 kilometers, and it has been planned with two lanes of traffic in each direction. One of the most important elements of the project is a tunnel section of 700 meters that goes from the area of Poikilo Polychoros to Egaleo Ring Road (Image 1). The line leads directly to the Egaleo Ring Road at

the Nato Avenue junction, thus a node of strategic importance is being created within the western industrial road network. The estimated cost of construction is between €70 and €100 million, which corresponds to the size of the project as well as the presence of tunneling and the related infrastructure works.

Image 1: Western Corridor (https://earth.google.com/web)



Advantages and Expected Benefits

The project is set to contribute significantly to mobility and urban performance across the whole western Athens metropolitan area. As a result of the diversion of through, traffic from local streets, surface road networks in Petroupoli, Peristeri, and Egaleo would be less congested, thus traffic flow and road safety would be improved in these densely populated districts. Moreover, the new link offers the shortest and most efficient way from the western suburbs to the Egaleo Ring Road as well as the Thriasio industrial area, thus both commuter accessibility and freight logistics get easier. Consequently, the time spent on the road between the residential neighborhoods and major employment and industrial areas will be shortened greatly, thus economic efficiency will be increased, vehicle emissions will be lowered, and urban livability will be improved in general.

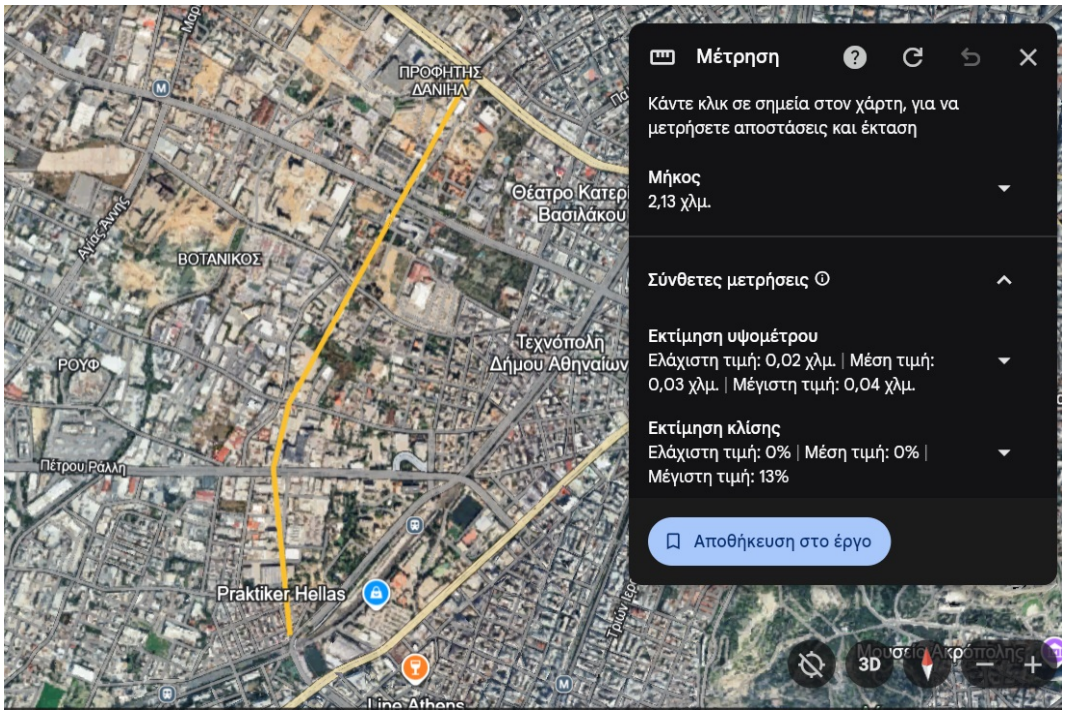
Central Axis – Athinon Avenue to Chamosternas Avenue / Peiraios Junction

Project Characteristics

The planned infrastructure project will span around 2.2 kilometers in total length, with the idea of having two traffic lanes in each direction (Image 2). The sizable and technically intricate nature of the intervention is mirrored in the approximate cost of construction between

€80 and €120 million. This estimate includes charges for extensive structural works, possible grade separations, and the blending of the project with the existing arterial road networks.

Image 2: Central Axis – (https://earth.google.com/web)



Advantages and Expected Benefits

This project broadly improves the connectivity of the Athens Metropolitan Area to the southwest and west with an emphasis on freight movement that is to be enhanced between Athinon Avenue and the southeastern suburbs through direct integration with the planned Southern Corridor. Besides that, the intervention is heavily anticipated to remove traffic bottlenecks along Kifissos Avenue, especially at the very congested stretch between the Athinon Avenue junction and the Neo Faliro / Poseidonos junction. By redistributing traffic flows and removing the traffic load from this crucial corridor, the project leads to a smoother circulation and higher network resilience. Moreover, the enhanced connection facilitates the accessibility of western Athens to the southern suburbs, thus the travel times are getting shorter, and the reliability of daily commuters is improving.

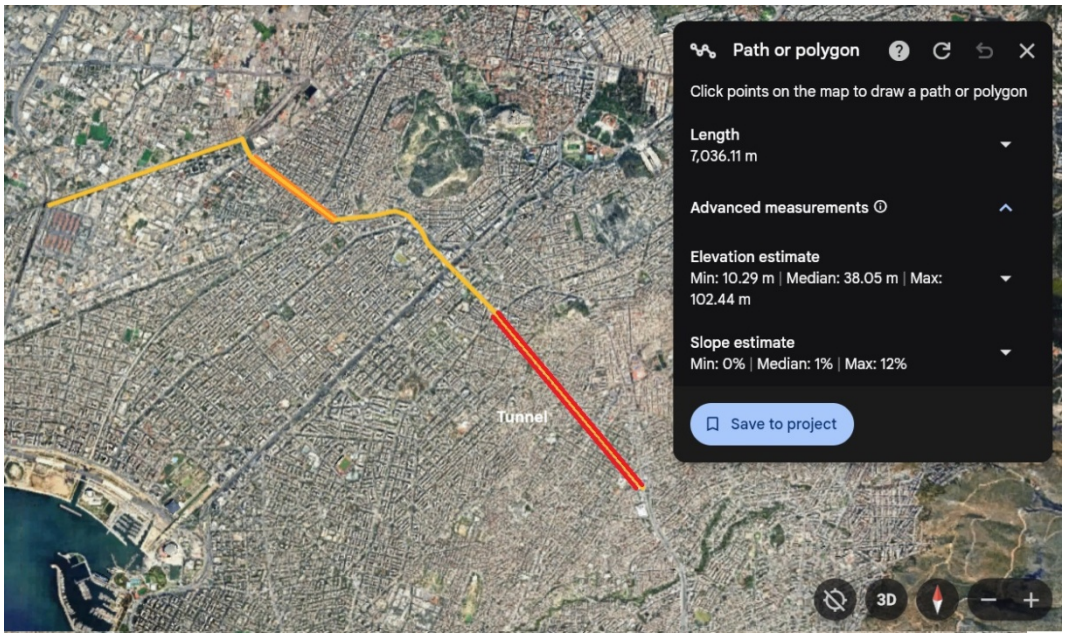
Southern Corridor – Kifissos Avenue to Vouliagmenis Avenue

Project Characteristics

The total length of the proposed corridor is about 7 kilometers, and the plan includes two traffic lanes in each direction. The main feature of the project is a tunnel of 1,900 meters in length, going from Chamosternas Avenue to Vouliagmenis Avenue under the densely built area of Ano Nea Smyrni (Image 3). In this underground part, the corridor goes beyond the limitations at the surface and at the same time, it minimizes the impacts on the existing neighborhoods and the urban fabric. The estimated construction cost is between

€250 and €350 million, which corresponds to the extent of the intervention, the tunneling works, and the necessary integration with major arterial routes.

Image 3: Southern Corridor (https://earth.google.com/web)



Advantages and Expected Benefits

The project creates a west-south urban corridor that extends the connectivity to the core of the city and beyond the metropolitan area. It links the western districts with the center of Athens, the southern neighborhoods, and the coastal zone. By giving a direct and uninterrupted route, the corridor elevates the cross, city access and is compatible with the most efficient transport solutions of different urban sectors.

The main advantage of the measure is the elimination of the excessive through, traffic that Syngrou Avenue and Vouliagmenis Avenue are currently suffering from. By distributing a large proportion of long, distance and cross, city traffic away from these two very congested areas, the project leads to better traffic flow, shorter travel times, and lower noise and air pollution levels on the existing routes.

Besides the private vehicles, the corridor aims at public transit integration thus allowing the introduction of a high, capacity transit service like Bus Rapid Transit (BRT) or a dedicated electric bus route.

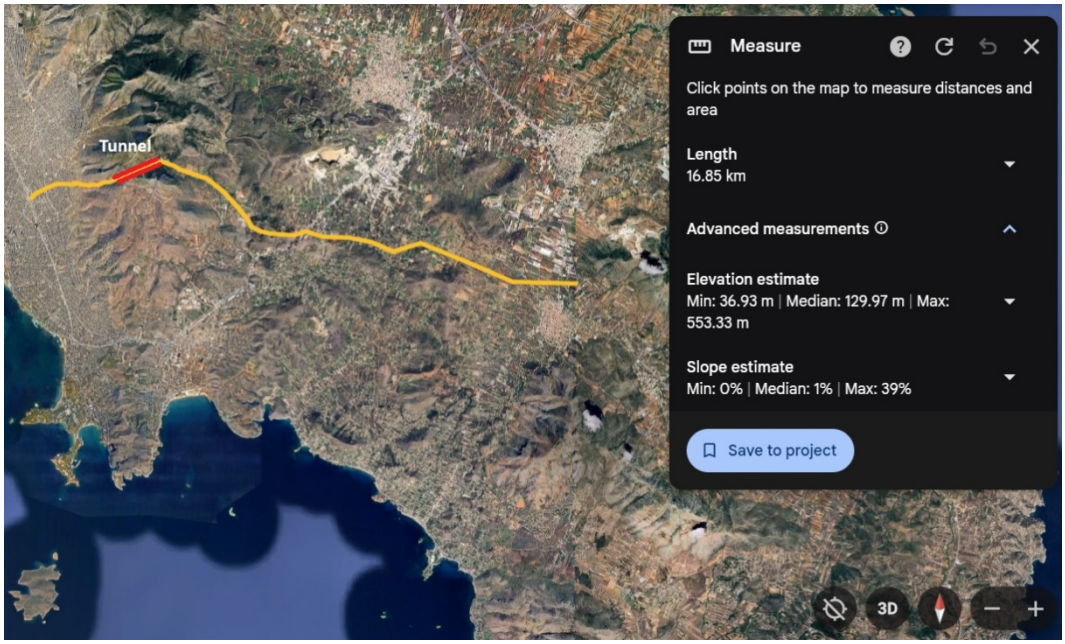
Southeastern Extension – Vouliagmenis Avenue to Varis–Koropiou Avenue / Lavriou Avenue

Project Characteristics

The planned southeastern passageway extends for about 17 kilometers and has been laid out with two traffic lanes in each direction. One of the most significant technical features of the project is a tunnel of 1,300 meters traveling from Ano Glyfada to Lamptres Kropias, which enables the route to go under the difficult terrain with a minimum surface disturbance

and less impact on nature (Image 4). The total building cost is believed to be between €150 and €200 million, which is a direct consequence of the corridor's length, the amount of tunneling, and the necessary junctions with the existing main roads.

Image 4: Southeastern Extension (https://earth.google.com/web)



Advantages and Expected Benefits

The corridor mainly facilitates the southeast metropolitan movement of people by establishing a direct and fast connection between the seashore and the inner parts of the Athens Metropolitan Area. By making it easier to get around this fast, growing part of the region, the initiative is instrumental in achieving a more balanced territorial development pattern and it also increases the daily mobility of residents, workers, and visitors. Moreover, the new road is an efficient way of getting away towards Attiki Odos, decreasing the traffic load that is caused by the southmost part of Varis-Koropiou Avenue, which is the source of heavy traffic. Through the redistribution of traffic flows and the extension of network redundancy, the operation is a step towards sub, system integration, and hence, it increases the systems overall resilience and reliability. In addition, the corridor is instrumental in the operation of a clear and efficient connection between Athens International Airport and the rest of the area, thus, helping to improve the logistics effectiveness of the entire southeastern metropolitan zone.

Enhancing Mobility systems and intermodal connections - Overall Assessment
Main Benefit
The main advantage of the suggested plan is the major upgrade of urban connectivity throughout the Athens Metropolitan Area. With the creation of new high, capacity corridors and better network integration, the plan alleviates traffic on the current arterial roads and makes the travel time between the main residential, industrial, commercial, and coastal areas shorter.

Environmental Value
Environmentally, the approach has a very positive impact. It can make a big difference in the air quality situation by moving traffic that is causing heavy emissions out of heavily polluted urban areas and thus reduce the total amount of greenhouse gases released into the atmosphere. When the strategy is implemented together with the use of the green and blue infrastructure, the effect will be very positive for the environment which will be beneficial for public health and will increase climate resilience at the metropolitan scale.

Total Estimated Cost
The overall estimated investment needed to put into action all the proposed measures is a minimum of between €550 and €770 million depending on the final design choices, construction methods, environmental mitigation measures, and results of detailed feasibility studies.

Mitigating Climate Impacts and Improving Bioclimatic Conditions

By using the integrated framework as a base for sustainable urban transformation, this part of the plan concentrates on extending climate resilience and raising bioclimatic performance all over the Athens Metropolitan Area. Since the city is exposed to the risk of increased temperatures, urban heat islands, and climate, related hazards, the approach mainly focuses on the regeneration of the landscape, restoration of the hydrological balance, and provision of thermal comfort. To accomplish these goals, the city is implementing three interlinked interventions that are each aimed at strengthening ecological functions, enhancing urban livability, and providing the creation of multifunctional green infrastructure.

Reforestation of Mt. Egaleo
This intervention aims to cover Mt. Egaleo extensively with forest and vegetation, especially its east and southeastern slopes that face the western suburbs of Athens. The initiative purports to alter the microclimates of the area, lessen the urban heat island effect, and purify the air by elevating tree density and introducing various plant species. As a matter of fact, the reforestation exercise is also a weapon against the foehn effect, the hot-dry winds that blow down the slopes and thereby increase summer temperatures in the western metropolitan areas. Besides temperature regulation, the project also enriches the local fauna, offers leisure facilities, and deepens the visual and ecological bond between the city and the adjacent nature.

Transformation of the Eleonas Area into a Metropolitan Park (with Artificial Lake)
The Eleonas area, which has been a heavily industrial and neglected region in the past, will become a large metropolitan park combining vast green areas with a central artificial lake. It is planned that the lake will feature treated water coming from Kifissos and Psitalia water recycling plants, thus promoting sustainable water management. The aim of this change is to supply an urban oasis of various functions that will help to cool down the city, provide recreational facilities, and be a significant ecological reserve among the highly built, up city center. By integrating green infrastructure with water, sensitive design, the initiative is also useful for dealing with stormwater, lessening the risk of floods, and improving the air quality in the local area, thus turning Eleonas into a pioneer of climate, resilient urban regeneration.

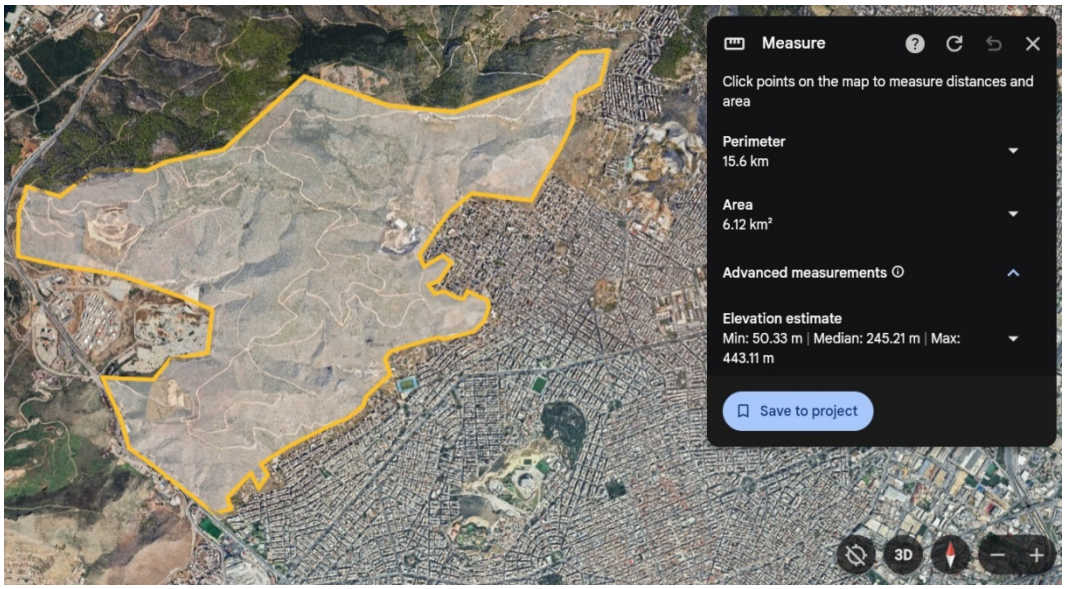
Construction of Small Dams in Mt. Egaleo and Mt. Imittos

This intervention envisages a series of small, scale retention dams that will be strategically placed along the seasonal gorges, streambeds, and natural depressions of Mt. Egaleo and Mt. Imittos. The dams are intended to hold rainwater and runoff during seasonal precipitation, thus facilitating the greening of the adjoining areas and lessening the flood risk downstream. By regulating the water flows, these dams also raise soil moisture levels, improve local vegetation, and create microhabitats that increase urban biodiversity. Furthermore, the stored water may be used for irrigation of nearby urban parks and landscaped areas, thus linking water management with public space enhancement and making a significant contribution to the metropolitan ecosystem's resilience.

Reforestation of Mt. Egaleo

The first objective of this treatment is to develop a vast forest and green vegetation cover all over Mt. Egaleo, especially the eastern and southeastern slopes that have a view of the western suburbs of Athens (image 5). Through the expansion of green cover, the initiative intends to adjust local microclimates, decrease heat stress in summer, and restrict the foehn effect that raises temperatures in the western metropolitan districts to a great extent at the time of the hottest period of summer. In addition to temperature control, the planting of trees in deforested areas enhances the diversity of species, purifies the air, and creates a healthy ecological bond between the city and the natural landscapes around it.

Image 5: Reforestation of Mt. Egaleo (https://earth.google.com/web)



Temperature Regulation

One of the main factors to cool the earth in the areas where the temperature is high is the application of planting trees. It is very effective in lowering both the temperature of the surface and the air of the surrounding area. By giving shade, raising evapotranspiration, and lessening heat absorption in urban areas, reforestation helps the heat that comes from the city to be less in areas around the residential and industrial ones. In this way, people benefit from better living conditions, the need for energy to be used for cooling decreases, and the health of the people is stabilized especially during long summer heatwaves.

Wind Flow Moderation
Recently planted tree-covered areas serve as natural windbreaks that regulate and calm local wind patterns. These vegetated areas, by diminishing the strength and velocity of hot, dry air masses (such as the foehn effect), are the main factors that prevent the flow of excessive heat from the surrounding rural areas to central urban districts. This cooling effect also leads to more stable microclimatic conditions, which are favorable for the local population and urban vegetation.

Air Quality Improvement
Plants in the forest replaced areas, naturally, are the ones who breathe new life into the air of these reforested areas. Besides absorbing carbon dioxide, which they store in their trunks and roots, they also help mitigate climate change by reducing the occurrence of global warming gases. These plants also absorb very tiny particle matters ($PM_{2.5}$ and PM_{10}) that are suspended in the air in addition to nitrogen oxides (NOx) and thus make the air clean and fresh.

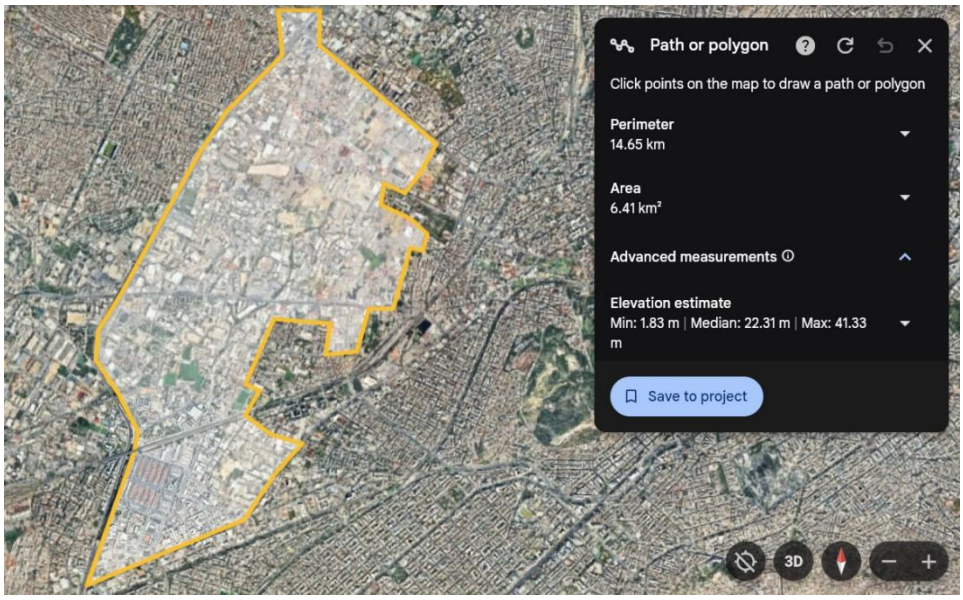
Erosion and Runoff Control
Roots of freshly planted trees hold the soil tight on inclines and lessen the chance of soil washing away, especially in areas that are either hilly or have been heavily degraded. Through the improvement of rainwater infiltration and the decrease of surface runoff, reforestation is able to not only lower the risks of floods but also it makes the local hydrological cycles healthier, and it even recharges the groundwater.

Estimated Cost
Initial calculations put the expense of a massive reforestation project covering about 1,500 hectares planting, site preparation, and the first five years of maintenance at around €40 and €60 million.

Transformation of the Eleonas Area into a Metropolitan Park (with Artificial Lake)

The main aim of the first intervention is to change a big part of the Eleonas district, which has been a shipping area of heavy industrial uses, uncooperative landowners, and neglected or abandoned plots, into a large, scale metropolitan park (Image 6). The redevelopment of the area around the lake is the core idea of the district transformation that is there to serve as the environmental and social anchor of the area both. The lake will be enriched with clean water from Kifissos River and Psitalia wastewater treatment and recycling plants, thus ensuring a sustainable and closed water cycle. This project intends to bring nature back to one of the most polluted urban areas of Athens, which will attract new residents and businesses.

Image 6: Transformation of the Eleonas Area into a Metropolitan Park (https://earth.google.com/web)



Urban Cooling
The creation of large, scale green spaces alongside open water bodies can, in fact, lead to a substantial decrease of local air temperatures in the areas that surround such quarters, where the respective cooling effects may reach up to around 2-3°C. The decrease is essentially the outcome of shading, evapotranspiration from plant cover, as well as the thermal buffering ability of water surfaces. Hence, the measure lessens the urban heat island effect, elevates the level of thermal comfort in periods of extreme heat, and lessens the energy consumption for cooling in the closest residential and commercial buildings.

Microclimate Regulation
By the addition of evaporation, cooling, and stabilizing humidity levels from the dense urban core, the artificial lake is the main source of local microclimate regulation. As a result, the heat situation is relieved, the outdoor comfort is improved, and it becomes easier to carry on with the usual activities, especially in the hottest summer days. Together the water and greenery are making the urban climate less extreme and more resistant to future changes.

Ecosystem Restoration
The project transforms a degraded brownfield landscape, into a multifunctional ecological system that accommodates native plant species, aquatic habitats, and urban wildlife. Through the recovery of natural processes and the planting of uninterrupted green spaces, the place turns into a biodiversity hub, at the same time, it also becomes a great public recreation space. Such a nature comeback not only makes the area more resistant to different kinds of environmental hazards but also re-establishes the connection between city dwellers and nature.

Air Quality and Carbon Benefits
An enlarged tree canopy along with open water surfaces lead to better air quality as they capture airborne pollutants like particulate matter and nitrogen oxides. In the same period, vegetation absorbs and stores carbon dioxide supporting climate change mitigation.

Social and Urban Value

Besides the ecological benefits, the big park in the city area brings a lot of social and urban value. Improved access to high-quality green space promotes physical activity, mental well-being, and social interaction, enhancing public health outcomes. At the same time, the transformation of Eleonas increases land value of the surrounding area resulting in sustainable urban regeneration, capital inflow, and long-term economic revitalization.

Estimated Cost

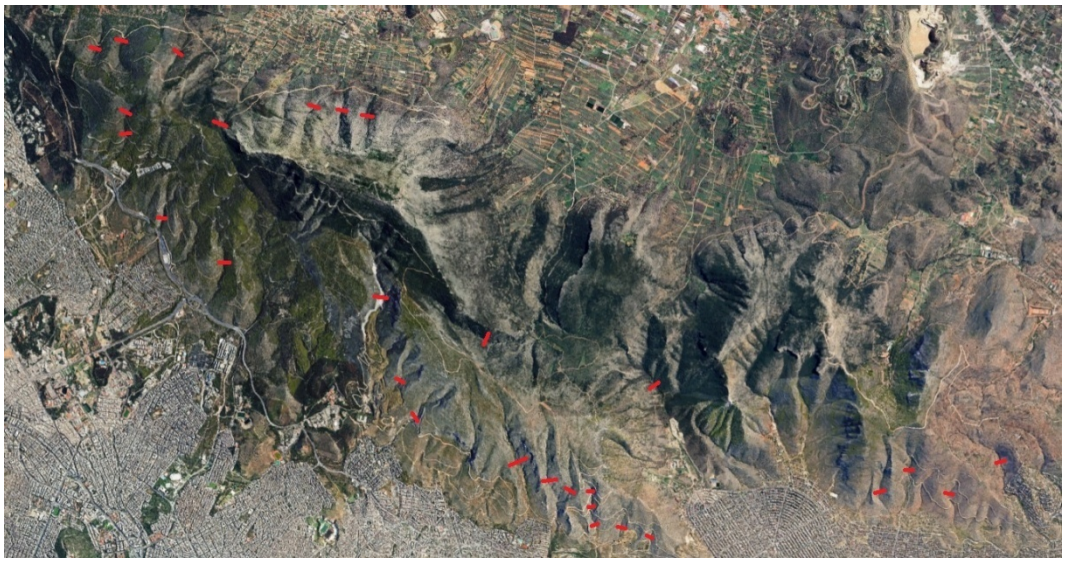
The combined estimated expenditure for the change of Eleonas into a metropolitan park, covering land rehabilitation, soil remediation where necessary, park and landscape construction, as well as the installation of water recycling and management infrastructure, is between €80 and €120 million.

Construction of Small Dams in Mt. Egaleo and Mt. Imittos

The main goal of this operation is the creation of a concerted system of small, scale retention dams that are placed in a very targeted way in the many seasonal gorges, ravines, and dry streambeds of Mt. Egaleo (Image 7) and Mt. Imittos (Image 8). These are intended to capture and even hold stormwater during short but heavy rain episodes, thus facilitating water retention, helping the growth of surrounding green areas, and lessening the risk of flooding of the downstream areas which are already built, up. The plan is centered on nature, based and minimally invasive engineering solutions which are compatible with the current topography and ecosystems.

Image 7: Construction of Small Dams in Mt. Egaleo (https://earth.google.com/web)

Image 8: Construction of Small Dams in Mt. Imittos (https://earth.google.com/web)



Flood Risk Reduction
Small, scale retention dams built can make stormwater captured and temporarily stored during a peak of rainfall. These facilities, by slowing down runoff and reducing its volume, significantly lower runoff velocity and thus the risk of flash flooding in urban areas downstream. The controlled water management thus ensures the safety of residential neighborhoods, transport infrastructure, and public assets located at the foothills and low-lying zones of the metropolitan area.

Groundwater Recharge
Through the retention of water in natural gorges and streambeds, the dams can facilitate the infiltration of water into the soils around as well as into the geological formations beneath. This, in turn, helps to refill local aquifers, thus making groundwater more accessible and increasing the resilience of the water supply system over the coming years.

Vegetation Growth
The retention of water in these areas creates ideal moisture conditions along water courses where the growth of riparian vegetation can be expected, and the regeneration of the degraded landscapes can take place. The greening resulting from this, serves to broaden the variety of microhabitats available to the native flora and fauna, raises the biodiversity level and reinforces the ecological corridors that link mountainous areas with urban green spaces.

Local Climate Moderation
As a result of the better water availability, more vegetation cover has a positive influence on the local climate. One of the main functions of green corridors is shading and evapotranspiration through which they help to lower air temperatures and keep the humidity at a certain level.

Estimated Cost
The overall estimated cost of the project to build several small-scale retention dams is roughly between €25 and €40 million.

Mitigating Climate Impacts and Improving Bioclimatic Conditions - Overall Impact and Integration

Urban Heat Mitigation
The planned combined use of green and blue infrastructure strategies should result in a cooling effect of the local urban and peri-urban areas by 2-4°C on average. With a higher shading, evapotranspiration, and better surface permeability enabled by the changes, the urban heat island effect is materially reduced, the thermal stress at extreme hot events is lessened, and the general outdoor comfort of inhabitants is improved.

Flood Management
By implementing water-sensitive urban design elements, there small-scale retention systems, restored natural watercourses, and enhanced infiltration zones, lowers the risk of stormwater overflow that results from heavy rainfall. The implemented measures slow and temporarily retain peak flows, thus, releasing the existing drainage infrastructure that is under pressure, and increasing flood resilience in susceptible neighborhoods.

Air Quality Improvement
The growth of tree canopies, reforested lands, and tree, lined corridors are all factors that improve air quality, as a result of increased carbon dioxide absorption and the removal of pollutants from the air that include dust and fine particulate matter. This nature-based solutions are aligned with public health goals and thus, they make a significant contribution to climate change mitigation by decreasing the exposure to toxic emissions.

Ecosystem and Biodiversity Recovery
The establishment of novel urban green and blue habitats, such as reforested hillsides and riparian corridors, as well as metropolitan parks and water bodies, not only supports the recovery of ecosystems but also the return of native flora and fauna.
Through the reinforcement of ecological connectivity throughout the metropolitan area, the strategy broadens the range of species, increases the resilience of habitats, and brings back the natural processes of the city.

Social Benefits
The strategy brings considerable social advantages by enhancing urban livability and the quality of life. Easier access to attractive green and blue spaces motivates physical activity, improves mental health and well, being, and strengthens social interaction and community cohesion. These advantages, which are essentially concentrated in densely populated urban areas where open space is scarce, have the greatest influence.

Estimated Total Cost
The total investment needed to carry out the integrated package of interventions is calculated to be around €120 and €180 million.

Prioritizing Ecological Sustainability and Human Well-Being

This component of the strategy focuses on creating a healthier, more resilient, and energy-efficient urban environment by addressing the physical characteristics of the built fabric, reorganizing mobility and parking patterns, and ensuring equitable access to efficient and sustainable transport options. By combining urban design, city planning, and environmental performance, this innovative approach is designed to: mitigate heat stress; reduce energy consumption; minimize exposure to air and noise pollutants; and, on top of that, it can significantly enhance urban comfort, safety, and the general quality of life for residents and users of the city.

Increasing the Albedo of Human-Made Surfaces
The goal of this intervention is deliberate spreading of reflective surface features over the roofs, pavements, and outer walls of the buildings, mainly in the compact urban areas where the problem of heat build-up is the strongest. The strategy, which involves the use of cool materials, reflective coatings, and light-colored finishes, reduces the solar heat absorbed and thus lowers the surface temperatures. These steps lead to lower temperatures in the open air, less need for cooling of the interior spaces, and consequently lower energy consumption, at the same time the urban heat island effect is being alleviated, and the thermal comfort level at the neighborhood scale is improving.

Parking Reformation: Diagonal Parking and One-Way Street Systems
The changes in parking and traffic patterns include the introduction of diagonal parking layouts and one-way street systems to make the space utilization more efficient and the circulation better. With this method, the widths of the roads needed for the movement of vehicles are decreased, thus the space that is reclaimed can be used for wider sidewalks, bicycle lanes, street trees, and green infrastructure. Besides making pedestrian safety and accessibility better, the reconfiguration also raises the possibilities of urban greening, helps traffic calming, and results in a more balanced and human, scaled street environment.

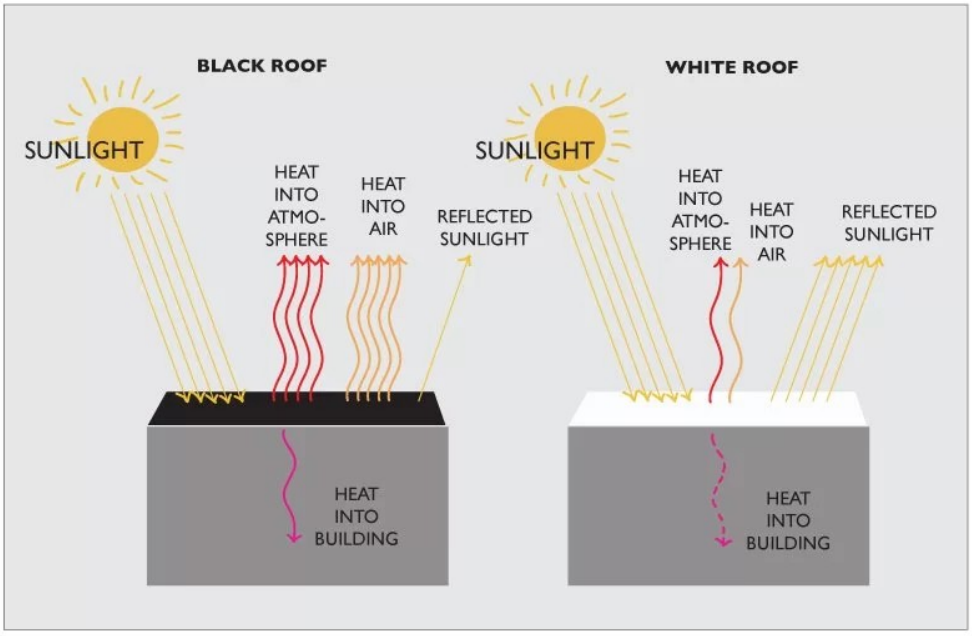
New Transportation Lines in Industrial and Commercial Zones
This intervention focuses on the establishment of new or extended public transport lines—such as bus rapid transit (BRT), light rail, or metro extensions—serving industrial, logistics, and commercial zones with high concentrations of employment and freight activity. Consequently, the strategy through such means as a clean, high, capacity, and reliable transport option eliminates the need for private vehicles, thus decongesting the area and enabling the emergence of more eco-friendly commuting patterns. In addition, increased public transport connectivity acts as a fuel for economic growth by making a city more accessible to the labor force and more compatible with the gradual transition to a metropolitan mobility system that is both more efficient and environmentally friendly in the long run.

Increasing the Albedo of Human-Made Surfaces

The main goal of this action intervention is to systematically increase the surface reflectivity (albedo) of human-made surfaces—including building roofs, streets, sidewalks, public squares, and facades—to reduce solar heat absorption and lower both outdoor and indoor temperatures (Image 9). The strategy is mainly aimed at dense urban districts where dark, impermeable

materials are the most used and, therefore, heat from the urban environment accumulates and raises the temperature in these areas. By changing the properties of the surface instead of the urban form, this intervention is a cheaper and faster way to be able to adapt to the climate.

Image 9: Albedo mechanism (rscentre.com.au/thermal-efficiency)



Temperature Reduction
Changing the surface albedo of urban materials from standard values of about 0.15 (which is typical for asphalt, dark concrete, and traditional roofing) to around 0.45 using reflective coatings and light, colored materials can have a very big effect on the reduction of heat that is absorbed. This alteration can bring down the outdoor air temperature at the neighborhood level by about 1-1.5°C. The temperature inside the buildings, for instance, in the top, floor apartments and the houses or buildings with a small amount of insulation, can be reduced by 2-4°C. Such decreases make a very small use of air-conditioners thus a cooling energy demand of about 15-25% is saved at the hottest hours of summer.

Urban Heat Island Mitigation
Highly reflective surfaces on roads and rooftops absorb less heat during the day and consequently, they also release less of this heat during the night, which is the main cause of the urban heat island effect. Besides they have a positive effect on cooling nighttime temperatures which leads to improvement of thermal comfort in compact residential areas, better conditions for sleep, and reduction of accumulation of heat fatigue during long, lasting heatwaves.

Air Quality Improvement
Lower surface and ambient temperatures have the effect of slowing the photochemical reactions that lead to the formation of ground, level ozone as well as the production of heat,

related air pollutants, thus their concentration decrease. As a result, improved albedo conditions contribute indirectly to better air quality, reduced respiratory irritation, and lower public health risks, particularly for vulnerable populations.

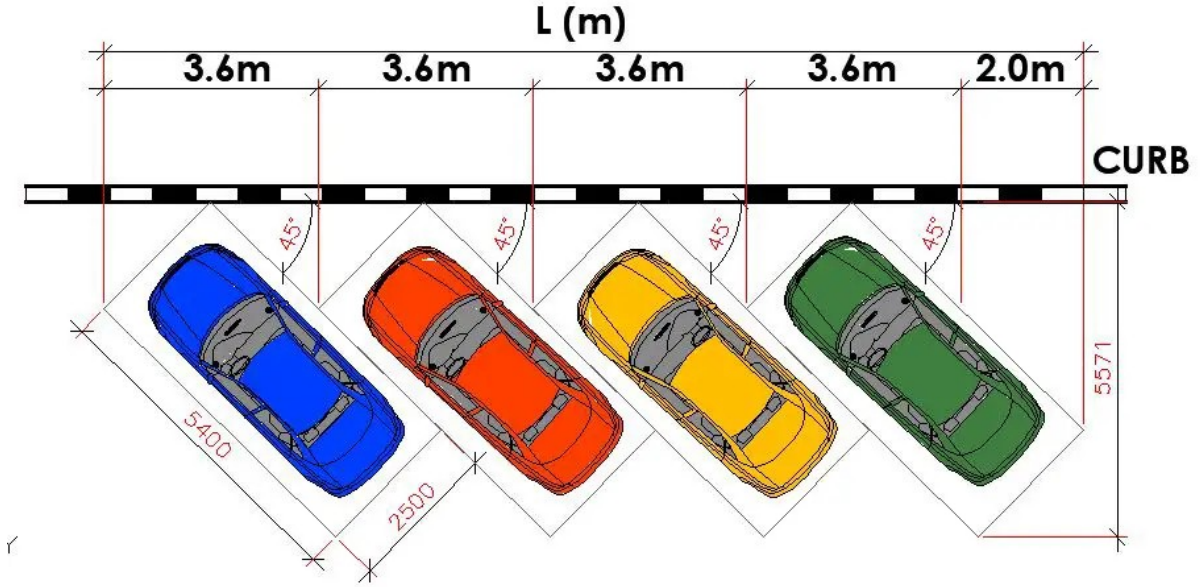
Economic and Health Benefits
Lowering the need for cooling leads to less electricity consumption and therefore energy costs go down for households, businesses, and public buildings. At the same time, cooler indoor and outdoor environments reduce the incidence of heat-related illnesses, hospital admissions, and heat-induced mortality, especially during extreme weather events. The total of these benefits has a positive effect on the economy over time and contribute to making public health more resilient.

Estimated Cost
It is estimated that the combined investments necessary for different high, albedo surface interventions implemented throughout a city amount to somewhere between €40 and €60 million the exact figure depends on factors such as the degree of coverage, the choice of materials, the requirements for surface preparation, and the planning of maintenance.

Parking Reformation: Diagonal Parking and One-Way Street Systems

This intervention aims to reorganize parking and circulation of the traffic in the selected urban areas to increase the spatial efficiency, enhance the safety of pedestrians and create the opportunity of urban greening (Image10). The strategy, through optimizing the way street space is allocated and used, aims at balancing the needs of vehicles, pedestrians, cyclists, and public space, to a level that is compatible with the benefits of improved environmental performance and urban quality of life.

Image 10: Parking Reformation: Diagonal Parking (structville.com/geometric-design-of-parking-facilities)



Spatial Efficiency
Diagonal parking makes it possible for vehicles to be placed in a clearer and more organized way, thus the limited street width can be used more efficiently, especially in dense neighborhoods with narrow or irregular road layouts. This method of parking by clearly marking parking bays helps to eliminate illegal stopping and double, parking that are frequently the main reasons of congestion and blocked sightlines. The increase in parking organization results in less traffic congestion and more predictable street behavior for all users.

Traffic Flow Optimization
The changes of certain streets to one-way systems help to streamline the flow of traffic and lower the number of points where vehicles can come into conflict at crossroad junctions. Fewer opposing traffic streams result in less stop-and-go driving, shorter idling times, and improved travel time reliability.

Space Reallocation
By making parking layouts and traffic circulation more efficient, it is possible to return valuable sidewalk and roadside space to the community. The space that has been released can be given back to nature or the city in the form of green strips, bioswales, permeable surfaces, or street trees. These measures not only help with the control of stormwater but also improve the local microclimate due to shading and evapotranspiration and make the urban streetscape more attractive and of a size suitable for humans.

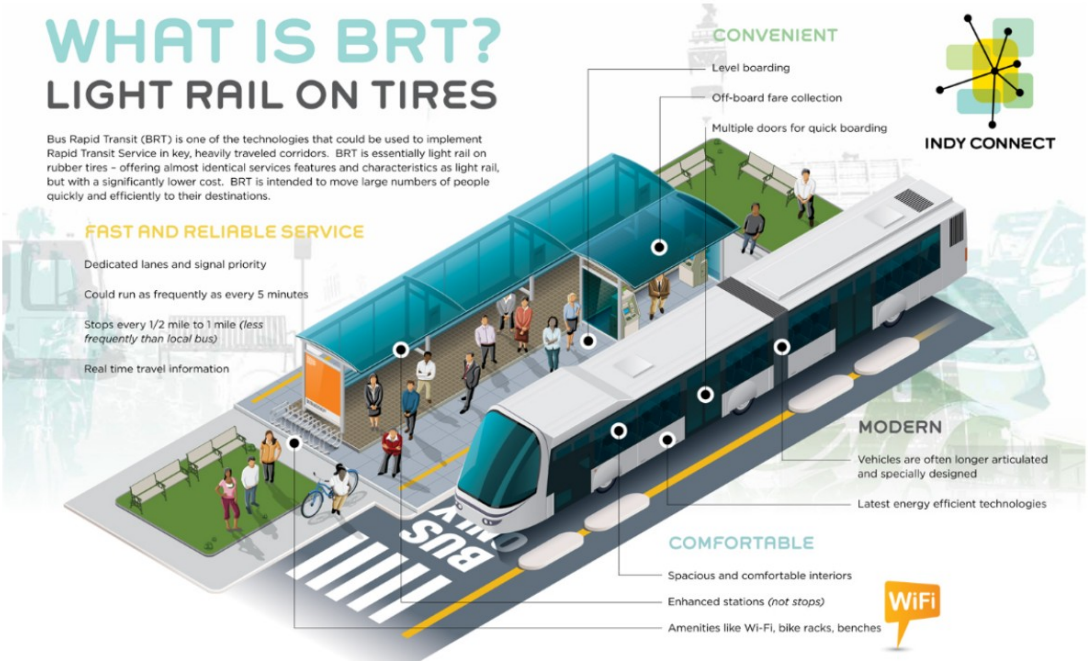
Human Well-Being
Where vehicle conflicts are less, lower traffic speeds and noise levels make for a safer pedestrian environment which in turn is likely to be walked, cycled, and used for street, level interaction. Enhanced walkability is good for physical health, mental well, being, and social interaction, and it also contributes to the growth of neighborhood identity and local economic vitality.

Estimated Cost
It is estimated that the price of carrying out these actions in a city, wide manner would run somewhere between €5 and €10 million. The variation in the cost depends on how far the measures are applied and how many streets are counted.

New Transportation Lines in Industrial and Commercial Zones

This intervention aims at the creation of new or the extension of existing public transport lines e.g. bus rapid transit (BRT), light rail systems, or targeted metro extensions directly serving industrial and commercial areas with a high concentration of employment, logistics, and freight activities (Image 11). With the supply of high, capacity, reliable, and low, emission transport to these zones, the strategy intends to lower the use of private cars to a significant level, enhance the efficiency of the daily journey, and back the emergence of sustainable mobility patterns in the whole metropolitan area.

Image 11: New Transportation Lines in Industrial and Commercial Zones (https://betterbuscoalition.org/bus-rapid-transit)



Emission Reduction

New high, capacity public transport lines mainly attract many people who previously used a private car thereby a shift from the one to the other is strongly observed. Such a shift is singled out to happen particularly in the areas of the city where there is a heavy flow of commuter and freight traffic. Consequently, this mode shift causes the decrease of the areas of congested traffic and the reduction of their carbon dioxide (CO) emissions, nitrogen oxides (NOx), and particulate matter ($PM_{2.5}$ and PM_{10}) becomes visible. In addition, the substitution of diesel buses, trams, or trains with cleaner technologies, including battery electric buses, modern metros or light rail, hardly fails to reverse air pollution and makes a positive contribution to climate change mitigation goals.

Accessibility

Enhanced public transport connectivity improves access for workers employed in major industrial and commercial districts such as Eleonas, Rentis, Thriasio, Metamorfosi, and Markopoulo. Good and regular services bring down the times when traveling is a matter of chance, thus, the actual labor catchment area of these zones becomes larger, and their interconnection with the adjoining residential neighborhoods is intensified, supporting both economic productivity and workforce mobility.

Efficiencys

During peak hours, high-capacity transit services are instrumental in congestion reduction as they are able to take in a larger proportion of commuter demand and at the same time offer quicker and more predictable travel times than what can be achieved by private vehicles. The use of dedicated lanes or segregated rail corridors essentially removes the delays caused by traffic conflicts which in turn results in shorter traveling times, better service reliability, and general increases in network efficiency.

Urban Regeneration
The presence of modern public transport infrastructure acts as a catalyst for sustainable urban regeneration in industrial and commercial areas. Improved accessibility attracts investment, supports mixed-use development, and enables the implementation of green logistics solutions, such as electric bus fleets, rail-based freight transport, and low-emission last-mile delivery systems. These changes contribute to cleaner, more resilient, and future-oriented economic activity.

Social Equity
By expanding affordable and reliable transport options, the intervention enhances access to employment opportunities, services, and amenities for lower-income residents and workers who rely on public transport. Improved connectivity reduces transport-related social exclusion, supports equal access to jobs, and contributes to a more inclusive and balanced metropolitan mobility system.

Estimated Cost
The estimated capital needed to put in place new public transport lines is said to be between €50 and €150 million per line.

Prioritizing Ecological Sustainability and Human Well-Being - Overall Impact and Integration

These planned measures should result in concrete environmental, energy, and social advantages that spread over the Athens Metropolitan Area. To illustrate the level of satisfaction with the temperature, the triple strategy of high-albedo surfaces, urban greening, and better street design can lead to a decrease in indoor temperatures of up to 4°C and outdoor temperature reductions of 1-2°C in the areas that have been treated with the mentioned interventions thus, heat stress in these areas will be mitigated significantly in the warm season.

Lowering these temperatures, they are talking about a 15-25% decrease in the cooling energy that is needed and thus help lowering the emissions of gases that contribute to global warming and the costs related to these operations for households and businesses decrease. Changes in mobility to become more efficiently parking reorganization, better street layouts, and expanded public transport access in areas with a high concentration of industry and commerce should lead to less congestion, fewer emissions from vehicles that are not moving, and general better functioning of the urban transport network.

Moreover, the quality of public space has been significantly improved with safer traffic conditions, the return of the street space, and several green areas resulting in more walkable, greener, and human, centered streets. These spatial changes enhance social interaction, active mobility, and a stronger sense of local community in neighborhoods. Less exposure to extreme heat, air pollution, and noise, from a public health and well, being perspective, is resulting in better physical and mental health, especially for a sensitive group of children, the elderly, and outdoor workers. All these factors, when taken together, make the urban environment more livable and resilient.

The overall approximate capital needed to carry out these initiatives varies between €100 million and €220 million, depending on the extent of the citywide application and the chosen transport modes.

3. CONCLUSIONS

The proposed framework is a single, coherent strategy that aligns the issues of urban mobility, climate resilience, and human well, being, and Athens' immediate challenges as well as its long, term future. Instead of treating transportation, environment, and public space as separate systems, it acknowledges their profound interrelation and arranges their interaction.

At the core of the strategy is a move to smarter and cleaner transport solutions, getting rid of the congestions that have been happening for a long time, reducing emissions, and making it possible to easily move around again the whole metropolitan area. Efficient, accessible, and environmentally friendly mobility is what will make it possible to move away from car dependency toward more balanced mobility choices in the city.

Nature reintroduction in the urban fabric is, however, as important as the other points. The large, scale reforestation of Mt.Egaleo coupled with the transformation of Eleonas into a metropolitan park creates not only a cooling but also an ecological network that will moderate temperatures, purify the air, and return green space to the most heavily populated parts of the city.

This green network is supported by the development of small-scale water retention bodies whose purpose is to delay runoff, mitigate the risk of flooding, and facilitate the revival of the local ecosystems. These measures not only ramp up the city's climate resilience capacity but also re-establish the city's connection with its natural hydrological cycles.

At the neighborhood level, this means the implementation of reflective materials, redesigned parking layouts, and new public transport lines that transform the streets we use daily into cooler, safer, and people, oriented places. Streets become areas where people can move, interact and relax, not just spaces for vehicles.

When combined, these measures present a way to express a shared vision of Athens: a city that is environmentally sustainable, socially inclusive and economically viable, creative while being respectful to nature, and where urban development results in an improved quality of life for all citizens.

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WIDENING OF THE INTERMEDIATE BETWEEN THE HILL AND THE CITY: AS A CASE STUDY, THE CORRELATION BETWEEN PHILOPAPPOU HILL AND ANO PETRALONA

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Abstract
The city of Athens presents significant interest in terms of its topography: its numerous hills, prominent features of its relief, hold pivotal and multifaceted importance. They function as fragmented remnants of the historical background, as "Cultural Landscapes." They stand out as reference points for their surrounding urban areas, as landmarks, as environmentally significant natural enclaves, and simultaneously as spaces for recreation. However, the expansion of the urban fabric seems to have created a problematic relationship with the hills and the natural topography. Urban development "besieges" the hills, which now resemble islands in an "urban archipelago." Consequently, it becomes evident that the relationship between the city and the hills is driven towards polarization, generating a dichotomy. This dichotomy is paradoxical when considering that the hills are vital and integral elements of the capital city. This study seeks to explore possible ways to renegotiate the rigid boundaries between the city and the hills, focusing on the intermediary space between them. Expanding this intermediary zone potentially achieves an organic osmosis that could enhance the interdependence of the natural and the artificial, the historical and the contemporary. Specifically, the study examines the case of Philopappou Hill and its problematic relationship with the Ano Petralona neighborhood. It aims to dissolve the rigidity of this dichotomy and introduce their fertile interpenetration. The goal is to design a common ground for coexistence, which will serve as a "threshold" to Philopappou and the diverse human activities that can take place there.

Key words: City, Interweave, Intermediate, Spectrum, Hill, Philopappou, Athens

1. INTRODUCTION

The urban fabric of Athens continually expands toward its surrounding hills. For Émile Burnouf, it is *"the city of hills,"* while Giorgos Seferis would later write: *"Nations of the Sun and you cannot face the Sun, nations of humans and you cannot face humans."* Perhaps, then, Athens is the city of hills and we cannot face the hills: places we struggle to confront, since they have become isolated within rigid boundaries of the urban network. Such separation reinforces a divide between natural and artificial, historical and urban. Italo Calvino would write in the "Invisible Cities": *"From one part to the other, the city seems to continue, in perspective, multiplying its repertory of images: but instead it has no thickness, it consists only of a face and an obverse, like a sheet of paper, with a figure on either side, which can*

neither be separated nor look at each other." This strict distinction between hill and city reflects a contemporary tendency: the "museum-ification" of historical places.

Yet this approach generates profound issues. Contemporary life withdraws from historical continuity, detaching itself from the flow of time. As a result, the relationship between genius loci and city, between individual and place, between society and history, becomes weakened. This fragmentation is paradoxical: humans are part of the natural, just as the natural becomes a vessel for the artificial. When divided, "place" loses its capacity to weave a meaningful, unifying narrative, and its spatial vitality diminishes.

Image 1: Map, the city of hills as an archipelago

Architectural synthesis has the potential to reassemble these fragments, to bind them into a coherent narrative that acknowledges both the passage of time and the lived present. Such a narrative must intertwine parallel threads of meaning, forming a spatial collage in four dimensions, with time embedded in its very genetic code. As Norberg-Schulz observed, *"Only when we comprehend our place will we be able to participate creatively and contribute to its history."* Each era inscribes itself upon place, layer after layer, like translucent sheets of rice paper that contemporary life painted over with dense pigment. Active participation in this continuum is often undermined—either through the detached display of the past as spectacle or through indifference to the traces it has left behind.

2. THE CASE OF PHILOPAPPOU HILL AND ANO PETRALONA

The strong polarities of the contemporary Athenian landscape inevitably create "cracks" along the fine line that separates them. The abrupt transitions between these poles weaken the dynamics of the in-between space. In the case of Philopappou Hill, viewed from Ano

Petralona, this "crack" is embodied by the elevated peripheral highway: an almost entirely impenetrable boundary of reinforced concrete that violently intervenes between the neighborhood and the hill. Yet the city and the hill should not (and must not) be seen as two distinct, demarcated, antagonistic entities with rigidly predetermined characteristics. The hill belongs to the city; it is an inseparable part of it. Perhaps the current dipole of "Hill or City" can be redefined through a merging, becoming "Hill in the City." Such an organic unification could enrich the experiential dynamic of place and bridge the gap between the polarities that have been violently entrenched in the foundations of the urban fabric: open and closed, accessible and inaccessible, public and private, present and past, built and unbuilt, city and nature, asphalt and rock. In every possible form, the city has been built upon oppositions and contradictions. A critical issue that should concern contemporary design, therefore, is how to process and adapt the urban fabric in ways that generate intermediate states, fluid transitions: an authentic intent of unification, blending, and bridging of these bipolar relations.

Observing the shoreline, one can draw the following conclusion: the limits between ocean and land are not as clear as we tend to think. The intermediate zones are undefined; if we were to see the coastline–ocean dipole as black and white, multiple shades of grey appear. This approach could potentially inform design, to soften the differences and emphasize the shared points of intersection between opposing forces.

"As inside and outside are nothing more than arbitrary segments of the division of an infinite time—time that, moving ever forward, continuously calls the center into question."

Perhaps, then, the aim is to emerge at the threshold of Plato's cave, at the point where sunlight penetrates, escapes, disappears, and oscillates between day and night, each time revealing a different aspect of things: a shifting objectivity that intertwines with the subjectivity of the self—the place, the threshold where the imaginary and the real collide productively.

"Boundaries must be filled with shadows and mystery."

Spatial oppositions—dual conditions such as inside and outside, open and closed, visible and hidden, day and night, light and shadow—when used in design, undeniably enrich the experience of space. They do so not because they offer themselves as fixed, integral properties, but precisely because they can shift between each other along a spectrum. Yet we often ignore the extraordinary potential offered by this spectrum, since we tend to perceive situations as clear-cut opposites. As Nietzsche observed: *"The generally inaccurate way of observing sees everywhere in nature opposites (such as hot and cold), where in fact they are not opposites at all, but gradations."*

Perhaps architecture should neither reinforce these strict, sharply defined polarities, nor aim to establish a universally clarified spatial condition. Instead, space should transmute the spectral nature of oppositions through their organic gradations. To achieve this, a first crucial step would be to "loosen" our tight grip on the desire to categorize things as black or white, to perceive them through a dialectical prism of "is" or "is not," of "yes" or "no."

image 2: the spectrum as an answer to dipoles

The proposed solution lies in the intermediary between these dipoles that are identified. This approach can challenge and realise an architectural syn-thesis that wants to achieve an osmosis between the anti-thesis that emerged. The strict limit that separates the hill and the city can be demolished, while keeping its traffic purposes. The urban fabric can be readjusted in a way that it can create a seamless introduction to the place of the hill. The proposal redefines the limit from a single "line" in the topography to an expanded space that penetrates both the area of the hill and the city. Now the threshold acts as a common space for contemplation and absorbing the essence of place.

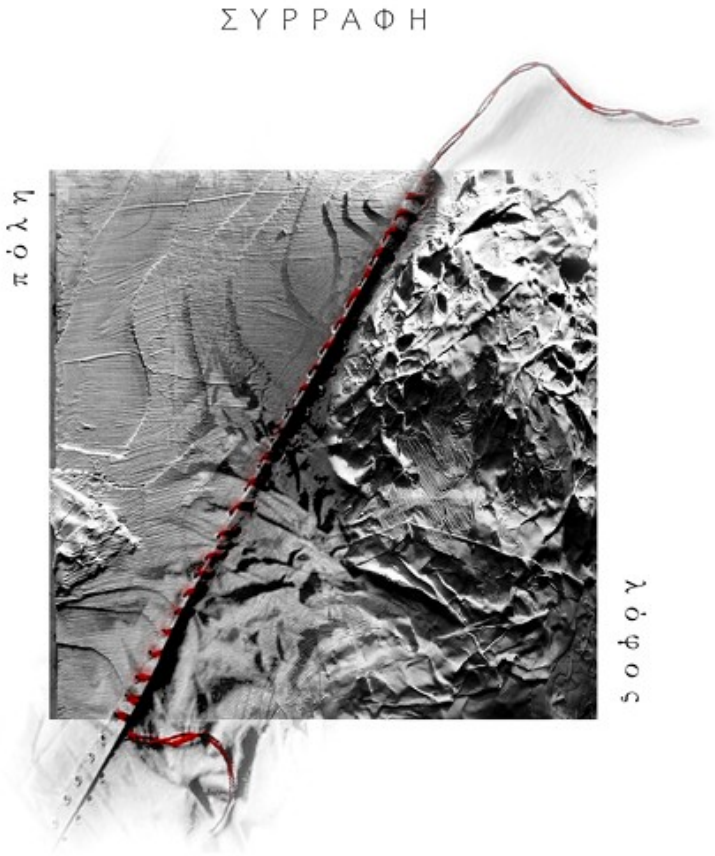

Image 3: The need for the city and the hill to be collated

THE SPATIOTEMPORAL EVOLUTION OF URBAN PLANNING IN THE HISTORIC CENTER OF KAVALA: CONTEMPORARY REFLECTIONS

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Abstract
Historic city centres often embody the cultural, architectural, and social identity of urban areas, serving as tangible links to the past while shaping trajectories of contemporary development. Their preservation and integration into modern urban life are critical for local and regional development dynamics, offering opportunities for tourism, investment, and creative industries, while simultaneously facing challenges such as overcrowding, gentrification, and pressures from modern infrastructure demands.

The Panagia district (Old Town) in Kavala exemplifies these dynamics. As the city's original historic core, it occupies a central position within the contemporary urban fabric and functions as a key organizing element of the city's spatial structure. The morphology of the walled city began to undergo significant transformations from the mid-19th century, coinciding with the onset of commercial expansion. An influx of new residents placed increasing demographic pressure on the peninsula, which until 1864 had developed within the fortification boundaries. By the time urban growth extended beyond the walls, the area had reached a high degree of densification: plots were fully built, neighbourhoods had lost distinctiveness, houses abutted fortifications, and dead-end streets proliferated.

This paper examines the evolution of urban transformations in historic cores, with a focus on the Panagia district in Kavala, analysing how urban morphology and spatial organization influence the developmental trajectory and identity of the region. It further investigates strategies to enhance resilience while safeguarding historical and cultural character, emphasizing adaptive reuse, heritage conservation, and sustainable development. By integrating these approaches, the research highlights how historic city centres can simultaneously preserve their intrinsic identity and accommodate contemporary functional, social, and economic needs, offering insights for balancing growth with conservation in urban planning.

Key words: Urban morphology, cultural heritage, urban resilience, historic core revitalization, urban planning

ASPHALT -ART AS AN INNOVATIVE WAY FOR SUSTAINABLE MOBILITY

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Abstract
In recent years, sustainable mobility has emerged as a central pillar in urban development strategies, aiming not only to reduce environmental impacts but also to enhance the quality of life in cities. Within this context, innovative approaches that combine functionality, aesthetics, and community engagement have gained increasing attention. One such approach is Asphalt-Art, an urban intervention that utilizes creative design and artistic expression on road surfaces to influence mobility patterns and promote safer, more inclusive public spaces.

Asphalt-Art goes beyond mere decoration; it acts as a tool for traffic calming, pedestrian prioritization, and the redefinition of underused urban areas. By introducing visually striking and context-specific artworks, streets can be transformed into dynamic environments that encourage walking, cycling, and other sustainable forms of mobility. Furthermore, these interventions often emerge from participatory processes, where local communities, artists, and city authorities collaborate to co-create meaningful urban experiences. This strengthens civic identity while simultaneously fostering environmental awareness and social inclusion. Asphalt-Art can also serve as a low-cost and flexible alternative to traditional infrastructural solutions, providing immediate and measurable benefits in terms of safety and accessibility. The integration of art into mobility planning highlights the potential of multidisciplinary strategies that merge urban design, culture, and sustainability.

Ultimately, Asphalt-Art demonstrates that innovation in sustainable mobility does not solely rely on technological advances, but also on creative, human-centered interventions that reshape the way people interact with public space.

Key words: Sustainable urban mobility, inclusion, accessibility, traffic safety, visual art intervention.

INTRODUCTION

One of the most significant challenges facing contemporary cities today is balancing their development dynamics with the reduction of their carbon footprint. In Greek cities, the lack of urban green spaces is considered one of the most critical environmental and structural problems. Furthermore, sustainable urban mobility aims both to enhance quality of life and to promote long-term sound environmental practices and economic development.

As is evident, the process of city formation is complex and multifaceted, shaped by a combination of factors. Each city has its own unique history and evolution over time, influenced by specific events and historical circumstances that define its spatial and developmental footprint (Samourkasidou, 2023).

Sustainable mobility ensures accessibility and seamless movement for all social groups, placing particular emphasis and priority on the most vulnerable. Traffic congestion today contributes to the degradation of mobility itself and of the environment, undermining urban

functionality by hindering or obstructing essential activities and restraining the development of new uses (Mendizabal et al., 2018).

The main reasons why sustainable urban mobility is considered a necessary condition for a city's sustainable development are the following (Samourkasidou, 2023):

⇒ Climate change mitigation
⇒ Reduced dependence on oil
⇒ Reduction of road accidents
⇒ Decrease in air pollution
⇒ Reduction of traffic congestion
⇒ Support for the local economy
⇒ Enhancement of the city's image
⇒ Creation of conditions for equal accessibility
⇒ Improvement of citizens' health and well-being

This paper explores the contribution of a contemporary participatory planning tool—asphalt art—to the promotion of sustainable urban mobility and to the creation of livable, safe, and attractive cities.

Through international best practices, as well as the presentation of an ambitious project in the city of Kavala aimed at creating school routes with the assistance of asphalt art, the study first seeks to investigate the degree of familiarity and acceptance of such participatory processes and practices within cities. Subsequently, it highlights the benefits arising from the adoption of such practices at the urban scale.

1. THEORETICAL FRAMEWORK

1.1 Participatory Planning

Participatory planning theory emphasizes the democratization of spatial decision-making processes. Rooted in communicative planning theory (Healey, 1997) and collaborative governance models, it recognizes citizens as co-producers of urban space rather than passive recipients of top-down interventions.

According to current trends and principles in spatial planning—such as the introduction of the 15-minute city model and the implementation of climate mitigation strategies at both local and neighborhood levels—the interaction and co-creation with local communities and stakeholders is considered vital in identifying and defining their needs. Consequently, the adoption of participatory planning models is becoming increasingly imperative.

The conclusions drawn from the systematic documentation of the evolution of this planning model highlight the importance of participatory processes and consultation in spatial planning, both during the design phase and throughout the implementation of a strategy or project. Another key issue emphasized is the high degree of social acceptance and "appropriation" of a project when the local community has actively participated in its design and/or implementation (Topouzi and Samourkasidou, 2025).

The methodological and theoretical insights derived reinforce the value of participatory planning, particularly with regard to (Topouzi and Samourkasidou, 2025):

a) rapid interventions (quick wins), adaptation measures, and mitigation actions that cities are required to undertake in response to climate change and the green transition;
b) increasing citizen participation in strategic planning and urban interventions, such as those supported by EU regional policy, where participation constitutes a conditionality; and
c) the utilization of different tools depending on the target group, as the approach varies, for example, between school communities and older adults.

Indicative tools include: Goals Grid Analysis, Collective Visioning, role-playing games ("Step Up"), board games such as "Build Your Own Block," walkshops, among others (Samourkasidou, 2025).

In this context, asphalt art operates as a participatory micro-intervention that engages local communities—particularly children, schools, and neighborhood stakeholders—in the co-design of public space. Such processes enhance social capital, foster place attachment, and strengthen civic ownership of mobility transformations.

1.2 Tactical Urbanism

Tactical urbanism has gained increasing attention as a flexible, low-cost, and participatory approach to urban planning, enabling cities to address urgent spatial challenges while actively engaging citizens. It plays a key role in fostering inclusivity, experimentation, and community empowerment, offering opportunities to test interventions in real urban contexts before committing to permanent solutions. At the same time, tactical urbanism raises questions regarding the longevity of interventions, the level of institutional support, and equity in access and benefits. Evaluating these interventions through citizen participation, including e-participation methods, provides valuable insights into public perceptions, acceptance, and priorities. Such evidence-based assessment not only enhances transparency and accountability in urban decision-making but also helps integrate social and psychological considerations into planning, ultimately supporting more resilient, human-centered, and adaptive urban environments (Tactical Urbanist's Guide, 2016).

By 2050, two-thirds of the global population is projected to reside in urban areas. People are migrating to cities at unprecedented rates, and this trend shows no signs of slowing. Such an unparalleled urban expansion must be addressed sustainably if we aim to advance toward resilient and livable cities.

Streets constitute an integral component of urban environments. They function as vital channels that enable the city to remain active, facilitate efficient movement, and provide services that enhance the overall quality of life. While this urban growth has brought many benefits, it has largely developed in an unregulated manner over recent decades, prioritizing automobiles and simultaneously marginalizing the role of pedestrians and local residents in public streets.

Historically, streets were not merely conduits for vehicles; they served as spaces for gathering, social interaction, and play. The notion that private automobiles dominate public space is a relatively recent phenomenon. In recent years, there has been an emerging recognition of the need to reconsider and redefine our relationship with streets, emphasizing inclusivity, accessibility, and multi-functional urban public space.

Asphalt art, as a tool of tactical urbanism, aligns with this framework by transforming road surfaces into multifunctional public spaces through artistic design. These interventions often recalibrate traffic behavior, visually narrow carriageways, improve pedestrian safety, and contribute to traffic calming without requiring large-scale infrastructural investments. Tactical urbanism is applied by a diverse set of actors—including governmental institutions, private enterprises, nonprofit organizations, citizen groups, and individual practitioners—particularly in contexts where there is a need for rapid, temporary, and cost-effective interventions. Such interventions are typically implemented as pilot initiatives, enabling a systematic evaluation of the design's effectiveness, continuous monitoring of functional performance, and iterative refinement to address any identified shortcomings. Equally critical is the assessment of social acceptance and community engagement, which provides insights into the intervention's perceived value, fosters a sense of local ownership, and informs

potential scaling or replication within the urban environment. This approach underscores the dual focus of tactical urbanism on both functional outcomes and participatory legitimacy in shaping resilient and inclusive public spaces.

In synthesis, the theoretical framework positions asphalt art at the intersection of sustainable mobility, participatory governance and tactical experimentation. It is conceptualized not merely as an artistic intervention, but as a spatial planning instrument capable of catalyzing behavioral change, strengthening community engagement, and supporting the transition toward low-carbon, inclusive urban systems.

2. ASPHALT ART AS A TACTICAL URBANISM TOOL: URBAN INTERVENTIONS

Asphalt art is an increasingly prominent and rapidly evolving tool in urban design. Globally, it is commonly employed to implement temporary interventions aimed at reclaiming public space and reducing its domination by motorized vehicles. Asphalt art is used both to redesign public areas—such as plazas and social gathering spaces—and to create designated pathways, including school routes. A defining characteristic of this approach lies in the high degree of community participation, the reliance on volunteer engagement, and the resulting social acceptance of the intervention.

The overall outcome of the entire process is complex and multifunctional. Beyond aesthetically enhancing the urban landscape and giving the area a strong local identity, it improves the distribution and accessibility of public spaces and reinforces the principles of sustainable urban mobility, such as enhanced road safety. Importantly, by actively engaging the local community through participatory design tools, the process fosters a sense of collective ownership and social acceptance of the interventions. In this way, the initiative not only strengthens the urban resilience of the area and supports its climate neutrality but also cultivates long-term community engagement and awareness of sustainable urban practices.

The following three examples illustrate successful applications of asphalt art: two involve the creation of public plaza spaces in New York City and Milan, respectively, and the third concerns the establishment of a school route in Limerick, Ireland. These cases are deemed successful not only because they fulfilled their intended objectives—by redesigning public space and reclaiming areas that had increasingly been occupied by private vehicles—but also because they achieved significant social acceptance, reflecting the active engagement and endorsement of the local communities.

The New York City Department of Transportation entered a transformative phase during the period 2007–2013. Throughout this time, the agency implemented a comprehensive redefinition of urban streetscapes, encompassing the rehabilitation of aging infrastructure, the introduction of a citywide bike-share program, the modernization of public bus systems, the addition of 400 miles of dedicated bicycle lanes, and the establishment of 60 pedestrian plazas. These interventions exemplify a strategic shift toward prioritizing multimodal mobility, public space enhancement, and sustainable urban transportation (New York Pioneers Asphalt Art, 2016).

Figure 1: Street view of a roadway enhanced with asphalt art in New York City

Source: https://www.moderncities.com/article/2016-jul-new-york-pioneers-asphalt-art

The DOT Art program further extends this vision by conceptualizing transportation infrastructure as a platform for temporary public art. Through collaborations with community-based organizations and professional artists, NYCDOT converts functional elements—such as traffic barriers—into large-scale murals and revitalizes underpasses through dynamic light installations. This integration of artistic interventions within the transportation network not only enhances the aesthetic and experiential quality of urban mobility but also fosters community engagement, placemaking, and a participatory approach to the reimagination of public space (New York Pioneers Asphalt Art, 2016).

Piazze Aperte, a citywide tactical urbanism program, was developed in Milan, Italy, with the support of AMAT – the Municipal Agency for Mobility and Environment – in collaboration with Bloomberg Associates and the Global Designing Cities Initiative. The project aims to enhance public spaces as community hubs, expand pedestrian areas, and promote green mobility, thereby improving both the urban environment and the quality of life for residents. By employing the principles of tactical urbanism, Piazze Aperte seeks to reestablish public squares as central components of neighborhood life, creating places that foster social interaction and community connection (Citywide tactical urbanism programme, 2019).

Since its inception in 2019, the initiative has involved continuous collaboration among multiple stakeholders in the design, development, and implementation phases, enabling its expansion across the city. Piazze Aperte aligns with Milan's 2030 strategic objectives for urban regeneration, environmental sustainability, and sustainable mobility. The program further incorporates participatory actions through Collaboration Pacts, guided by the principles of shared governance, as part of a co-design process actively involving the city administration, local actors, and residents (Citywide tactical urbanism programme, 2019).

Figure 2: Piazza Aperte

Source: https://urbact.eu/good-practices/citywide-tactical-urbanism-programme

The Safe Routes to School (SRTS) Programme was developed in partnership with the National Transport Authority (NTA) and Green-Schools in 2020 as a response to the need to support schools to increase walking and cycling to school.

Figure 3: School Route in Limerick, Ireland

Source: Safe Routes to School (https://www.limerick.ie/council/services/roads-and-travel/active-travel/active-travel-limerick/safe-routes-to-school)

3. ENHANCING SCHOOL ROUTES THROUGH ASPHALT ART: THE CASE OF KAVALA

Although the experience of mobility directly affects the quality of life of children and adolescents in the city—particularly in their daily journeys to and from school—these age groups are often excluded from planning processes.

Through the use of participatory planning tools, children and young people will have the opportunity to express their views, co-design interventions in the neighborhoods surrounding their schools, and collaborate in the implementation of pilot applications of their ideas. The aim is to improve infrastructure suitability, enhance travel safety, and ensure accessibility for all.

Through awareness-raising activities, children and young people are encouraged to develop a new, more environmentally friendly mobility culture, contributing to the creation of better conditions for the future and assuming an active role in promoting sustainable mobility.

Within the framework of European Mobility Week 2022, a voluntary intervention was conducted on Nikis Street by the Municipality of Kavala, to enhance its aesthetic quality, including a raised crossing to improve safety, primarily for students. In collaboration with the school community of the 10th Primary School, a safe school route was established.

The following photographic documentation illustrates the pre-intervention conditions and the outcomes of the urban intervention following the participatory collective actions.

Nikis Street prior to the intervention

Πηγή: Source: Author's personal collection

The following photographic documentation illustrates the participatory asphalt-art intervention on Nikis Street during the implementation of a school route.

Πηγή: Source: Author's personal collection

In the third and final set of photographs, the completed outcome of the school route intervention following the participatory process is presented. The core concept centered on the creation of a musical staff, including notes, the G-clef, and other familiar musical symbols, deliberately selected to provide an accessible and engaging theme that enabled active involvement of primary school students. The design process was carried out under the supervision of an experienced asphalt artist and involved collaborative workshops with students and local stakeholders. High-performance paints with specialized properties were employed, designed to reduce surface slipperiness, enhance long-term durability, and maintain aesthetic quality under outdoor conditions. This approach demonstrates the potential of participatory urban interventions to combine educational engagement, safety, and aesthetic improvement within school-centered urban environments.

Πηγή: Source: Author's personal collection

CONCLUSIONS

The implementation of participatory urban interventions, such as asphalt art applied to school routes, demonstrates that sustainable urban mobility can be effectively promoted when design processes actively involve local communities, including children and students. The co-creation of urban spaces not only enhances the functional quality and safety of infrastructure but also fosters a sense of ownership and engagement among residents, contributing to the social sustainability of the city. By integrating aesthetic, educational, and safety considerations, such interventions highlight the potential of small-scale, temporary, and cost-effective measures to serve as pilots for broader urban planning strategies.

Moreover, the combination of sustainable mobility initiatives and urban green infrastructure reinforces the resilience and livability of medium-sized cities. Streets and public spaces, when designed as multifunctional environments, can simultaneously accommodate mobility needs, environmental objectives, and social interaction. The evidence from case studies, such as the Kavala school routes project, suggests that participatory and tactical urbanism approaches can provide measurable benefits in terms of safety, environmental awareness, and behavioral change, while also serving as replicable models for similar interventions in other urban contexts. These findings underline the importance of integrating participatory, sustainable, and climate-responsive planning into the ongoing evolution of urban environments.

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THE PHYSIOGNOMY AND SUSTAINABILITY OF RAFINA CITY THROUGH STUDENTS' PERSPECTIVE

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Abstract
The present study explores the physiognomy and sustainability of the city of Rafina, a coastal urban area in Eastern Attica, Greece, through the eyes of its young citizens. Conducted within the framework of the postgraduate course "Sustainability and Smart Cities" at Harokopio University of Athens, this research aims to examine how students perceive their city's identity, environmental and cultural characteristics, and its transition toward a more sustainable and "smart" future.

A structured questionnaire was distributed to 250 students from the 2nd and 3rd grades of the 1st Gymnasio of Rafina. The survey, based on the official guidelines of the course, focused on key dimensions such as local landscape, heritage monuments, traditional customs, environmental challenges, and the implementation of sustainability projects by the school, including Erasmus+ "Protect Your Nature, Protect Your Future,""E.A.R.T.H.," and "Create Project," as well as participation in the Blue Schools Network and the municipal CLIMAAX climate resilience initiative.

The Results indicate that students strongly associate Rafina's identity with its coastal ecosystem, pine forests, and maritime life, while acknowledging both the beauty and environmental vulnerabilities of their city. They emphasize the value of civic engagement and environmental education as pathways to sustainability. The positive perceptions include the sense of community, the natural landscape, and the school's active engagement in green initiatives, while the concerns focus mainly on pollution, the port's expansion, the pressures on the Megalo Rema stream, and urban congestion..

The study highlights the importance of integrating youth perspectives into local sustainability planning. It demonstrates how school-based environmental education can strengthen civic responsibility and foster a collective vision for a resilient, inclusive, and environmentally conscious smart city.

Keywords: Rafina, city physiognomy, sustainable development, smart cities, environmental education-literacy, civic engagement.

1. INTRODUCTION

The physiognomy of a city is a complex and multidimensional concept that reflects its unique identity through its physical, cultural, social, and economic characteristics. It is not limited to the city's form or landscape but also encompasses its collective memory, historical continuity, and social values. The physiognomy of a city includes both its "logos" and its "myth"—the

way a community perceives itself and expresses its relationship with space and time *(Astara κ.ά., 2008)*.

The preservation of urban physiognomy is closely linked to the principles of sustainable urban development, which seek to balance environmental protection, economic viability, and social cohesion. Sustainability requires maintaining harmony between the natural and built environment, promoting civic participation, and ensuring intergenerational justice *(Astara et al., 2008)*. Within this framework, the contemporary concept of "smart cities" emerges as a new model of urban governance that integrates technology and innovation to enhance quality of life, improve energy efficiency, and reduce environmental impact *(Badas, 2019)*.

Within this theoretical and developmental context lies the case of Rafina, a coastal city in Eastern Attica where natural beauty coexists with significant development pressures. Surrounded by pine forests and connected to the Aegean Sea through its port, Rafina functions both as a residential area and as a hub of touristic activity. The city's physiognomy is shaped by its maritime identity, its refugee heritage, and its vibrant social life; however, it simultaneously faces growing challenges related to port expansion, traffic congestion, and the need to protect its coastal ecosystem *(Municipality of Rafina–Pikermi, 2024)*.

This study aims to investigate the physiognomy and sustainability of Rafina through the perspective of its young citizens. Drawing on data collected from 251 students of the 1st Gymnasio of Rafina, the research seeks to capture their perceptions of the city's identity, its environmental characteristics, and its prospects for a more sustainable and "smart" future. The findings are expected to highlight the role of environmental education in cultivating civic responsibility and strengthening participatory planning processes. As emphasized by UNESCO, empowering young people to actively engage in local sustainability issues is a key factor in shaping resilient, inclusive, and future-oriented communities *(UNESCO, 2025)*.

2. PURPOSE AND OBJECTIVES OF THE STUDY

The purpose of this study is to investigate how students perceive the physiognomy and sustainability of the city of Rafina. More specifically, the research aims to explore young citizens' views regarding the city's identity, its cultural and environmental characteristics, and the main challenges it faces on its path toward sustainable development. Particular emphasis is placed on understanding students' perceptions of the city's potential transition toward a "smart" urban model that integrates environmental protection, technological innovation, and community well-being.

In addition to examining students' conceptualizations of Rafina, the study aims to document their assessment of sustainability-related challenges, such as environmental pressures, coastal vulnerability, and issues of urban management. An equally important objective is to analyze how students interpret the role of their school in promoting environmental awareness, civic engagement, and sustainable practices. This includes the impact of school-based European and environmental initiatives—such as Erasmus+ *Protect Your Nature, Protect Your Future*, Erasmus+ *E.A.R.T.H.*, the *Create Project*, participation in the Blue Schools Network, and the municipal CLIMAAX climate resilience program—on shaping students' attitudes and values related to sustainability.

Through these interconnected objectives, the study seeks to highlight the importance of youth perspectives in local planning, while demonstrating how educational environments can function as catalysts for cultivating responsible, informed, and actively engaged future citizens.

3. THEORETICAL FRAMEWORK

3.1 City Physiognomy

The physiognomy of a city is a multidimensional concept that encompasses the physical, morphological, cultural, and social characteristics that shape its identity. Beyond the visible elements of the urban landscape, city physiognomy integrates historical memories, residents' values, collective narratives, and cultural representations that define the "character" of a place *(Astara et al., 2008)*. In coastal cities such as Rafina, physiognomy is strongly influenced by the marine environment, forests, coastline, and sociocultural factors such as refugee heritage and maritime identity. The study of urban physiognomy serves as a key tool for understanding how a city evolves, develops, and adapts to emerging challenges *(Astara et al., 2008)*.

3.2 Sustainability

Sustainability refers to a place's ability to ensure the harmonious coexistence of environmental, social, and economic dimensions. In the urban context, sustainable development seeks to preserve natural resources, reduce environmental pressures, strengthen social cohesion, and guarantee fair and equitable access to essential infrastructure *(Mitoula, 2023)*. It encompasses actions such as ecosystem protection, improvement of quality of life, enhancement of public spaces, and the promotion of green modes of mobility. In sensitive coastal areas, sustainability also involves addressing risks such as erosion, sea-level rise, and pressures stemming from tourism and urban expansion *(Mitoula, 2023)*.

3.3 Smart Cities

The concept of "smart cities" refers to a contemporary model of urban governance that leverages digital technologies, innovation, and information systems to improve quality of life, enhance the efficiency of urban services, and reduce environmental impact *(Badas, 2019)*. Smart cities develop digital management systems—such as smart waste bins, environmental sensors, and digital information displays—promote open governance, and create tools that strengthen citizen participation in decision-making processes. An effective transition to a smart city model requires not only technological infrastructure, but also active, informed, and engaged citizens *(Badas, 2019)*.

3.4 The Role of Environmental Education

Environmental education constitutes a fundamental pillar for cultivating ecological awareness, responsibility, and active student participation in issues affecting their city. Through experiential activities, school-based programs, and engagement in European initiatives, students develop knowledge, critical thinking, and collaboration skills that enable them to contribute to the sustainable development of their community *(UNESCO, 2025)*. Initiatives such as Erasmus+ School Education, the Blue Schools Network, and the CLIMAAX programme strengthen students' understanding of environmental issues, encourage responsibility, and promote the role of the school as an active agent of change. Empowering students, as highlighted by UNESCO, is a critical tool for fostering resilient and participatory communities *(UNESCO, 2025)*.

4. METHODOLOGY

4.1 Sample

The sample for this study consists of 251 students from the 1st Gymnasium of Rafina, which is the only public lower secondary school in the city and serves the entire adolescent population of the area. With an overall enrolment of 371 students, the school provides a representative setting for the research, as the sample corresponds to a substantial proportion of the school population.

Participants were drawn from Grade 1 and Grade 3 and included students who were present at school on the day of data collection. Specifically, 145 students from Grade 3 (76 boys and 69 girls) and 106 students from Grade 1 (65 boys and 41 girls) participated in the study. The age range of the participants was 12 to 15 years.

Data collection was conducted anonymously, without the recording of any personal information, and in accordance with the ethical standards of educational research. The high participation rate and the population-wide coverage of the school strengthen the reliability and validity of the study's findings.

4.2 Study Area: The City of Rafina

Rafina is one of the most characteristic coastal municipalities of Eastern Attica, combining a long historical presence, a distinctive cultural identity, and a natural environment of high ecological value. The area has been continuously inhabited since prehistoric times, as demonstrated by findings of rectangular dwellings and copper-processing facilities. During the Classical period, Rafina—known as *Araphin*—was one of the one hundred demes of ancient Athens established by Cleisthenes, taking its name from the mythical local hero and governor of the region. Archaeological remains from the Roman era, including baths, statues, and building structures, further attest to the enduring importance of the site. In the area of Asketario (Marikes Beach), fortified settlements from the Early Bronze Age have also been excavated.

The modern physiognomy of Rafina was decisively shaped after 1923 by the arrival of refugees from Triglia in Asia Minor. The expropriation of the Skouze estate and the establishment of the refugee settlement created strong social cohesion, a new architectural character, and cultural features that remain present today. Over the following decades, the town continued to grow by leveraging the strategic position of its port, which functioned both as a leisure destination and as a small-scale tourist hub. During the German occupation, fortified structures were constructed along the coastline, while the post-war period brought rapid economic and residential development, marked by the creation of key public infrastructures, the first hotels, and improvements to the main road network *(Municipality of Rafina–Pikermi, 2024)*.

Geographically, Rafina forms part of the natural and social mosaic of Eastern Attica, a region characterized by coastal ecosystems, small wetlands, hills with Mediterranean maquis, and extensive forests of Aleppo pine (*Pinus halepensis*). At the same time, its proximity to Athens has made the area particularly vulnerable to anthropogenic pressures such as urban sprawl, tourism-driven expansion, and the lack of coherent spatial planning. Eastern Attica has experienced significant demographic growth in recent decades, further intensified by major infrastructure projects such as the Attiki Odos motorway and the Athens International Airport. Increased housing demand, the expansion of holiday-home zones, and dispersed unregulated construction have led to habitat fragmentation and environmental conflicts *(Samara, 2025)*.

Adding to this already pressured environment was the devastating wildfire of 23 July 2018, which struck the wider region of Eastern Attica, with the tragedy centered in nearby Mati and with direct consequences for Rafina. The fire resulted in the loss of dozens of lives, leaving a profound social and psychological impact on the community and highlighting the need for enhanced civil protection and climate-resilience mechanisms. The event exposed weaknesses in spatial planning, the absence of fire-break infrastructure, and the challenges facing coastal and peri-urban ecosystems under extreme weather events. Its effects remain visible in both the landscape and the collective memory of the local population, making Rafina a significant case study for issues of sustainable reconstruction and climate adaptation *(Samara, 2025)*.

Beyond environmental pressures, Rafina has undergone substantial demographic shifts over the past three decades. The population increased from 8,894 residents in 1991, to 13,625 in 2001 (+53%), 20,266 in 2011 (+49%), and 22,328 in 2021 (+10%). This continuous increase has strained existing infrastructures, heightened demand for housing, and intensified the need for modernization of municipal services.

A major factor shaping the city's sustainability challenges is the role of the Port of Rafina, the second-largest passenger port in Attica. Intense summer activity leads to dramatic increases in traffic congestion, with large accumulations of private cars, buses, and freight vehicles, especially during peak departure times for the Cyclades. This seasonal surge produces significant air pollution, traffic-related disturbances, and acoustic pressure on nearby residential areas.

Additionally, the municipality's proximity to Athens International Airport contributes to persistent aircraft noise pollution, particularly in flight and overflight corridors. This chronic acoustic burden is now recognized as an environmental and public-health factor influencing residents' quality of life.

As a coastal city with critical infrastructures, Rafina stands at a transitional point between urban and natural space. Its coastal ecosystem, pine forests, the Rafina stream, and areas of high biodiversity coexist with increasing pressures from traffic, port expansion, tourism flows, and climate vulnerability. These combined dynamics make Rafina an ideal study area for examining issues of sustainability, urban physiognomy, climate resilience, and participatory planning.

4.3 Research Tool

The research data were collected using a structured online questionnaire developed with Google Forms. The instrument was designed specifically for this study, following the pedagogical principles of the course *Sustainability & Smart Cities* (Harokopio University), and was informed by contemporary literature on city physiognomy, sustainability education, youth civic engagement, and smart city frameworks. The questionnaire consisted of nine thematic sections, combining closed-ended Likert-scale items with open-ended qualitative prompts, in order to capture both measurable trends and rich personal perceptions of the students.

The first section included a brief introductory statement outlining the purpose of the study, assuring anonymity, and explaining that there were no "correct" or "incorrect" answers. The second section collected basic demographic information, specifically gender and grade level, allowing for comparative analysis across student groups.

The third section explored students' perceptions of the physiognomy, cultural identity, and sensory landscape of Rafina. This part employed open-ended questions inviting students to describe key colors, sounds, smells, natural elements, foods, cultural events, monuments,

and personal meanings associated with the city. Additional items examined the perceived influence of Rafina's refugee heritage and historical past on the city's contemporary identity.

The fourth section addressed sustainability and environmental challenges, using 5-point Likert scales (1 = strongly disagree, 5 = strongly agree). Items measured students' understanding of sustainable development, their assessment of the city's environmental problems (e.g., waste management, traffic, forest and coastal protection), and the perceived role of the school in developing environmental awareness and resilience. Students were also asked to rank environmental challenges according to personal significance (e.g., pollution, urban expansion, wildfires, floods).

The fifth section focused on youth participation and active citizenship. Students reported whether they had taken part in environmental or community actions, the types of activities involved (e.g., tree planting, beach clean-ups, school programs, collaborations with the Municipality), and the extent to which they felt their opinions could influence local decision-making. Additional questions examined preferred forms of school–municipality collaboration and sources of environmental information.

The sixth and seventh sections investigated perceptions of European and school-based programmes related to sustainability (e.g., Erasmus+, Blue Schools, CLIMAAX). Through Likert-scale items, students evaluated their awareness of these initiatives, their perceived educational value, their influence on students' environmental habits, and their contribution to Rafina's image as a "green" or sustainability-oriented city. Students also reflected on whether participation in Erasmus+ activities strengthened their environmental knowledge, motivation, and sense of agency as active citizens.

The eighth section examined views on Rafina as a "smart" and sustainable city of the future. Students assessed how "smart" they consider the city today and the potential benefits of green technologies (e.g., sensors, renewable energy, smart lighting). They also evaluated the importance of citizen–municipality cooperation and proposed their own ideas for sustainable or digital improvements. Open-ended questions invited them to imagine Rafina in 2035 and to suggest smart-city solutions they would like to see implemented.

Finally, the ninth section included reflective questions such as "If you were the mayor for one day, what action would you start to make Rafina more environmentally friendly?", enabling the collection of deeper insights into students' priorities, creativity, and sense of responsibility toward their city.

Overall, the questionnaire was designed to generate comprehensive data on how students perceive Rafina's identity, environmental challenges, civic engagement opportunities, and future development as a sustainable and smart coastal city. The combination of quantitative and qualitative items allowed for a multi-layered analysis consistent with the study's mixed-methods approach.

5. DATA ANALYSIS

5.1 Descriptive Statistics (Demographics)

A total of 251 students from the 1st Gymnasium of Rafina participated in the study. The sample included 141 boys and 110 girls, while 106 students were enrolled in Grade 1 and 145 students in Grade 3 of lower secondary education. These distributions reflect the population structure of the school and ensure adequate representation across gender and grade levels.

The demographic variables were used descriptively to contextualize the findings, while the subsequent analysis focused on thematic patterns related to city physiognomy, sustainability awareness, civic participation, and smart-city perspectives.

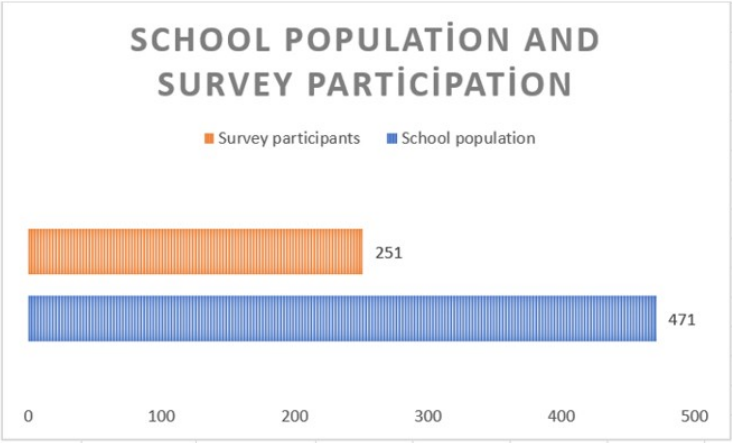

Figure 1: School population vs. survey participants (53.3% participation rate)

5.2 Physiognomy

The first thematic cluster explored how students perceive the physiognomy of Rafina through sensory associations, symbolic elements, and personal experiences. The responses reveal a consistent and vivid image of the city, strongly connected to its coastal character and natural environment.

Colours Associated with the City

The vast majority of students described Rafina using blue and light-blue tones, directly linked to the sea and the sky. Secondary references included green, reflecting the presence of pine forests and coastal vegetation.

Characteristic Sounds of Rafina

The dominant soundscape described by students includes waves, the sea, and ship engines, which form the core of the city's acoustic identity. Additional sounds such as wind and cicadas were also frequently mentioned, particularly by students living near natural areas. A smaller but meaningful proportion referred to traffic noise and aircraft sounds, indicating awareness of human-induced noise and the influence of nearby transport infrastructure.

Smells and Scents Associated with the City

The most common scent linked to Rafina was the smell of the sea, confirming the strong emotional and sensory connection to the coastal environment. However, many students also mentioned the smell of ship exhaust, often described as "the smell of the port," highlighting the environmental burden of maritime activity. Natural aromas such as pine, tamarisk, olive trees, and vineyards were also noted.

Plant or Tree Representing Rafina

Students most frequently selected pine trees as the plant symbol of the city, followed by tamarisk and olive trees, reflecting the typical vegetation of Eastern Attica and the coastal landscape.

Foods Associated with Rafina

The gastronomic identity of the city, according to the students, is mainly represented by seafood and fish, consistent with Rafina's maritime character. Souvlaki also appeared frequently as a common local food preference.

Traditional Events and Festivals
Students identified the Panagia Pantovasilissa celebration and the national parades as the most characteristic local events of the city.
Favourite Places in the City
The most frequently mentioned favourite places include Agios Nikolaos, Marikes Beach, the port area, Karamanlis Park, and the central square, indicating the importance of both natural landscapes and social public spaces.
Monuments Linked to Rafina
Students referred to symbolic sites such as the War Memorial, the Monument of Saint Chrysostomos of Smyrna, and, in several cases, the statue of the refugee girl, reflecting the strong presence of Asia Minor refugee memory in the city's collective identity.
One-Sentence Description of Rafina
When asked to describe Rafina in one sentence for someone who has never visited, students most commonly characterized the city as "coastal," "small," "peaceful," and "beautiful." A smaller number of students described it as "boring," suggesting differentiated levels of emotional engagement with the urban environment.

Students' Perceptions of the Influence of Refugee Heritage on Rafina's Contemporary Identity
The responses indicate that students generally acknowledge the strong influence of Rafina's historical and refugee heritage on the city's contemporary identity. Most participants selected values of 4 or 5, indicating that they believe the Asia Minor origins of the local population continue to shape cultural memory, social life, and the symbolic character of the city.

A smaller proportion of students selected value 3, suggesting a moderate perception of influence, while only a few participants chose values of 1 or 2, indicating limited recognition of this historical dimension.

Overall, the results highlight that the refugee past remains a central component of the city's physiognomy, particularly for the younger generation, who appear aware of the significance of monuments, traditions, and local narratives associated with Asia Minor heritage.

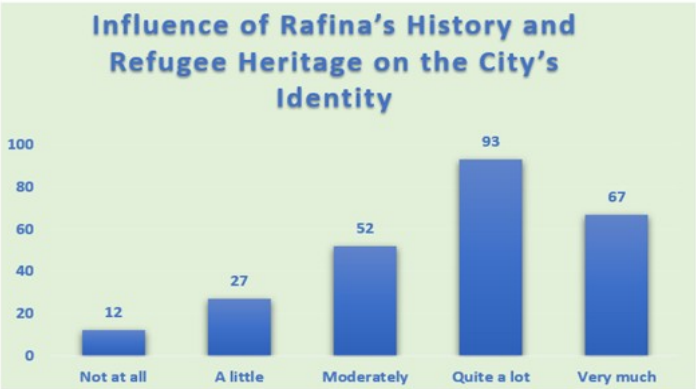

Figure 2: Students' perceptions of the extent to which Rafina's history and refugee heritage influence the city's contemporary identity (n = 251). Responses are presented on a 5-point Likert scale (1 = Not at all, 5 = Very much).

5.3 Students' Perceptions of Sustainability and Local Environmental Challenges

This section presents the findings related to students' perceptions of sustainability, local environmental challenges in Rafina, and the role of the school in promoting environmental awareness and active citizenship. The analysis is based on a series of Likert-scale questions (1 = "Strongly disagree" to 5 = "Strongly agree") that examined students' understanding of key sustainability concepts, their evaluation of environmental pressures affecting the city, and their views on how effectively the school supports environmental education and resilience.

The descriptive results provide insight into how young residents perceive both the natural and urban environment of Rafina, as well as their level of engagement with issues related to environmental protection and community well-being. The visual representations that follow (bar charts) illustrate the distribution of responses and highlight emerging trends in students' attitudes toward sustainability, environmental challenges, and the school's contribution to shaping environmentally responsible citizens.

Figure 3: Distribution of students' responses regarding their understanding of the concept of sustainable development (1 = Strongly disagree, 5 = Strongly agree).

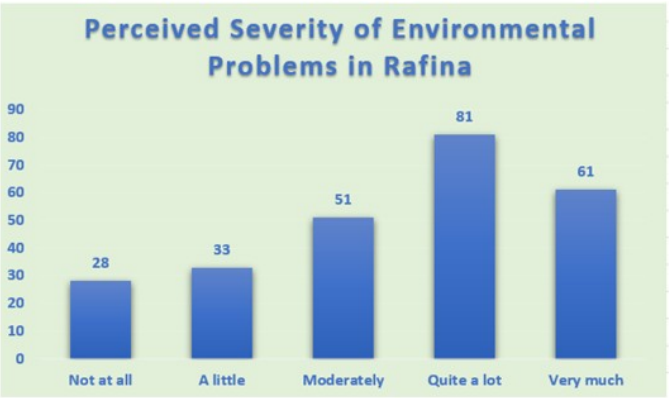

Figure 4: Students' perceptions of the severity of environmental problems in Rafina (N = 251). Responses range from 1 = "Not at all" to 5 = "Very much.

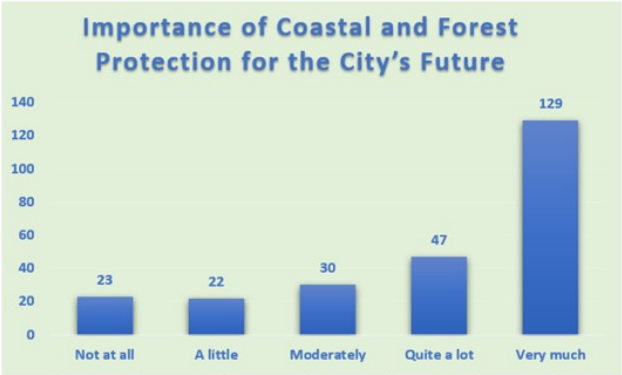

Figure 5: Students' views on the importance of protecting Rafina's coasts and forests for the city's future (N = 251). Responses range from 1 = "Not at all" to 5 = "Very much."

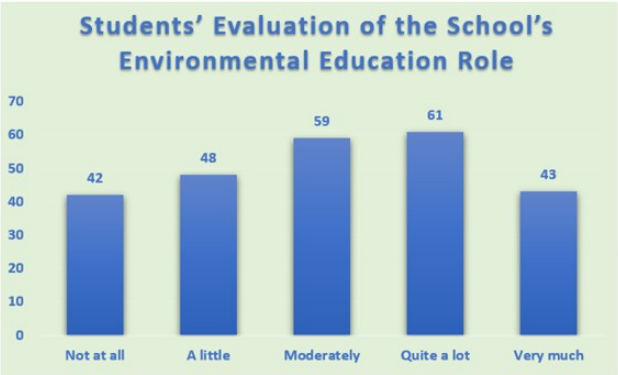

Figure 6: Students' evaluation of their school's role in promoting environmental education and awareness (N = 251). Responses range from 1 = "Not at all" to 5 = "Very much."

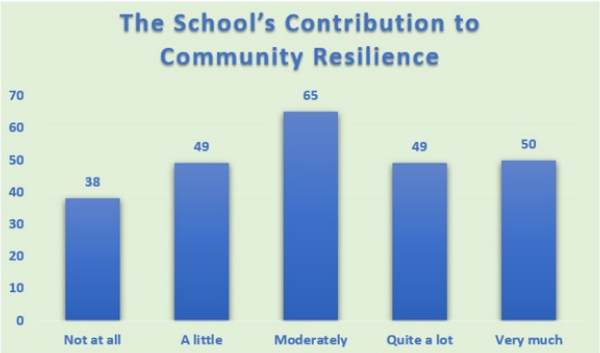

Figure 7: Students' evaluation of their school's role in promoting environmental education and awareness (N = 251). Responses range from 1 = "Not at all" to 5 = "Very much."

5.4 Environmental Concerns Identified by Students

When students were asked to select the single most important environmental problem in Rafina, pollution (including waste, noise, and vehicle emissions) emerged as the top concern, chosen by 62 participants. The expansion of the port (48 votes) and the degradation of the Megalo Rema stream (47 votes) also ranked highly, indicating students' awareness of pressures affecting the coastal and natural environment. Issues such as forest loss and wildfire risk (39 votes) and reduction of green areas (31 votes) followed, while traffic and parking problems (19 votes) were considered less critical in comparison. Flooding and coastal erosion received the fewest first-choice selections (5 votes), suggesting that students prioritize everyday and visible environmental pressures over seasonal or long-term risks. Overall, the ranking demonstrates a clear emphasis on pollution and coastal environmental challenges as the city's most urgent problems.

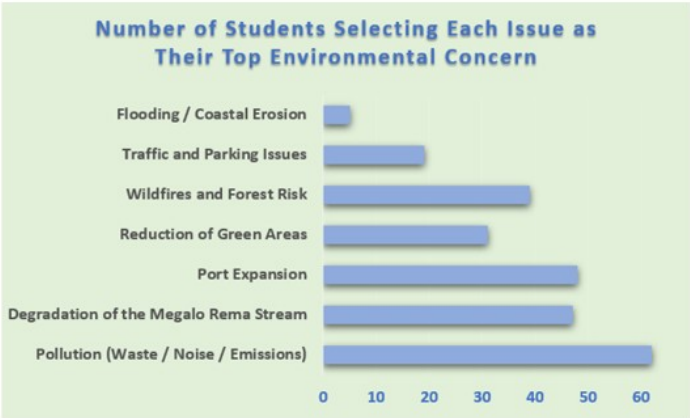

Figure 8: Distribution of students selecting each environmental issue as their top concern.

5.5 Students' Civic Engagement and Participation

This section examines the extent to which students in Rafina are actively engaged in environmental or community-related actions, either individually, through school initiatives, or in collaboration with the municipality. The analysis focuses on students' participation in activities such as tree planting, beach clean-ups, school environmental programs, and municipal actions, as well as their perceived ability to influence decisions affecting their city.

The findings provide insight into students' sense of agency, their willingness to participate in collective efforts, and their expectations for stronger cooperation between the school community and the local authorities. These indicators are essential for understanding the development of active citizenship and environmental responsibility among young people.

To better understand students' level of civic engagement, the first indicator examined was whether they have ever proposed or participated in an action aimed at improving their school or their city.

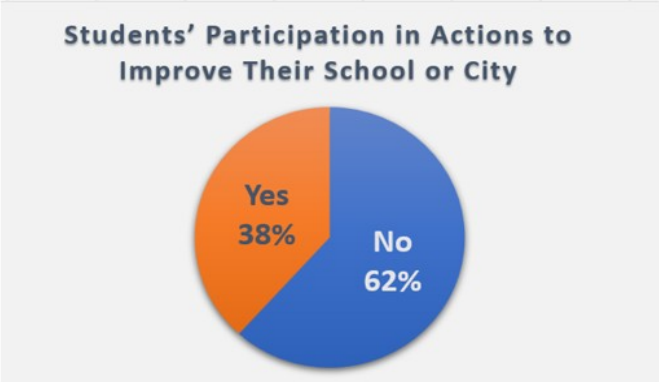

Figure 9: Distribution of students who reported having proposed or participated in an action aimed at improving their school or the city of Rafina. The majority (62%) indicated that they have not yet engaged in such initiatives, while 38% reported active involvement

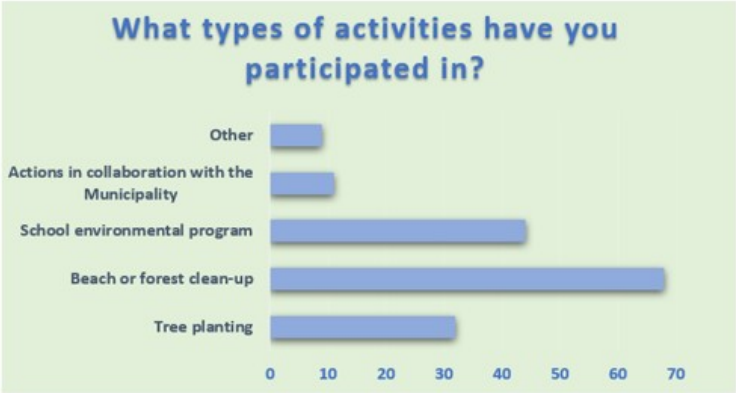

Figure 10: Distribution of students' participation across different types of environmental and community activities.

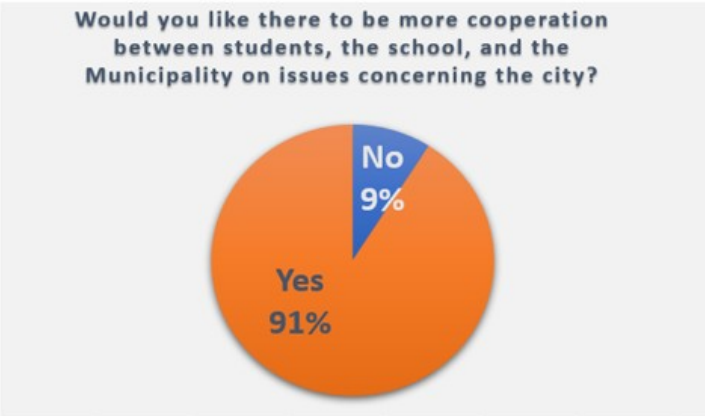

Figure 11: Students' willingness to see stronger cooperation between the school and the Municipality.

5.6 Students' Perceptions of European and School Programs

European and school-based programs—such as Erasmus+, Blue Schools, and environmental education initiatives—play a crucial role in strengthening students' environmental awareness, sustainability literacy, and sense of European citizenship. These programs provide experiential learning opportunities, foster intercultural understanding, and promote active engagement with real-world environmental challenges. In the context of Rafina, where coastal and forest ecosystems are central to local identity, such initiatives help students connect global sustainability principles with the needs of their own community.

This section presents students' perceptions of how effectively these programs contribute to environmental knowledge, influence daily habits, enhance the city's environmental image, and motivate young people to participate in positive change.

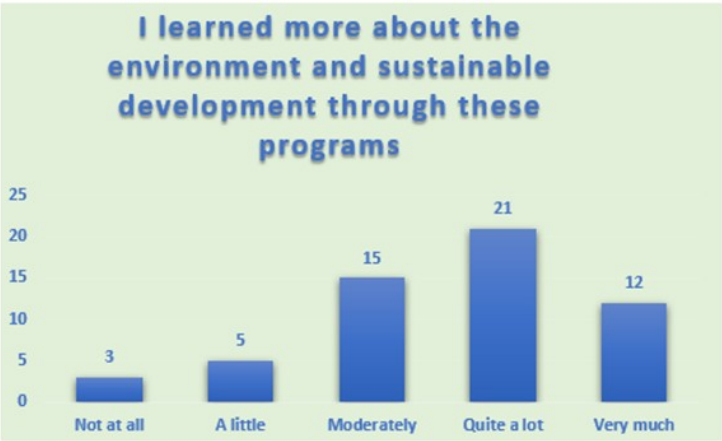

Figure 12: Distribution of responses among the 56 students who reported personal participation in a European program, regarding the statement "I learned more about the environment and sustainable development through these programs." The results illustrate the educational impact of European initiatives on participating students.

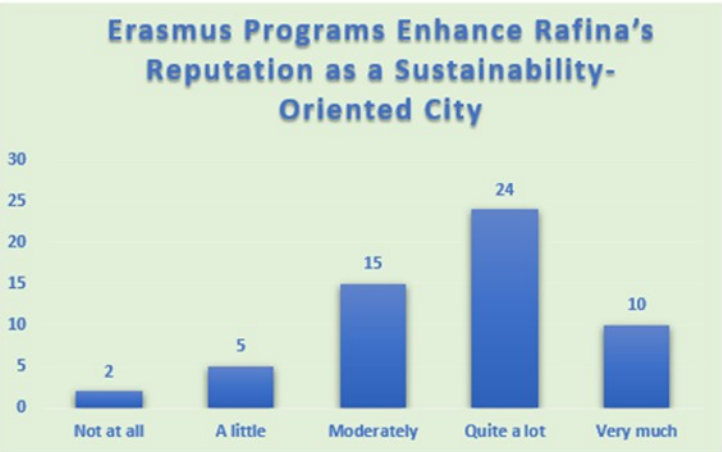

Figure 13: Distribution of responses among the 56 students who reported personal participation in a European program, regarding the statement "I believe that Erasmus Erasmus programs make Rafina more well-known as a city that cares about sustainability." The results highlight students' perceptions of the external visibility and local impact of European initiatives.

As part of the open-ended responses, several students shared personal reflections on how their participation in European programs influenced their environmental awareness and sense of responsibility. One student expressed the following:

"What I appreciated most about my participation was the feeling of belonging to a group of students who were genuinely trying to address important environmental issues in each city. Through this experience, we learned meaningful ways to respond to environmental challenges, such as climate change. I believe that the school also benefited positively, as our actions encouraged greater awareness and efforts to reduce environmental problems in our community."

This testimonial illustrates how European programs can foster a deeper sense of collective purpose, strengthen students' environmental literacy, and enhance the school's contribution to promoting sustainable values.

5.7 Students' Vision for a "Smart" and Sustainable City

As part of the questionnaire, students were invited to reflect on what constitutes a "smart" and environmentally sustainable city and to evaluate the future prospects of Rafina through this lens. Their responses offer valuable insight into how young citizens perceive the role of technology, green infrastructure, and community participation in shaping urban development. This section examines students' views on the current level of "smartness" in Rafina, their expectations for digital and environmental improvements, and their ideas for building a city that is modern, inclusive, and ecologically responsible. These perspectives contribute to understanding how future generations imagine the evolution of Rafina and highlight the importance of integrating youth-driven proposals into municipal planning.

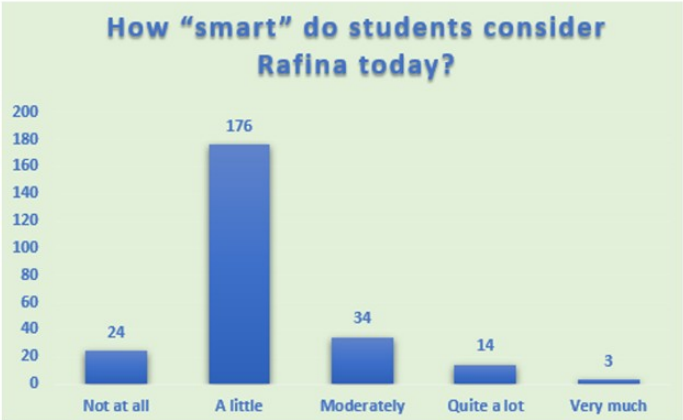

Figure 14: This figure illustrates the distribution of students' responses to the question "How smart do you consider Rafina today?". The results show that the majority selected "A little" (176 students), indicating that most perceive Rafina as having limited smart-city characteristics. Only a small proportion rated the city as "Quite a lot" or "Very much", suggesting substantial room for technological and sustainable urban development.

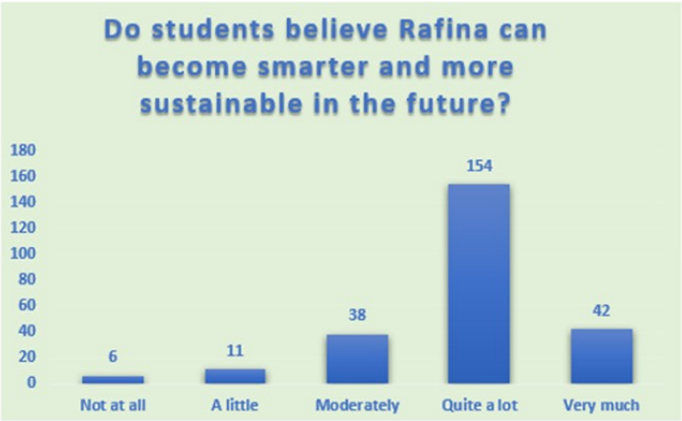

Figure 15: This figure presents students' responses to the question "Do you believe Rafina can become smarter and more sustainable in the future?". The majority expressed strong optimism, with 154 students selecting "Quite a lot" and 42 selecting "Very much." Only a small number of students chose lower agreement levels, indicating that most young residents view substantial potential for future development through technology, green innovation, and collaborative local action

Beyond evaluating their current city, students were invited to imagine Rafina in the year 2035 and propose specific solutions that would make it smarter, greener, and more sustainable. Their responses—drawn from both open-ended questions and multiple-choice items—provide a forward-looking perspective and reveal a clear willingness to engage in shaping the city's future.

Across the dataset, several recurring priorities emerged. Students emphasized the need for smart waste-management technologies (such as smart bins with sensors), expanded bike lanes, and green mobility options. Strengthening coastal protection measures and preserving beach ecosystems were also highlighted frequently, reflecting their awareness of local environmental vulnerabilities. Many students proposed digital solutions, including real-time information systems, smart lighting, and digital signage for public spaces. Additional priorities included the creation of green corridors, more trees, pocket parks, and the enhancement of public transport to reduce traffic and emissions.

Overall, students envision a future Rafina that remains beautiful and familiar, yet also significantly improved through thoughtful environmental planning and smart innovation. Their proposals reflect optimism, creativity, and a strong belief that the city can evolve into a model of sustainable coastal living—provided that technology, environmental care, and community collaboration move hand in hand.

6. DISCUSSION

The findings of this study demonstrate that students hold a clear, consistent, and multidimensional understanding of Rafina's physiognomy, sustainability challenges, and future prospects. Their responses—both qualitative and quantitative—showcase how young residents interpret the city's identity, evaluate its environmental pressures, engage with civic and school-based initiatives, and imagine a "smart" Rafina in the years ahead. The discussion below synthesizes these insights, structured according to the major thematic clusters reflected in the results.

6.1 Students' Perceptions of Rafina's Physiognomy

The sensory and symbolic associations provided by students reveal a cohesive and vivid image of Rafina. The predominance of blue and light blue tones, the recurrent reference to the sound of waves and ship engines, and the characteristic smell of the sea all underline the

strong emotional and spatial connection students have with the coastal environment. At the same time, natural references such as pine trees, tamarisks, and Mediterranean vegetation highlight the significance of the surrounding forests and green areas.

Cultural identity also emerges strongly in this cluster. Many students refer to monuments linked to the Asia Minor refugee heritage, traditional celebrations, and symbolic public spaces. These findings indicate that younger residents perceive Rafina not only through its natural landscape but also through its cultural memory and everyday social life. Their "one-sentence descriptions" of the city—frequently "beautiful," "peaceful," "small," and "coastal"—confirm a well-formed and balanced perception of Rafina's character.

6.2 Awareness of Environmental Concerns

Students show a high level of environmental awareness, demonstrated by their prioritization of issues such as pollution, port-related pressures, and the degradation of the Megalo Rema stream. These results reflect their sensitivity toward both visible, everyday environmental problems and broader ecological risks affecting the city.

The emphasis on pollution (waste, noise, emissions) suggests that students experience these pressures directly in their daily lives, while concerns about the stream, forest loss, and wildfire risk indicate a deeper understanding of ecological systems and vulnerabilities. Less frequently mentioned issues—such as flooding and coastal erosion—show that students tend to prioritize immediate environmental conditions over long-term or seasonal threats. Overall, this cluster illustrates a youth population with strong observational awareness and critical engagement with environmental quality.

6.3 Civic Engagement and School-Based Participation

The analysis of civic engagement reveals that students are willing to participate in environmental and community-oriented actions, particularly when these are facilitated or encouraged by the school. Many students have taken part in activities such as tree planting, beach clean-ups, or environmental projects, demonstrating that experiential learning plays a key role in shaping attitudes and behaviors.

Furthermore, the belief that school initiatives can influence the community—and that student ideas can meaningfully contribute to local improvement—highlights an emerging sense of agency. Students express interest in stronger cooperation between schools and municipal structures, even if they do not yet feel fully empowered to impact decision-making. This suggests that environmental education and participatory school programmes can serve as foundational mechanisms for developing active citizenship

6.4 The Impact of European and School Programs on Students' Environmental Attitudes

The students' perceptions of Erasmus+, the Blue Schools Network, and climate-related projects indicate that these programmes significantly shape environmental knowledge, motivation, and personal responsibility. Many students report that participation enhances their awareness of climate change, strengthens environmentally friendly habits, and fosters a sense of belonging to a group working toward meaningful goals.

The qualitative testimonials further illustrate this impact. Students describe these experiences as opportunities to learn practical solutions, collaborate with peers from different contexts, and cultivate a deeper commitment to sustainability. In this sense, the school functions not only as a learning environment but also as a platform for developing environmental citizenship, where international cooperation broadens perspectives and reinforces positive ecological behaviors.

6.5 Students' Vision for a Smart and Sustainable Rafina

In their future-oriented reflections, students articulate a clear, hopeful, and realistic vision for Rafina in 2035. The most frequent proposals—smart waste bins, expanded bike lanes, digital information systems, smart lighting, and enhanced public transportation—indicate that students understand smart-city solutions both technologically and environmentally.

Equally important is the emphasis on nature-based approaches, such as coastal protection, preservation of beach ecosystems, creation of green corridors, and planting more trees. This dual focus suggests that students view "smartness" not merely as digital innovation but as the integration of technology with ecological care and sustainable mobility.

Their responses demonstrate optimism and creativity, but also a grounded awareness of the city's needs. The consistency of their proposals across open-ended and multiple-choice items confirms that young people hold well-developed ideas about the directions in which Rafina should evolve—ideas that could contribute meaningfully to long-term planning if incorporated into participatory processes.

Overall, the students' views reveal an integrated understanding of identity, environmental responsibility, and technological potential, highlighting the role of young people as co-creators of sustainable urban futures.

7. CONCLUSIONS

This study examined how students of the 1st Gymnasio of Rafina perceive the physiognomy, environmental challenges, and future prospects of their city. The findings reveal a youth population with strong place-based awareness, ecological sensitivity, and a clear understanding of both the city's strengths and its vulnerabilities. Through their responses, students demonstrate a comprehensive appreciation of Rafina's natural and cultural landscape, as well as a genuine interest in contributing to its sustainable development.

First, students show that they hold a well-formed and multidimensional understanding of Rafina's identity. Their sensory descriptions, symbolic references, and cultural associations reflect a deep connection to the coastal environment, pine forests, and the historical legacy of the city. These perceptions highlight the coexistence of natural beauty, cultural memory, and everyday social life as defining elements of the city's character.

Second, the study indicates that environmental awareness among students is consistently high. Pollution, pressures related to port activity, degradation of the Megalo Rema stream, and wildfire risk emerge as the most urgent environmental issues. Students' ability to identify these challenges demonstrates a keen observational understanding of ecological conditions and a sensitivity to both immediate and long-term threats facing their community.

Third, students recognise the important role of the school as an agent of environmental education, civic engagement, and sustainability. Participation in Erasmus+, Blue Schools, and climate-related programmes enhances their knowledge of environmental issues, shapes positive habits, and increases their sense of responsibility toward their city. The school functions as a key catalyst in fostering environmental citizenship and encouraging young people to take part in collective action.

Fourth, students express a strong willingness to engage in actions that improve their city. They believe that youth participation can influence positive change, especially when supported by school-based initiatives. Their future-oriented ideas illustrate not only creativity but also an understanding of the practical steps needed to make Rafina greener, smarter, and more resilient.

Finally, the students' vision for Rafina in 2035 demonstrates a coherent and hopeful outlook. Their proposals combine technological innovation with ecological care, indicating that they perceive smart-city development as a balanced integration of digital tools, sustainable mobility, green infrastructure, and environmental protection. This future-oriented thinking underscores the potential of young people to contribute meaningfully to participatory urban planning and long-term sustainability strategies.

Overall, the study concludes that students are not passive observers but active, informed, and engaged members of the community. Their perspectives offer valuable insights into the identity, challenges, and potential of Rafina, underscoring the importance of incorporating youth voices into environmental education, local decision-making processes, and sustainable urban development.

8. RECOMMENDATIONS

The students' responses highlight specific needs, priorities, and opportunities for strengthening sustainability education and promoting a more environmentally conscious future for Rafina. Based on these insights, the following recommendations aim to translate the students' perspectives into meaningful actions.

Creating Joint School–Community Initiatives

Students express a desire to participate in actions that benefit their city, especially when these activities are organised through school structures. Collaborative projects—such as shared clean-up efforts, tree-planting days, thematic workshops, or small-scale environmental campaigns—can provide young people with hands-on experience while supporting the local community. Involving students in the planning stages of such initiatives reinforces their sense of responsibility and encourages a more participatory culture.

Strengthening Urban Nature and Everyday Access to Green Spaces

Many students highlight the importance of forests, coastal zones, and natural vegetation in shaping Rafina's identity. Their comments suggest that protecting and expanding green areas should remain a priority. Establishing small green pockets, improving biodiversity in schoolyards, and promoting activities that bring students into closer contact with nature can support long-term ecological awareness. Approaches based on nature—such as restoring damaged areas or enhancing natural shading and greenery—can also contribute to a healthier urban environment.

Improving Mobility Through Environmentally Friendly Options

A recurring theme in students' suggestions is the need for safer, more sustainable ways to move around the city. Their interest in bike lanes and pedestrian-friendly streets shows that they view sustainable mobility as a core element of a better everyday life. Schools can support this mindset by integrating awareness activities on mobility choices, encouraging walking or cycling to school where feasible, and engaging students in discussions about how mobility affects the environment.

Using Digital Tools to Support Environmental Learning

Students associate "smart" elements with both environmental protection and practical daily improvements. Their suggestions—ranging from smart waste bins to digital information panels—indicate that technology can play a supportive role in sustainability education. Schools may consider incorporating digital sensors, environmental monitoring apps, or data-based student projects into classroom activities. These tools can help students understand environmental change in real time while simultaneously strengthening digital skills.

Expanding International and European Opportunities

Students clearly recognise that programmes like Erasmus+, Blue Schools, and climate-related projects broaden their understanding of environmental issues. Continuing and expanding involvement in such programmes can enrich students' experiences and expose them to different approaches to sustainability. Encouraging collaborative student projects, virtual exchanges, and thematic mobility experiences can further support their growth as environmentally active young citizens.

Encouraging Youth Voices in Planning and Decision-Making

Throughout the questionnaire, students demonstrate not only awareness of environmental challenges but also a desire to contribute ideas for improving their city. Creating structured opportunities—such as youth consultation groups, student panels, or idea-sharing platforms—would allow young people to express their views more systematically. Their perspectives, grounded in personal experience, can offer valuable input for shaping future initiatives that concern their daily life and the environment.

Cultivating Long-Term Environmental Awareness

The students' strong sense of concern for pollution, forests, and coastal areas highlights the importance of sustaining environmental education over time. Activities such as river monitoring, beach observation, or student-led environmental clubs can help maintain this awareness. Embedding long-term practices into the school culture supports continuity, helping students develop a lasting connection with their local environment and a deeper understanding of ecological stewardship.

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ENVIRONMENTAL LIVING CONDITIONS IN URBAN CENTERS AND THEIR IMPACTS ON HEALTH: CASE STUDY OF THE ATTICA REGION

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Abstract
This study examines how urban environmental conditions shape health in the Attica Region, with emphasis on the highly urbanized Central Sector of Athens compared with other regional units. The contribution clarifies pathways linking air and noise pollution, traffic congestion, limited green space, and barriers to physical activity with risks for cardio-respiratory and mental health, and translates evidence into actionable guidance for regional and municipal decision makers. A cross-sectional, online survey (April–June 2022) captured 1,881 residents' responses across the seven units of Attica using a structured 29-item instrument on demographics, neighborhood density, mobility, access to green and recreational spaces, noise and air quality perceptions, water quality concerns, social cohesion, safety, extreme weather impacts, work conditions, and access to public health services. Comparative analyses by unit, urbanization level (population density), age, and sex were conducted.

Findings indicate that residents of the Central Sector reported more frequent traffic congestion, higher exposure to environmental noise, and greater perceived air pollution, alongside lower access to green space, cycling infrastructure, and opportunities for everyday physical activity, compared with less dense units. Car dependence and commuting difficulties co-occurred with noise and pollution complaints. A substantial subset across units reported recent disruptions from extreme weather. When asked about solutions, respondents prioritized expanding and maintaining green spaces, building continuous cycling networks, improving and making public transport more accessible, strengthening waste management, implementing noise-abatement measures, enhancing public safety, and increasing equitable access to low-cost recreational and health services. Overall, higher urbanization intensity was associated with more adverse environmental exposures. Implementing residents' preferred interventions could plausibly reduce preventable cardio-respiratory and stress-related morbidity while supporting healthier behaviors and, indirectly, moderating public pharmaceutical expenditure.

Keywords: Urbanization; Environmental health; Attica Region; Air pollution; Noise; Physical activity; Public health policy

SUSTAINABLE DEVELOPMENT CONDITIONS IN THE MUNICIPALITY OF MOSCHATO-TAVROS, ATTICA, GREECE: SWOT ANALYSIS OF GEOGRAPHICAL, ENVIRONMENTAL, ECONOMIC, SOCIAL AND CULTURAL DIMENTIONS

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Abstract
This paper examines the conditions for sustainable development in the Municipality of Moschato–Tavros, an urban coastal district located between the metropolitan poles of Athens and Piraeus. Positioned within the South Athens Regional Unit, the municipality represents a densely built and socio-economically diverse urban area shaped by industrial legacies, limited green space, strategic transportation links, and emerging redevelopment initiatives. The aim of this paper is to examine the key conditions that shape sustainable development prospects in Moschato–Tavros and to identify strengths, weaknesses, opportunities and threats across geographical, environmental, economic, social and cultural dimensions.

The study is based on secondary data analysis and official public sources, including national statistical databases, municipal planning documents and academic literature. The methodological framework follows the SWOT approach to investigate internal characteristics and external contextual factors influencing sustainable development trajectories and prospects. The study examines key aspects such as built environment and land use, green infrastructure and public space provision, transport and mobility networks, demographic and economic profile, cultural assets and social dynamics.

Preliminary findings indicate that Moschato–Tavros benefits from strategic spatial positioning, strong transport interconnectivity, mixed-use urban structure supportive of sustainable mobility, and active cultural institutions. However, environmental constraints, including high urban density, limited green infrastructure, traffic-related air and noise pollution, and vulnerability to climate-related pressures, pose substantive challenges. The findings indicate the importance of implementing targeted interventions, including further expansion of green infrastructure, stricter noise-control and air-quality management, and promotion of circular-economy practices such as recycling, waste-separation and resource recovery - supported by structured environmental education initiatives aimed at residents and local businesses.

Keywords: Sustainable development; Urban sustainability; Moschato–Tavros

INTRODUCTION

Sustainable development has emerged as a central objective of urban policy. At the municipal level, sustainable development is shaped not only by local characteristics but also by wider regional dynamics, including transport networks, demographic trends, and governance frameworks. Urban municipalities located within dense metropolitan cores face specific challenges, as opportunities for spatial expansion are limited and development strategies must focus on the efficient management, adaptation, and upgrading of the existing urban fabric.

The Municipality of Moschato–Tavros constitutes a representative case of such an urban context. Situated between the metropolitan poles of Athens and Piraeus within the South Athens Regional Unit, the municipality combines high population density, mixed land uses, strategic transport accessibility, and proximity to coastal and industrial zones. Its historical development has been influenced by industrial activity and infrastructure corridors resulting in a compact built environment with limited green space and persistent environmental pressures. At the same time, Moschato–Tavros exhibits socio-economic diversity, an active local economy, and established cultural institutions that contribute to social cohesion and urban vitality.

The aim of this paper is **to examine the key conditions shaping sustainable development prospects in the Municipality of Moschato–Tavros and to identify strengths, weaknesses, opportunities, and threats across geographical, environmental, economic, social, and cultural dimensions**. To achieve this aim, the study adopts a SWOT analysis framework, allowing for the systematic assessment of internal municipal characteristics alongside external contextual factors influencing sustainability trajectories. The analysis is based on secondary data derived from official statistical sources, municipal documents, and relevant academic literature.

The paper is structured as follows. Chapter 1 presents the geographical and spatial characteristics of the municipality, followed by an environmental assessment in Chapter 2. Chapter 3 examines the local economic profile, while Chapter 4 focuses on demographic and social conditions. Chapter 5 explores cultural infrastructure and activities as components of social sustainability. Finally, Chapter 6 synthesises the findings through a SWOT analysis, highlighting key leverage points and constraints for sustainable development in Moschato–Tavros.

1.1 Geographical and Spatial Overview of the Municipality

The Municipality of Moschato–Tavros is located in the southern sector of the Athens metropolitan area, within the South Athens regional unit of the Attica Region. It occupies a strategic position between the central city of Athens and the port city of Piraeus. This location places the municipality at the nexus of residential, commercial, industrial and transport-oriented land uses (CityPopulation, 2025; EMDTA, 2022).

According to the 2021 Census of the Hellenic Statistical Authority (ELSTAT), the municipality recorded a resident population of 39,658 inhabitants within an area of approximately 5.24 km², corresponding to a high density of roughly ~7,560 inhabitants per km². These figures underscore the intense settlement and limited physical space typical of inner-metropolitan suburbs (CityPopulation, 2025; EMDTA, 2022). The topography of the area is largely flat and low-lying, which has facilitated dense urban development, but also imposes constraints on the expansion of open green areas and natural buffering zones (Wikipedia, 2025).

The land-use pattern within Moschato–Tavros is characterised by a compact mix of high-density residential zones, commercial strips, logistics and light industrial facilities, major roads and rail links, and coastal frontages. The juxtaposition of different land uses within close proximity reflects the historical development of the area and the limited availability of undeveloped land (Spanogianni, 2020). Moreover, the urban form is heavily influenced by major municipal units: the former municipalities of Moschato and Tavros were merged during the 2011 administrative reform, resulting in a contiguous built-up urban fabric with limited spatial differentiation (Wikidata, 2013).

From a sustainability perspective, the spatial layout of the municipality exerts both enabling and constraining influences. On the one hand, the compactness of urban form supports short travel distances, enhanced accessibility to public transit and pedestrian mobility, and efficient land use—all favourable attributes for sustainable urban development (Athens Social Atlas, 2020). Connectivity to major transport networks further strengthens the municipality's integration into the wider metropolitan system, enhancing mobility options and access to regional resources (AthensSocialAtlas, 2020). On the other hand, the dense built-environment and the municipality's proximity to high-traffic transport corridors, port facilities, and industry bring elevated risks of air and noise pollution, traffic congestion, and heat-island effects (Myofa, 2020). The limited availability of large open green spaces restricts ecological services such as storm-water infiltration, micro-climate moderation, habitat connectivity and urban biodiversity (Spanogianni, 2020). Ensuring that the compact urban morphology remains a strength rather than a vulnerability therefore requires integrated planning, investment in green infrastructure, and targeted interventions in mobility and land-use management.

In summary, Moschato–Tavros presents a typical inner-urban municipality profile: high density, mixed land uses, excellent connectivity, yet constrained by limited physical space and exposed to various environmental pressures. Understanding this spatial context is essential for designing and implementing sustainability strategies tailored to the municipality's specific strengths and weaknesses.

1.2 Environmental Profile of the Municipality

The environmental profile of the Municipality of Moschato–Tavros reflects the typical pressures of inner-urban municipalities within the Attica basin: **constrained green space** and **high built-up density**, **transport-related pollutant loads**, **dependence on regional waste treatment schemes**, and **infrastructure vulnerabilities related to urban heat.** The sections below summarise the main environmental domains.

Air quality

Air quality in Moschato–Tavros is primarily influenced by traffic emissions, port-related activity in nearby Piraeus, and local industrial/logistics sources. Although the municipality does not host its own continuous monitoring station, national monitoring and mapping indicate that southern sectors of the Attica basin—where Moschato–Tavros lies—regularly record elevated concentrations of nitrogen dioxide (NO_2) and particulate matter (PM2.5/PM10), particularly along major arteries and near port corridors (ΥΠΕΝ, 2025; AQICN, 2025). The Greek Ministry of Environment (ΥΠΕΝ) maintains the National Network of Air Quality Monitoring and produces annual reports and spatial pollution maps that identify urban hotspots and attribute them largely to road transport and maritime activity (ΥΠΕΝ, 2025). Local exposure to traffic-related pollutants and episodic exceedances of EU/WHO guideline values constitute an ongoing public-health concern at the municipal scale.

Green areas and urban greening

Historically, Moschato–Tavros has had limited large green spaces due to dense development; however, municipal regeneration efforts in recent years have increased public green provision. The municipality documents several key projects and existing parks (e.g., Park of the Armed Forces, the Traffic Education Park) and highlights the development of the flagship "Αέναον" park on the coastal zone as a major recent investment (Δήμος Μοσχάτου-Ταύρου, 2024). While these interventions improve accessibility to green space and local recreation, official sources and spatial analyses indicate that total per-capita green area remains constrained

relative to WHO recommendations, and green space is often fragmented rather than forming large contiguous ecological corridors (Δήμος Μοσχάτου-Ταύρου, 2024; Spanogianni, 2020).

Waste management and recycling
Waste management in Moschato–Tavros operates within the wider Attica framework. Regional monitoring and coordination mechanisms (ΕΔΣΝΑ / RecycleAttica) aim to expand separate collection (including bio-waste) and improve recovery, yet regional recycling performance has historically lagged behind EU targets (RecycleAttica; ΕΔΣΝΑ). At the municipal level, recent local actions include deployment of underground bins, installation of brown bins for bio-waste, and procurement of new general and recycling containers to improve service coverage (Δήμος Μοσχάτου-Ταύρου, 2022; MyMoschato, 2025). Despite ongoing municipal initiatives to expand waste-sorting infrastructure, practical challenges remain evident in terms of public participation and correct separation of materials. Observational evidence within the municipality indicates that residents frequently dispose of mixed waste in bins designated for specific streams (e.g., blue recycling bins or brown bio-waste bins), suggesting **limited awareness and understanding of proper sorting practices.** This behavioural gap undermines the effectiveness of the circular-economy framework and highlights a need for strengthened public education, community engagement, and monitoring mechanisms to ensure proper waste-management practices at the household level.

Noise pollution
Noise levels in the Attica metropolitan area frequently exceed EU-recommended thresholds in high-traffic corridors and near ports or industrial zones. Strategic noise mapping undertaken under EU directives has identified extensive urban population exposure to elevated day- and night-time noise, while academic assessments highlight the problem along major arterials and ring roads (ΥΠΕΝ, 2022; Vogiatzis et al., 2014). Moschato–Tavros, given its proximity to Pireos Street, logistics areas and rail links, is prone to elevated ambient noise; however, the municipality lacks a network of local noise monitoring points and formal, municipality-specific data.

Urban heat island (UHI) effects
The dense built fabric and limited green cover predispose Moschato–Tavros to urban heat-island effects, consistent with empirical findings for the wider Athens basin, where both surface and atmospheric UHIs have been extensively documented (Cartalis & Polydoros, 2013; Zoulia, Santamouris, & Dimoudi, 2008). Satellite and in-situ studies for Athens show marked daytime and night-time temperature differentials between heavily built zones and peri-urban/green areas, which amplify heat stress, increase cooling demand and interact with air-quality problems (Gardner et al., 2003; Τσακίρης et al., 2010). At the municipal level, the scarcity of large green areas and expanses of heat-retaining surfaces (roads, roofs) elevate vulnerability to heat waves and related public-health risks.

Municipal environmental initiatives and recent actions
Moschato–Tavros has undertaken several local initiatives aimed at improving environmental outcomes and resident welfare. Key municipal actions documented publicly include: (a) urban greening and park development, most notably the Αέναον coastal park project and other playground/park refurbishments and (b) modernization of waste containers and selective collection infrastructure (installation of underground bins and distribution of new recycling and organic waste containers). These local measures are complemented by participation in

regional programmes such as RecycleAttica (ΕΔΣΝΑ) for separate collection and by cooperation with EYDAP for water-related communications. While these initiatives mark positive municipal leadership, their effectiveness depends on scale (coverage of collection points), behavioural uptake by residents, and alignment with regional infrastructure (e.g., functioning waste-recovery units and treatment capacity).

Short assessment (implications for sustainability)

Overall, Moschato–Tavros evidences a mixed environmental profile: strengths include active municipal investments in parks and incremental upgrades to waste-collection infrastructure; weaknesses are the legacy effects of dense urban morphology—limited contiguous green space, exposure to traffic-related pollution and noise, and limited awareness and understanding of proper sorting practices. To advance municipal sustainability, policy priorities should include expanding accessible green infrastructure, enhancing local noise and air monitoring networks, accelerating separate collection and local composting pilots, and addressing behavioural challenges, as observational evidence indicates that residents frequently dispose of mixed waste streams in inappropriate bins despite the availability of differentiated collection infrastructure, highlighting the need for targeted education campaigns and community engagement to improve source separation and overall resource recovery.

1.3 Economic Profile of the Municipality

The economic structure of the Municipality of Moschato–Tavros reflects its strategic urban position within the metropolitan core of Attica, characterised by a predominance of service-sector activities, commerce, and small- to medium-sized enterprises, alongside residual industrial and logistics functions linked to its proximity to major transport corridors and the port of Piraeus. Although detailed, disaggregated employment figures at the municipal scale are limited, national labour-force data indicate that services constitute the dominant employment sector in Greece, followed by commerce and industry (Hellenic Statistical Authority [ELSTAT], 2024). Within this context, Moschato–Tavros hosts a diverse array of economic units, including retail establishments, food-chain supermarkets, small manufacturing workshops, and logistics firms, which collectively contribute to local employment and economic activity. The municipality's location along primary arterial routes and near port-related networks enhances commercial flows and supports the presence of transport- and trade-oriented enterprises.

Like many municipalities in the Attica region, Moschato–Tavros exhibits a dual economic structure, combining a long-standing base of small, family-owned businesses—particularly in retail trade, services, and household-scale workshops—with an emerging presence of medium- and large-scale corporate entities. In recent years, the municipality has increasingly attracted company headquarters and leased office space to metropolitan-scale enterprises, supported by its strategic location between Athens and Piraeus and strong transport connectivity. These new office buildings tend to adopt sustainability-oriented design features, frequently securing recognised environmental certifications (e.g., LEED) and high energy-performance classifications, reflecting a shift toward greener commercial infrastructure (e.g., a project by the Hellenic Properties development near Kallithea station). These dynamics signal a diversification from traditional commerce toward a more complex urban economic ecosystem, in which legacy businesses coexist with expanding corporate services, logistics functions, and sustainability-oriented investment. This transformation not only influences employment and municipal revenue but also affects land-use patterns, energy consumption, and environmental performance.

Economic activity in Moschato–Tavros influences municipality's environmental performance. The logistics-related activities contribute to increased vehicular circulation, freight movements, and associated emissions of air pollutants and noise, which can adversely affect local air quality and noise pollution levels. Light industrial workshops and storage facilities further create localised environmental pressures, including waste generation and potential water-runoff contamination, although heavy industrial uses are limited compared to neighbouring municipalities in the southern Athens–Piraeus zone. At the same time, the predominance of service-oriented economic functions offers opportunities for a lower-emission urban economy, particularly when supported by digital work models and sustainable working spaces. The municipality's economic profile therefore presents a dual dynamic: while logistical and commercial activities intensify pressure on urban environmental systems, the continuing transition towards service-based employment and municipal greening initiatives can facilitate improved urban environmental outcomes and align local development with broader regional sustainability objectives.

In summary, the economic profile of Moschato–Tavros combines traditional commerce, logistics activity, and an expanding service sector. This structure generates both challenges and opportunities for sustainable development: logistics operations increase traffic, emissions, and noise, while the growth of service-based employment and modern office uses can support lower-carbon economic activity. Policy priorities may therefore include stricter monitoring of industrial emissions and freight-related noise, restrictions on heavy-vehicle access near residential and school zones, and incentives for energy-efficient commercial buildings and certified "green" office developments. Such measures can help balance economic activity with improved environmental performance and quality of life for residents.

1.4 Social Profile of the Municipality

The Municipality of Moschato–Tavros is characterised by a compact, densely populated urban environment with sociological dynamics typical of inner-metropolitan suburbs. According to the 2021 Population-Housing Census data compiled by the Hellenic Statistical Authority (ELSTAT), the resident population of Moschato–Tavros is approximately 39,507, with a density of around 7,539 inhabitants per km². (Απογραφή Πληθυσμού 2021). The municipality exhibits a slight population decline in recent years, a balanced gender distribution, and a diverse age structure shaped by working-age residents and a significant proportion of older adults. Detailed demographic indicators for the Municipality of Moschato–Tavros are presented in Appendix A.

Regarding gender distribution, the population is relatively balanced, with men representing 53.03% and women 47.97% of residents (Απογραφή Πληθυσμού 2021). The age structure reveals a predominance of middle-aged and older cohorts. The largest age group corresponds to residents aged 45-59 years (8,428 individuals), followed by the 60-79 age group (6,848 individuals). Younger cohorts are comparatively smaller, including 0-14-year-olds (5,803 individuals) and 15-24-year-olds (4,124 individuals), reflecting broader national demographic challenges related to low birth rates and population ageing (Απογραφή Πληθυσμού 2011; Απογραφή Πληθυσμού 2021).

Educational attainment data highlight a diverse profile. The majority of residents have completed secondary education (42.20%), followed by tertiary education graduates (24.71%) and primary education graduates (17.67%). A smaller portion of the population (15.42%) falls into other categories, including individuals who did not complete formal schooling but possess basic literacy skills (Απογραφή Πληθυσμού 2011).

Demographic indicators reflect structural trends characteristic of mature urban municipalities. The dependency ratio stands at approximately 44%, while the replacement ratio is around 81%, underscoring demographic ageing and the need for supportive social and community services (Απογραφή Πληθυσμού 2011). These dynamics reinforce the municipality's imperative to implement policies that enhance social inclusion, support active ageing, and sustain population vitality.

1.5 Cultural Profile of the Municipality

The cultural domain constitutes an integral component of urban sustainability, shaping how communities interact with their environment. Culture influences patterns of consumption, modes of production, social values, and collective identity — all of which determine the long-term resilience of urban areas (UNESCO, 2016).

The Municipality of Moschato–Tavros maintains an active cultural framework that contributes to the social cohesion and identity of the local community. Cultural activities are organized under the supervision of the municipal Department of Culture and include recurring events that have become institutionalized over time. The most notable are the **Moschato–Tavros Carnival**, consisting of two major parades—a night parade in Tavros and a daytime parade in Moschato—both of which engage schools, cultural associations, and local organizations (Δήμος Μοσχάτου–Ταύρου, n.d.-a). Another significant annual event is the **"Tavreia – Cultural September"** festival, which includes concerts, theatrical performances, and art exhibitions held in public spaces, promoting accessibility to cultural expression (Δήμος Μοσχάτου–Ταύρου, 2025a).

The municipality also supports permanent cultural structures, such as the **Municipal Conservatory**, which provides music education, choir participation, and orchestral activities, as well as **municipal art workshops and libraries** that facilitate lifelong learning and artistic engagement (Δήμος Μοσχάτου–Ταύρου, n.d.-b). In 2025, the municipality published the first volume of the **Local History Book of Moschato–Tavros**, aiming to document the area's historical and social development and preserve local memory (Δήμος Μοσχάτου–Ταύρου, 2025b).

From a sustainable development perspective, these cultural initiatives contribute to the social and cultural dimensions of urban sustainability. Cultural events foster community participation and social inclusion. The preservation of local heritage and the promotion of cultural activities enhance the attractiveness of the municipality as livable space.

2. SWOT ANALYSIS

2.1 Strengths

Moschato–Tavros exhibits a series of strengths that create favorable **internal conditions** for sustainable urban development. The municipality's strategic location between the metropolitan centres of Athens and Piraeus is a core **structural spatial asset**, offering high regional accessibility through major transport corridors such as Pireos Street, the Kifissos interchange and the public transport network (Metro Line 1, suburban railway, extensive bus routes). This spatial configuration not only facilitates sustainable mobility and reduces reliance on private vehicles, but also **enhances local economic activity**, as proximity to the port, logistics nodes and employment centres improves the municipality's integration into wider production and service networks. Empirical evidence from metropolitan planning authorities shows that areas situated along primary transport corridors within the Athens–Piraeus axis exhibit higher business concentration and stronger commercial dynamics,

reflecting the economic benefits of agglomeration and spatial accessibility (ΥΠΕΝ, 2021; ΕΛΣΤΑΤ, 2021). The strategic positioning of Moschato–Tavros therefore supports **labour-market connectivity** by facilitating access to employment opportunities for residents, while simultaneously attracting commercial and logistics-related enterprises. In addition, Moschato–Tavros maintains a functionally diverse local economy, integrating services, commerce and logistics-related activities (ΕΛΣΤΑΤ, 2021). These dynamics contribute to economic resilience, support local employment and reinforce the municipality's role within the broader metropolitan system.

From an environmental perspective, the municipality benefits from its **coastal interface with the Faleron Bay**, which provides microclimatic moderation compared to fully landlocked inner-urban areas. While direct environmental control remains limited, the presence of the coastal zone constitutes an existing environmental asset embedded within the municipal territory.

The presence of municipal institutionalised cultural activities—such as the Moschato–Tavros Carnival and the Tavreia Cultural September festival as well as cultural institutions such as the Conservatory, contributes to social engagement and increases the municipality's attractiveness as a place to live and overall quality of life. (Δήμος Μοσχάτου–Ταύρου, n.d.-b).

In summary, Moschato–Tavros' strengths derive primarily from **existing spatial accessibility, functional economic diversity, coastal conditions, and established cultural infrastructure**. These internal characteristics define the municipality's current development capacity within a mature and densely built metropolitan environment.

2.2 *Weaknesses*

Despite its structural assets, the Municipality of Moschato–Tavros exhibits a set of internal weaknesses that constrain its sustainability performance and limit the effectiveness of local policy interventions. These weaknesses arise primarily from its dense urban form, legacy land uses, and established patterns of everyday activity, rather than from short-term planning deficiencies.

High density and congestion. A central structural weakness concerns the municipality's fully built-up urban fabric, which affords little flexibility for spatial reconfiguration. High building density, limited available plots, and fragmented ownership patterns restrict opportunities for large-scale green infrastructure, new public spaces, or comprehensive urban redesign. Consequently, sustainability interventions are often limited to small-scale or incremental projects, diminishing their cumulative impact on environmental and social conditions (ΥΠΕΝ, 2021).

Limited green space. Moschato–Tavros continues to face significant deficits in accessible and continuous green space. Although recent municipal initiatives have increased the number of parks and upgraded public spaces, per-capita green area remains substantially below international recommendations, and green elements are spatially fragmented rather than forming coherent ecological networks (WHO, 2016; Δήμος Μοσχάτου–Ταύρου, n.d.-a). This structural limitation reduces natural cooling capacity, exacerbates urban heat island effects, and constrains ecosystem service provision within the municipal territory.

Legacy economic structure. The municipality's historical economic composition continues to generate localized environmental pressures. Light industrial activities, storage facilities, and logistics-related uses contribute to increased freight movements, noise disturbance, and waste generation. While these activities provide employment opportunities, their coexistence within a compact residential environment produces enduring tensions between economic function and environmental quality (ΕΛΣΤΑΤ, 2021).

Ageing building stock. The municipality's older housing and commercial buildings require ongoing maintenance and retrofitting to meet contemporary energy efficiency and safety standards. The prevalence of ageing infrastructure limits opportunities for sustainable urban renovation and can exacerbate environmental inefficiencies.

Limitations in public participation. From an institutional and behavioural perspective, the effectiveness of existing municipal infrastructure is constrained by citizen practices and governance capacity. Observational evidence suggests deficiencies in waste separation behaviour, with frequent misuse of recycling and bio-waste bins, undermining the performance of municipal waste-management systems. This gap reflects limited public awareness, inconsistent enforcement, and constraints in monitoring capacity, rather than a lack of physical infrastructure (Δήμος Μοσχάτου–Ταύρου, n.d.-b).

In summary, the principal weaknesses of Moschato–Tavros derive from its dense and inflexible urban structure, limited green space, ageing buildings, legacy economic activities, and behavioural constraints. These internal limitations reduce the municipality's capacity to enhance sustainability outcomes rapidly, even when policy intent and basic infrastructure are in place.

2.3 Opportunities

The development opportunities of Moschato–Tavros are shaped by its character as a fully urbanised municipality with no remaining land reserves and limited potential for spatial expansion. As a result, opportunities for sustainable development are not associated with greenfield development, but rather with the **adaptive reuse, upgrading, and functional repositioning of the existing urban fabric**. Former industrial and logistics areas, underutilised plots located along the Piraeus axis, and ageing building stock constitute a tangible opportunity for regeneration through conversion to mixed-use, service-oriented, or energy-efficient uses. Such processes are typical of dense inner-metropolitan suburbs and can contribute to economic renewal while limiting additional land consumption and urban sprawl.

A further opportunity arises from the municipality's functional proximity to the metropolitan centres of Athens and Piraeus, **contingent upon strategic municipal planning and targeted investment to leverage its location effectively**. Positioned between major employment centres, port-related activities, office clusters, and cultural infrastructure, Moschato–Tavros is well placed to operate as an intermediate urban space within the Athens–Piraeus metropolitan system. In this context, opportunities are not linked to quantitative growth, but to functional intermediation, including the accommodation of office back-up functions, service providers, and complementary activities that benefit from accessibility without requiring a central-location premium. This compression effect between two metropolitan poles is an observable and realistic dynamic in inner urban municipalities.

The **compact and dense urban structure** of Moschato–Tavros also creates opportunities for low-cost, high-impact urban improvements. Short distances, extensive public transport coverage, and fine-grained urban blocks mean that relatively small-scale interventions—such as pedestrian-priority measures, neighbourhood public-space upgrades, and micro-greening initiatives—can generate disproportionately positive effects in terms of accessibility, environmental comfort, and everyday mobility. In such contexts, incremental physical interventions can significantly improve urban liveability without the need for large-scale restructuring.

Finally, opportunities emerge in the field of local governance and behavioural change, where infrastructure largely already exists, **provided that municipal authorities implement coordinated management strategies and engage residents effectively.** Improvements in

waste-sorting practices, public-space maintenance, and environmental awareness can substantially enhance sustainability performance at the municipal level. Strengthening coordination mechanisms, monitoring, and community engagement represents a realistic and measurable opportunity to improve environmental outcomes without major capital investment. In dense municipalities such as Moschato–Tavros, governance and behavioural leverage can play a decisive role in determining the success of sustainability-oriented policies.

2.4 Threats

Despite the presence of favourable internal characteristics and identifiable development opportunities, Moschato–Tavros is exposed to a series of external threats that may constrain the pursuit of sustainable urban development.

A major external threat to the sustainable development of Moschato–Tavros arises from **persistent metropolitan environmental pressures** associated with its location along the Athens–Piraeus corridor. High baseline levels of air pollution and noise are generated by intensive regional traffic flows along Pireos Street, the Kifissos interchange, and adjacent arterial routes. These pressures are further intensified by port-related transport and logistics activities connected to the wider metropolitan system. As the principal sources of emissions and noise originate beyond municipal boundaries, local authorities have limited capacity to mitigate their impacts effectively. Consequently, residents are exposed to chronic environmental externalities that fall largely outside municipal jurisdiction, constraining local sustainability outcomes (European Environment Agency, 2022; ΥΠΕΝ, 2021). Addressing these environmental pressures often requires coordinated action with regional and national authorities, reflecting the municipality's reliance on higher-level policy frameworks to manage externalities effectively.

Climate-related risks constitute an additional external threat that is **amplified by the municipality's dense urban form**. The combination of compact building patterns, extensive sealed surfaces, and limited green space increases vulnerability to urban heat-island effects, particularly during periods of extreme summer temperatures. Heatwaves pose heightened public-health risks, especially for elderly populations and other vulnerable groups. In the absence of large-scale green or blue infrastructure, climate pressures may increasingly exceed the adaptive capacity of the existing urban fabric, reinforcing long-term environmental and social vulnerability (European Commission, 2021).

Finally, Moschato–Tavros is affected by **socio-demographic trends driven by national-level dynamics**. Population ageing, low birth rates, and the potential contraction of the working-age population mirror broader demographic developments in Greece. These trends are associated with increasing demand for health, accessibility, and social-care services, while simultaneously placing pressure on municipal financial and administrative resources. Over time, such dynamics may weaken community-level resilience and complicate the implementation of sustainability-oriented policies, particularly in the absence of compensatory regional or national support (ΕΛΣΤΑΤ, 2021).

Overall, these threats highlight that the sustainability trajectory of Moschato–Tavros is shaped by external environmental, climatic, spatial, and demographic forces that extend beyond direct municipal control. **Effective management therefore requires sustained coordination across governance levels and realistic alignment of local planning strategies with wider metropolitan and national frameworks.**

2.5 SWOT SYNTHESIS

The SWOT analysis of Moschato–Tavros reveals a complex interplay between internal capacities and external pressures shaping the municipality's sustainable development potential. Internally, the municipality benefits from strategic spatial accessibility, a functionally diverse local economy, coastal microclimatic conditions, and established cultural infrastructure, which collectively provide a foundation for economic, environmental, and social initiatives. These strengths can be leveraged to capitalize on opportunities arising from urban regeneration, adaptive reuse of underutilised plots, micro-greening projects, and the expansion of sustainability-oriented service and office spaces.

Conversely, internal weaknesses—including dense urban fabric, limited green space, ageing buildings, legacy industrial and logistics activities, and behavioural-institutional constraints in waste management—pose persistent challenges that constrain the municipality's capacity to implement large-scale interventions. These vulnerabilities intersect with external threats, such as metropolitan-scale air and noise pollution, climate-related risks amplified by urban heat-island effects, and demographic pressures linked to population ageing and declining working-age cohorts. Together, these external forces underscore Moschato–Tavros' dependence on broader regional and national frameworks for environmental regulation, infrastructure investment, and social policy support.

Overall, the synthesis highlights a dual dynamic: while the municipality's internal assets offer tangible leverage points for sustainable development, enduring structural and behavioural limitations, compounded by external metropolitan and demographic pressures, necessitate carefully targeted policies, coordinated governance, and incremental interventions. Strategic planning that aligns internal capacities with external opportunities and mitigates threats will be essential to enhance the municipality's long-term urban sustainability outcomes.

CONCLUSION

The analysis of sustainable development conditions in the Municipality of Moschato–Tavros reveals a complex urban system characterised by both significant assets and persistent structural constraints. The municipality benefits from strong metropolitan accessibility, a functionally diverse and predominantly service-oriented local economy, and established cultural infrastructure that supports social participation and urban vitality. These internal strengths provide important leverage points for promoting sustainability within a dense and spatially constrained urban environment.

At the same time, the study highlights enduring weaknesses linked to the municipality's compact urban morphology, limited green infrastructure, ageing building stock, and legacy industrial and logistics activities. These internal challenges are further intensified by external pressures, including metropolitan-scale air and noise pollution, climate-related risks associated with urban heat, and demographic ageing. As a result, the sustainable development trajectory of Moschato–Tavros depends less on outward expansion and more on the qualitative upgrading of the existing urban fabric, behavioural change, and effective coordination across municipal and regional governance levels.

The SWOT synthesis underscores the importance of targeted, incremental interventions that align internal capacities with external opportunities, such as urban regeneration initiatives, micro-scale greening projects, adaptive reuse of underutilised spaces, and the promotion of environmentally sustainable service-sector activities. Equally important is the municipality's reliance on broader regional and national policy frameworks for environmental regulation, infrastructure investment, and social support mechanisms.

Overall, this study contributes to sustainable urban planning research by illustrating how local urban structures interact with metropolitan-scale pressures in mature urban environments. By applying SWOT analysis as a planning-support tool, the paper demonstrates its usefulness in identifying realistic pathways for evidence-based sustainability strategies at the municipal level, particularly in dense metropolitan contexts such as the Athens–Piraeus urban region.

Appendix A

Table A1. Demographic characteristics of the Municipality of Moschato–Tavros

Indicator	Value
Population (2021)	39,507 residents
Municipal Area	5.24 km²
Population Density	7,539 residents/km²
Population Growth Rate	−2.24%
Dependency Ratio	~44%
Replacement Ratio	~81%

(Sources: ELSTAT, Census 2021; ELSTAT, Census 2011)

Table A2. Gender Distribution

Category	Percentage
Male	53.03%
Female	47.97%

(Source: ELSTAT, Census 2021)

Table A3. Age Structure

Age Group	Population
0–14 years	5,803
15–24 years	4,124
25–34 years	6,546
35–44 years	6,688
45–59 years	8,428
60–79 years	6,848
80+ years	1,976

(Source: ELSTAT, Census 2011)

Table A4. Educational Attainment

Education Level	Percentage of Population
Primary Education	17.67%
Secondary Education	42.20%
Tertiary Education	24.71%
Other	15.42%

(Source: ELSTAT, Census 2011)

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SESSION

"Tackling socio-economic inequalities and in-work poverty"

Chaired by **Prof Papadakis Nikos** and
Lect Vlachadi Maria

LABOUR MARKET, SOCIO-ECONOMIC INEQUALITIES AND IN-WORK-POVERTY, IN MOMENTOUS TIMES: THE ROLE OF THE WELFARE STATE AND THE POLICY CHALLENGES FOR SOCIAL SUSTAINABILITY

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Abstract
The debate on sustainable development and its content, since the '70s, has gradually led to the creation of several different definitions, but the common element was (and remains) the effort to deepen both the environmental issues and the socio-economic ones. The issues raised in the UN relevant conference in Johannesburg include (among others): the link between green growth and the struggle against unemployment, inequalities and poverty. Undoubtedly, in our momentous times, the Labour Market is, globally, under transition and its turn affects substantially the Society at Large.

The paper deals with the key trends and transformations in the Labour Market, their impact on socio-economic inequalities, the association between precarious work and in-work-poverty and the rising challenges for the both the Welfare State and the Social Sustainability. Rapid transformations and trends such as intensification, are due on the one hand to the impact of the "permacrisis" (i.e. the 2008 Economic Crisis and Recession, the Pandemic, the ongoing Refugee-Migrant Crisis and the current energy- inflation crisis) on employment and labour market, and on the other hand due to Mega-Trends (i.e. new forms of globalization, lego- flexibility, digital transformation and gradual dominance of the digital economy, demographic and social changes, etc). These Mega-Trends seem to have a clear impact on the structure of economy and labour market, including work relations, forms of employment and contracts types and, consequently, on social welfare systems in Europe and subsequently on Social Sustainability. Both the permacrisis and the Mega-Trends, due to their impact on the labour market, seem to substantially affect the state-of-play regarding socio-economic inequalities, as well as the risk of poverty and social exclusion and consequently undermine the well-being and life chances of the socially vulnerable groups, such as unemployed, under-employed, NEETS, migrants etc.

Given the abovementioned, the paper, initially, provides an overview of the prevailing transformations and trends in the Labour Market (including the rising of the various forms of precarious work and its association with the social vulnerability), while addressing issues concerning job-polarization, labor market slack, as well as the impact of the aforementioned in socio-economic inequalities. Emphasis is laid, among others, in the association between

active employment policies and training policy, within the framework of the rising "lego-flexibility" in Economy and Markets (in Sennett's terms), while it attempts to cast the light on the association between the active employment policies and social policy. There is no doubt that, at the international level, the socio-economic context is becoming more complex, creating new challenges for tackling social vulnerability, which is clearly associated with the changing Labour Market and the multi-level impact of the above-mentioned trends and transformations. Thus, the paper further examines the role and the critical challenges for both the Welfare State & Social Policy, as well as Social Sustainability, which if of vital importance for safeguarding social justice and subsequently social inclusion & cohesion.

Key Words: Labour Market, Mega-Trends, Crises, Socio-economic Inequalities, Poverty, Social Vulnerability, Welfare State, Social Sustainability & Policy

NEW TRENDS-TYPES OF MIGRANTS TOWARDS SUSTAINABLE CITES

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Abstract
This specific study focuses on the evolution of the migration-refugee phenomenon in the light of the crisis that Europe has faced from 2020 to the present, with an emphasis on the situation in Greece. In particular, special categories of refugees and migrants were investigated, such as the case of unaccompanied minors, new forms and trends-types of migration such as environmental migrants and digital nomads. Regarding the methodology, the method followed included the critical analysis of international and Greek bibliography and articles and the utilization of all available information from studies by research organizations, EU statistics and reports by international organizations and publications in scientific journals. The survey conducted among Greek citizens aims to review their opinions and perceptions regarding the evolution of the phenomenon towards sustainable cities.

Key-words: Migration-Refugee Issue, Unaccompanied Minors, Environmental Migrants, Digital Nomads, Sustainable Cities

1. INTRODUCTION

Population movement is a timeless phenomenon, multidimensional and multilevel. In ancient times, people moved mainly for reasons of survival. They chose areas with a warmer climate, richer in food and more security against enemies. In today's era, in addition to the search for security due to increasing armed conflicts, there are other reasons for movement, such as the reunification of minors with their families and the assurance of better living conditions, the climate crisis and new flexible forms of work (Guillot, 2024). Our era is characterized by the transformation of the international system from unipolar to multipolar, as the omnipotence of the USA decreases and new other superpowers emerge. In this context, a systemic competition between them is observed to acquire more power (Waltz, 2011). As a result, we are experiencing a period of intense instability and conflict worldwide, where many people, adults and children, choose to flee to safer countries (Red Cross, 2019). At the same time, the climate crisis facing the planet demonstrates that in the near future an increasing number of people are expected to move as extreme weather events will affect their living conditions (European Commission, 2022:1). At the same time, the rapid development of technology is also bringing changes to traditional forms of work, creating a new category of migrants, digital nomads who constantly move from country to country, as they can work from anywhere, combining flexibility in work and their desire to travel (Aroles et al, 2020). These

new conditions create an additional challenge for modern societies that are called upon, in addition to traditional forms of migration, to manage new types of refugees - migrants (World Migration Report, 2024). A survey is being conducted to investigate the knowledge and opinions of participating public servants on new types of refugees - migrants towards new sustainable cities and the analysis of the data. Finally, the conclusions arising from the analysis and the relevant proposals with which the study is completed are presented.

2. MIGRATION – REFUGEE CRISIS

The refugee issue came to the forefront of Greek and European attention in 2015 with the hundreds of thousands of third-country nationals from Asia and Africa flocking to the EU periphery, with the aim of moving to the countries of northern and central Europe. It was the largest and most pressing refugee exodus to European territory since World War II. Furthermore, as refugee flows mixed with migratory flows, they created a complex problem. The graph below shows the huge increase in the number of illegal crossings that Europe had to deal with during the crisis (FRONTEX, 2016). The main reasons that contributed to the flight of hundreds of thousands of citizens from their homes were the war in Syria, the near-civil war in Afghanistan, the attacks by extremist Islamists in Somalia, the authoritarian regime in Eritrea, the precarious situation in Iraq due to the armed conflicts within it between the various militias, military organizations and terrorist groups, and the adverse socio-economic conditions in Pakistan and Bangladesh (FRONTEX, 2016). In addition to the circumstances prevailing in the countries of origin, the main cause of the refugee crisis was the adverse economic and social conditions encountered by refugees in the first host countries, such as Lebanon, Turkey, Egypt and Jordan, where the respective states, either by choice or due to the prevailing economic conditions, did not allow for their smooth social life and economic survival. As a result, the refugee crisis was transferred to the EU countries, as people who left their countries of origin were not satisfied with the conditions they encountered in the first host countries and decided to follow the path to Europe for a better future (UNHCR, 2023). Greece, which has long been the main gateway to Europe due to its geographical proximity to areas of instability, received the largest number of arrivals. During the two years 2015-2016, it is estimated that 1,200,000 people arrived on the islands and approximately 7,000 in the Evros region via the land border with Turkey. In particular, refugees and migrants entered either by sea from the coast of Turkey to the nearest Greek islands such as Lesvos, Chios, Samos, Kos and Leros, or by land from Edirne via Evros. The majority of those entering came from Syria, Afghanistan and Iraq (Special Secretariat for Communication Planning on Migration and Refugee Policy, 2017). The massive flow of mixed flows, mainly of applicants for international protection and, secondarily, of irregular migrants from the Middle East, the conflict-ridden regions of Asia and Africa and North Africa, has led to the exceeding of the limits of Greece's reception and accommodation capacity. Consequently, this huge number of inflows has given the phenomenon characteristics of a humanitarian crisis (Gemi and Feta, 2024). At the end of 2023, according to estimates, 117.3 million people worldwide were forced to flee their homes within and outside their countries, due to conflict, violence, political or economic instability, as well as due to climate change and other disasters (IDMC, 2024). This number includes 68.3 million internally displaced persons, 31.6 million refugees and persons in refugee-like situations, 6.9 million asylum seekers, 5.8 million other people in need of international protection under the mandate of the United Nations High Commissioner for Refugees (UNHCR), and 6 million Palestine refugees under the mandate of the United Nations Relief and Works Agency for

Palestine Refugees in the Near East (IOM, 2024). Of the internally displaced, an estimated 9.1 million people were displaced within Sudan, the largest internally displaced population ever reported. This was followed by Syria (7.2 million) and Congo (6.7 million) (IDMC, 2024). Compared to a decade ago, the total number of refugees worldwide has more than tripled. The largest proportion of refugees worldwide were from Afghanistan and Syria. They were followed by Venezuela (6.1 million refugees and other people in need of international protection) and Ukraine (6 million refugees) (IOM, 2024). According to a report by the International Organization for Migration (IOM), the number of people migrating globally has increased from 84 million in 1970 to 281 million in 2020. Taking into account the growth of the world's population, the proportion of migrants has increased from 2.3% to 3.6% in fifty years. (UNHCR, 2023).

3. ILLEGAL BORDER CROSSINGS IN THE EU – ASYLUM APPLICATIONS

In the first 11 months of 2024, irregular crossings of the EU's external borders decreased by 40%, to 220,700, according to data collected by the European Border and Coast Guard Agency (Frontex). This significant drop is mainly due to large reductions in flows in the Western Balkans (-80%) and on the Central Mediterranean routes (-60%) (FRONTEX, 2024). The Central Mediterranean region continued to decline in 2024, with irregular migrants limited to 62,000 in the period January-November. The reduction in flows is largely due to preventive measures taken by the Tunisian and Libyan authorities in the context of restricting smugglers (Politis, 2025). At the same time, different routes are showing increasing pressure elsewhere. In particular, flows from West Africa recorded 41,800 crossings in the period January – November 2024, which is the highest number since 2009 (FRONTEX, 2024). Security issues and the existing humanitarian situation in the West African region led to the large number of migrants. Smugglers in this region, in order to make more profits, directed even more people on a dangerous journey to the Canary Islands (Velazquez, 2024). The largest increase in flows was recorded in 2024 at the eastern land borders with a 200% increase to 16,530 arrivals. The largest percentage of people detected on this route were Ukrainian men of military age (FRONTEX, 2024). According to the latest available data from FRONTEX, the Aegean route recorded an 18% increase, raising the number of migrants to 64,000 in the period January – November 2024. The dangerous sea crossing of the Mediterranean, in which smugglers' rings lead thousands of people, continued to have a devastating toll with over 2,200 lives lost at sea in 2024, according to UNICEF estimates (CNN Greece, 2025).

In terms of asylum applications, in 2023, there were 1,048,880 first-time asylum seekers (non-EU citizens) seeking international protection in EU countries. This is an increase of 20.1% compared to 2022 (873,680) and is the highest number since the peaks recorded during the refugee crisis related to the war in Syria in 2015 (FRONTEX, 2024). People who applied for asylum for the first time in the EU represented the vast majority (92.9%) of the total number of asylum seekers (1,129,640) recorded in 2023. Most were men, with the 18-34 age group accounting for 41.7% of the total. The percentages of boys and girls under 14 years of age were similar, with more boys (5.1%) than girls (1.5%) aged 14-17 (FROTEX, 2024).

In terms of destination countries, Germany accounted for 31.4% of all asylum seekers in the EU, with 329,035 applicants registered in 2023. This was followed by Spain (160,460 or 15.3%), France (145,095 or 13.8%) and Italy (130,565 or 12.4%). The lowest number of asylum seekers was observed in 2023 in Hungary (30), Slovakia (370), Malta (490) and Lithuania (510) ((EUAA, 2024). Among EU countries, the number of first-time asylum

seekers increased in 13 countries in 2023. The largest relative increases, compared to the previous year, were recorded in Latvia (+198.2%), Greece (+98.8%), Italy (+69.1%) and Germany (+51.1%). The largest decreases were observed in Austria (-49.3%), Denmark (-47.4%), Malta (-46.4%), Cyprus (-46.0%) and Lithuania (-43.6%) (FRONTEX, 2024).

A total of 48,721 refugees and migrants arrived in 2023, an increase of 159% compared to 2022 (18,780). Of these, 41,561 crossed the Aegean Sea and 7,160 crossed the Evros River, according to UNHCR data (Gemi and Feta, 2024). In 2024, the situation worsened with the number of migrants and refugees increasing by 79% to 61,480, the highest number since 2019, according to an analysis of UNHCR data (UNHCR, 2024). The majority of the newly arrived individuals were from Syria (31%), Afghanistan (20%), Palestine (16%), followed by Somalia (6%) and Eritrea (4%) (Aida, 2023). According to data from the Ministry of Immigration and Asylum, in the first ten months of 2024, the Asylum Service recorded 54,315 new asylum applications and 4,184 previous requests, with the majority of applicants being from Syria (30.6%), Afghanistan (19.4%), Egypt (10%), Turkey (6.2%), Palestine (3.6%), Iraq (3.5%) and Pakistan (3.2%) (YMA, 2024).

4. UNACCOMPANIED MINORS

In Europe, the influx of unaccompanied minors began in some Member States, such as Germany, as early as the late 1970s. Before 1990, they also appeared in the United Kingdom and France, in the late 1990s in Spain, while in the 2000s, Belgium and Ireland were added to the host countries (Pompidou, 2022).

In Greece, unaccompanied minors appeared with the first migratory flows in 1990 and are the so-called children of the traffic lights. Specifically, after the dissolution of the former Yugoslavia and the crisis faced by neighboring Albania in 1990, the country welcomed a large number of unaccompanied minors for about a decade (Teloglou, 2008). The UN High Commissioner for Refugees is seeking a mechanism to identify unaccompanied children, as many of them give false dates of birth to the authorities in the hope that they will not be stopped and thus continue their journey to the country of destination. Some are still unaware of the procedures for providing them with assistance. The majority of them come from Afghanistan and Syria, followed by Egypt, Pakistan, Iraq, Morocco, Bangladesh, Somalia, Sudan and Algeria (EASO, 2019). Unaccompanied minors are usually boys between 12 and 17 years old. Younger children rarely come alone, but they can often get lost with their parents during the journey or traffickers choose to separate them (NCSS, 2021). A minor is a third-country national or a stateless person under eighteen (18) years of age (Directive 2013/33/EU of the European Parliament).

An unaccompanied minor is a person under eighteen years of age who enters Greece without the accompaniment of an adult who is responsible for him or her in accordance with Greek law, and for as long as the care of him or her has not been assigned to an adult. (Article 2, paragraph 1 of Law 4636/2019, A'169).

"Separated minor" or "separated minor" is a person under the age of 18 who does not enjoy parental care, but is accompanied by an adult relative, who essentially takes care of him (article 41 par. i of law 4636/2019).

The term "international protection" includes both refugee status and subsidiary protection status based on the Geneva Convention relating to the Status of Refugees and the New York Protocol, as ratified by law 3989/1959 (A' 201) and law 389/1968 (A' 125) respectively, as well as Directive 2011/95/EU. (EASO, 2016).

A guardian is a person appointed by the competent public authority to assist a minor who

is a third-country national or a stateless person and who is deprived of parental care in his or her affairs, is independent of the authorities responsible for determining the legal residence status, ensures the best interests and general well-being of the minor and supplements the minor's legal capacity, where necessary (EASO, 2019).

A representative is understood to be the person or organization designated by the locally competent Juvenile or First Instance Prosecutor in order to assist and represent an unaccompanied minor in the procedures provided for asylum procedures and reception conditions, as these have been incorporated into national legislation with the aim of ensuring the best interests of the child and completing the minor's legal capacity where necessary (Law 4636/2019).

5. THE EXTENT OF THE PHENOMENON IN EUROPE

In 2023, based on available data, the total number of unaccompanied minors who applied for asylum in EU countries for the first time reached 41,525 people, an increase of 4.0% compared to 2022 (39,915).

The largest number of unaccompanied minors was reported by Germany (15,270), the Netherlands (6,045) and Austria (5,055). More than 2,000 unaccompanied minors applied for asylum for the first time in Bulgaria (3,845), Greece (2,635), Belgium (2,550), Spain (2,505) and Italy (2,205). Among these eight EU countries, the number of unaccompanied minors increased in five compared to 2022, with the highest absolute increase observed in Germany (7,995 more applicants). The highest decrease was recorded for Austria (8,160 fewer applicants) (EUAA, 2024).

According to the statistical data of the Greek Government, in December 2024 the estimated number of unaccompanied minors in Greece amounted to 2414, of which 103 are separated minors who are accompanied by an adult who is not their primary guardian by law. In terms of their demographic characteristics, 89% are boys, 11% are girls and only 15% are under 15 years of age. Regarding their place of residence, 1372 A.A. reside in accommodation centers, 209 in semi-autonomous living apartments, 151 in emergency accommodation structures, 506 in reception and identification centers, 176 unaccompanied minors in controlled accommodation structures for asylum seekers (YMA, 2024). In relation to the countries of origin, 45% come from Egypt, 16% from Somalia, 16% from Syria, 10% from Afghanistan, 3% from Pakistan and 9% from other countries. It is observed that compared to 2023, the number of unaccompanied minors from Egypt shows a large increase, while on the contrary, unaccompanied minors from Somalia have been limited. Over time, according to data from the National Center for Social Solidarity, from 2018 to 2021, unaccompanied minors from Afghanistan and Pakistan, who in 2018 presented the highest percentages, have decreased (SGVP, 2024).

Also, the percentage of unaccompanied minor girls more than doubled between 2018 and 2024, going from 6% to 14%, while the percentage of unaccompanied minors under 14 years of age has fluctuated steadily between 7% and 8% during the same period. Finally, over time, the evolution of the number of unaccompanied minors in Greece has shown a decreasing trend. However, with regard to the migration and even more so the refugee phenomenon, it is estimated that official statistics represent only a small part of the real dimensions of the populations (Aida, 2023).

The legal categorization of unaccompanied children, that is, whether they are unaccompanied, separated, beneficiaries of international protection, is a very important feature of their protection. The most important thing, however, is that they are children. In this

context, the rules of law at international, European and national levels create a protective regime for minors. (Mentzelopoulou, 2022).

6. ENVIRONMENTAL REFUGEES

A new phenomenon has been observed more and more frequently in recent years at a global level. Large numbers of people, mainly due to climate change, are leaving their homes in search of a better life (FAPESP, 2023). The extent and complexity of forced population movements as a consequence of environmental factors such as deforestation, desertification, global warming, natural disasters, nuclear and industrial accidents has created a new category of people in need of special legal protection, environmental refugees (The Nansen Conference, 2011).

Migration and displacement caused by environmental factors could in the future take on unprecedented proportions. Projections on the extent of displacement estimate that the total number of people displaced according to the Intergovernmental Panel on Climate Change (IPCC), the body tasked by the United Nations to investigate the causes and impacts of the climate crisis, will be 150 million environmental refugees by 2050 (Siscou, 2021).

Regarding the legal status of these people, there is currently no specific legal framework guaranteeing assistance or protection. The Geneva Refugee Convention adopted by the United Nations in 1951, as amended by the New York Protocol (31-01-1967), due to the historical context of its signing, does not cover environmental refugees (IOM Strategic Plan 2024-2028, 2023).

At the European level, today when the cohesion of the Union is being tested by the massive influx of immigrants and refugees, the recognition of a special regime in favor of environmental refugees is not on the horizon (European Commission, 2022:1).

However, there are some initiatives at the international level with the contribution of activists, Non-Governmental Organizations and the United Nations High Commissioner for Refugees, in order to develop a framework of guidelines or a tool that can be applied in cases of external displacement beyond those covered by the existing legal framework and in particular in cases of forced displacement of populations due to climate change and natural disasters (Monsalve, (2023). The Geneva Convention, adopted by the United Nations in 1951, does not include environmental refugees (Convention relating to the Status of Refugees, 1991). It was signed after the war in a historical context different from today. According to the Convention, a refugee is someone who is persecuted "because of his race, religion, nationality, membership of a particular social group or his agreement with some political view". There is no mention anywhere of people who are forced to move for environmental reasons (Marshall, 2011). In Greece, the majority of refugees belong to the "Convention refugees" and "de facto refugees". The latter enjoy a weak, uncertain and temporary protection regime which is now applied by most EU countries (Siskou, 2021). According to another view, the legal protection of these people should be released from the provisions of the Geneva Convention, thus avoiding the need to change the national legislation of the states and be based on a new framework founded on environmental law (Gizari, 2020). The theorists of Law in this effort met at the Limoges conference in 2005 and proceeded to adopt a text with references to basic human goods, such as the right to life (European Convention on Human Rights, 1950), to human dignity and health, to the right not to be expelled, to the right to work and to family reunification as well as to social benefits. The convention, based on the principles of prevention and precaution enshrined in international environmental law for the response to ecological disasters, requires states to implement them by providing legal protection to this

category of people, otherwise their international responsibility for an internationally wrongful act will be established (SCR 689, 1993).

7. DIGITAL NOMADS

In 1997, the book "Digital Nomad" by Makimoto and Manners was published, which, triggered by the development of technology, described a new working reality, which at that time was considered very distant. The need for work combined with the human desire to travel, brought back the ancient practice of nomadism with modern features (Makimoto, Manners, 1997).

The definition and evolution of digital nomadism cannot be separated from technological development. This type of worker is initially observed in teleworking positions, which created a wave of travelers in Thailand in the 1980s. Then digital nomads appeared in the USA in the 2000s, when the first programmers started working from their homes (Aroles et al, 2020).

According to a very broad and commonly accepted definition, a "digital nomad" could be described as someone who works exclusively online using technology, while also traveling either within or outside the country, and more specifically, a person who, in the above context, constantly changes their place of residence. These workers do not have a fixed place and working hours and are completely detached from a fixed work base (Whiting and Symon, 2020). To better illustrate the difference between digital nomads and another similar category that is often confused, telecommuters, it is stated that the term digital nomad implies the element of travel (Aroles, Bonneau, & Bhankaraully, 2022).

The trend of digital nomads is on the rise globally (McDonagh, 2021). According to the research study by MBO Partners, the number of digital nomads in the US has been increasing continuously since 2019. As expected, the health crisis with the Covid-19 pandemic acted as a catalyst, accelerating the new work reality, as all countries, even the least technologically advanced, adopted flexible forms of employment such as teleworking (Lund, Madgavkar, Manyika, & Smit, 2020). The highest increase was observed in 2020, where 10.9 million digital nomads were recorded, as opposed to 7.3 million in 2019 — an increase of 49% (State of Independence in America, 2019). In 2021, the number of digital nomads increased by an additional 42% compared to 2020, with 15.5 million Americans identifying as digital nomads (MBO, 2024).

Although not as dramatically as in the early years of the pandemic, the numbers continued to rise steadily in 2022, when 16.9 million Americans reported working as digital nomads. The data shows that the overall increase reached 131% from the pre-pandemic years (2019) to 2022. Following the upward trend, 2023 saw a 2.3% increase in the number of American digital nomads compared to 2022 — translating to approximately 17.3 million people currently identifying as digital nomads in the US. This was followed by a further 4.6% increase in 2024, now standing at 18.1 million (State of Independence in America, 2024).

The biggest change in work, however, concerns the creation of a third category of migrants, digital nomads, and this is because they are completely detached from the place. They can work from anywhere, from their home, from another city, country, continent (Choudhury et al., 2019).

The conditions that gave impetus to the digital nomad trend were initially the fluidity of work, the flexibility of the workplace and, above all, the desire for a balance between work and free time (Orel, 2019). In particular, an important factor in the development of digital nomadism is the beneficial situation for both businesses and employees. Companies have the ability to attract and retain top talents who are motivated by this way of life, and employees

work when and where they want (MBO, 2024). The main reasons for digital nomadism are the sense of freedom of being able to work from anywhere, the strong desire to travel, and the desire to get to know different cultures and lifestyles (Hemsley et al., 2020).

The reasons why people were involved in digital nomadism were also presented to us in his research by Schlagwein (2018): Of course, there was the desire to travel, which broadens horizons, but there was also the need to socialize with people with similar interests and concerns. In addition, an important reason is the reduced cost of living in some countries such as Thailand, Portugal, etc., which even with travel, was much lower than the cost of living in their country of origin. Without the low cost, many survey participants reported that their income would not be enough to support this lifestyle, they would have to work much longer, and their quality of life would be worse. Furthermore, a country with a low cost of living is a competitive environment for starting a new business (Schlagwein, 2018).

Although digital nomads report high levels of satisfaction, their work situation faces some difficulties (Sutherland et al., 2019). The top challenges reported by digital nomads are financial stress (27%), separation from family and friends (26%) (Thompson, 2018), their safety (24%), time differences that make work difficult (23%), and professional burnout (21%). These challenges have existed over time, however, the number of digital nomads reporting them has decreased since 2020, mainly due to the relaxation of pandemic measures (Michos, 2021). Regarding the type of their work, (Vincej, 2022), according to a 2022 survey, 37.8% are freelancers and 33.1% are company employees who work remotely. 10.2% are company owners and 7.9% are innovative entrepreneurs. 29.9% are active in the IT sector and 15.7% are involved in marketing (Katrana, 2022). The reduction in tourism revenues caused by the pandemic has led several countries, taking into account the forecasts for the high number of digital nomads in the coming years6, to choose and adopt a policy to attract them, providing significant economic incentives (Corbley, 2021). According to a survey by a body that provides information on global visas, the best destinations for digital nomads were sought, prioritizing some elements that directly affect the lifestyle of a digital nomad. These factors include: Availability of active visas, internet speed, tax criteria and tax-free duration, necessary income for visa applications, cost of living in euros, Global Health Score (GHS), and popularity of Tourism.

These factors are combined to form a score, highlighting the most suitable countries for digital nomads. According to this ranking, Spain is the top country, with a score of 4.50. Argentina follows in 2nd place with a score of 3.72. Romania, the United Arab Emirates and Croatia are ranked in 3rd, 4th and 5th place respectively to complete the top five of the list of the best countries for IDPs. (Visaguide.world, 2024). Greece, according to this ranking, is in 28th place. The high 20% tax rate, the very low internet speed, the high monthly income required for the issuance of a residence permit and the relatively high cost of living are highlighted as inhibiting factors (Visaguide.world, 2024). Greece seeks to attract IDPs through legislation with the new "Immigration Code" (Touchtidou, 2021). In this context, the current legal regime, the new law 5038/2023, is presented. The aim is to update the Immigration Code and reduce the time and supporting documents for the provision of residence permits by the Greek state to third-country citizens (Immigration Code, 2023).

However, apart from the legal framework, infrastructure and internet issues that need immediate attention are of key importance in attracting Digital Nomads (Pantziou, 2021). The average speed of 36.42 Mbps ranked Greece in 100th place worldwide, while our country was among the 10 countries that had the most to do, in terms of the fiber optic network, since 3.99 million households were still unable to connect (Tsoulakis, 2021). Although the project started in 2019, coverage was at 7% and far from the European A.V. (44%). In addition, the

country had the most expensive internet in the EU: in 2020 it was 73% more expensive than the European A.V. (Tsoulakis, 2021). The situation in 2024 remains similar, with few things having improved, both in terms of speed and prices, as according to a study carried out on behalf of the European Commission, our country has attractive prices at low speeds, but is expensive at speeds above 100 Mbps (broadband connections). For mobile connections, Greece is ranked among the relatively expensive countries (European Commission, 2022).

8. RESEARCH CONDUCT

81.1 General

The research method followed in this paper was to conduct a quantitative survey using a structured questionnaire with the aim of investigating the knowledge and opinions of the participants on the new types of refugees-immigrants, analyzing the data and finally formulating conclusions and suggestions.

8.2 Purpose - research questions

The purpose of this paper was to record the opinions of public sector employees on the new types of refugees-immigrants, as well as to investigate their knowledge of the institutional framework that governs them. The research questions of this paper were formulated as follows:

a. What are the knowledge and perceptions of public sector employees in Greece on the management of the migration-refugee issue to date?

b. To what extent do they know and what are their views on the new types of refugees - immigrants?

In particular, it was sought through the recording of their views to draw useful conclusions and to record proposals, in order to make Greece a model country in the implementation of the human rights of refugees - immigrants and, in parallel with the social integration of those legally residing in the country, to improve the standard of living of the entire population living in Greece.

8.3 Methodological Measurement Tool

The main measurement instrument for conducting the research was the questionnaire. The respondents - subjects of the research completed a written and anonymous questionnaire that was compiled by the author and aimed at investigating their awareness of the evolution of the refugee - immigration issue and in particular about the new types of refugees - immigrants.

The questionnaire was created in the form of a written text, which was initially subjected to a reliability and validity test by distributing it to a small number of the sample. After the resulting adjustments, it was modified electronically using the "google forms" application for faster distribution and immediate collection of responses.

It then consisted of three parts: The first part contained the demographic data of the sample (gender, age, previous work experience, level of education, family status). The second part included questions investigating their knowledge and opinions on the refugee-immigrant issue in general and its management in our country. The third part, which concerns the new types of refugees-immigrants, consisted of three subsections with 5 questions each. In particular, the first subsection referred to unaccompanied minors, followed by the second section on environmental refugees and the questionnaire was completed with the subsection with questions on digital nomads.

In order to obtain a wide range of possible responses, questions with multiple choice

answers were mainly used, where the variety of options was designed to capture the variety of possible responses to the questions given.

The questionnaire also contained some questions with ranking scales, which are a useful mechanism for conducting the research as they incorporate a degree of sensitivity and differentiation of responses, while at the same time yielding qualitative data. They are also particularly useful for capturing the behaviors, perceptions and opinions of the participants.

8.4 Measurement procedure

Before administering the questionnaire in question, in accordance with international practice, it was piloted on a sample of 5 civil servants and the appropriate modifications were made to ensure face validity (Cohen et al, 2008). The main survey followed during the period of December 2024. It was distributed electronically by sending a link through the use of the application

«viber» which directed the participants to the corresponding page of «Google forms». For a more complete understanding of the questions, the necessary clarifications were initially included. The total duration of its completion was approximately 10 minutes.

The respondents, entering the questionnaire, gave their relevant answers. The answers were automatically recorded in real time in a spreadsheet, from where the researcher has the ability to manage them, analyze them and export the results visualized in diagrams.

The main advantage of the online questionnaire was the simple and fast process for collecting data. The ease of submitting the questionnaire led to a high response rate, as the link was sent to 81 people and a total of 57 people responded, a rate of 70.3%. The response rate is considered satisfactory and is probably also due to the presence of a cover letter to encourage participation.

The data collected were processed appropriately and are presented below. After collecting the data, a comparative analysis and search for patterns were carried out in order to find trends in the responses. Each question is also presented with the corresponding graph for the visualization of the results (Rumrill & Cook, 2001).

8.5 Checking the validity and reliability

The validity of the research is achieved as it is based on a satisfactory sample. Also, as the sample was obtained by random sampling, it is representative and the conclusions of the research can be generalized. Regarding the methodological tool used, its construction is estimated to be able to measure what it has been constructed for. In order to ensure content validity and achieve the greatest possible clarity, the questions it contains are based on the bibliography. Regarding the apparent validity, a pilot study was conducted on a small part of the sample for the possible need to further adapt the questionnaire (Cohen et al, 2008).

Regarding ensuring reliability, the stability of the results was investigated through the deliberate formulation of the same questions (2-3) with different wording and their dispersion within the questionnaire (Ouzouni, Nakakis, 2011).

8.6 Ethical dilemmas

The most important ethical dilemma of this particular research, as it was addressed to adults, was the anonymity of the participants/subjects. Anonymity was ensured both by the possibility of anonymous completion of the questionnaire, and by the possibility of anonymous data collection through the "Google forms" application. In the introductory note of the questionnaire, assurances were given to the participants to ensure their anonymity and the confidentiality of the information they provided (Cohen et al, 2008).

8.7 Research results – data analysis

8.7.1 Sample characteristics

The sample consisted of 57 individuals, including 50 men (8.7%) and 7 women (12.3%), representing a reduced number of women, which in any case corresponds to the reduced number of women in this particular public sector. The dominant age group, 49.1% (28 individuals), was 35-44 years old, with more than 20 years of experience (66.7%, i.e. 38 individuals), demonstrating the potential and

at the same time the experience of the sample in its workplace. Regarding the level of education of the participants/respondents, we observe in graph 4 that it included all educational levels, with a dominant 38.6% (22 individuals) of compulsory education, making the results of the survey more representative.

The representation of their marital status is presented in graph 5. The vast majority of respondents, 75.4% (43 people), were married.

8.7.2 Descriptive Analysis-Presentation of Research Results

The second part begins with the participants' opinions on the most important issues facing the country. This shows that 61.4% (35 people) consider the course of the economy – the standard of living as the most important issue, 40.4% (22 people) security – crime and in third place immigration – refugees with 31.6% (18 people).

Almost all participants, 89.5% (51 people) consider that the number of immigrants in Greece is excessive or quite large. 77.2% (44 people) believe that their existence has a negative impact on the Greek economy.

Regarding the risk of national identity alteration, if we exclude a small percentage of 7% (4 people) who believe that the presence of immigrants in Greece enriches Greek society culturally, the vast majority of respondents, 84.2% (48 people) believe that their presence constitutes a risk to our national identity. The largest percentage, 91.2% or 52 participants, believe that immigration does not help solve the demographic problem and that their presence, according to 77.2% (44 people), increases crime.

Regarding the operation of reception and identification structures, 59.7% (34 people) have a negative and rather negative impression. Regarding the participants' opinions on migrants arriving in Greece, according to the results, 96.5% (55 respondents) of the sample believe that mass refugee arrivals are a definitely and probably more permanent phenomenon, 82.5% (4 people) estimate that the European Union-Turkey agreement to reduce migrant flows in the Mediterranean is definitely not and probably not effective, and finally 89.2% (50 participants) are of the opinion that in the future more or the same number of refugees and migrants will arrive. Regarding Greece's stance on dealing with refugee-migrant flows, 91.2% (52 people) are of the opinion that it should be stricter, as the limit of migrants that the country can accept has been exceeded. It then appears that 94.6% (53 participants) believe that the EU should provide more assistance to Greece in guarding its borders.

The following questions reflect the majority opinion of the respondents (52.6% or 30 people) that refugees in Greece wish to leave for other European countries, and then 66.7% (38 participants) believe that the state does not provide sufficient care for the integration of refugees entitled to asylum.

The following presents the sample's beliefs about the living conditions in the Registration and Accommodation Centers, the role of NGOs, the financing and management of European funds by the Greek state.

Of particular interest is the question regarding the role of various bodies in the management of the refugee issue in Greece. The highest positive role is played by local

communities and ordinary people, while the highest negative contribution is made by the media. This is followed by the third part of the research, with the first section referring to unaccompanied minors. From the data collection, it is found that while the majority of participants are aware of the issue of unaccompanied children, there is a division of opinions regarding whether they receive the assistance they are entitled to, as most are not informed about the establishment of the General Secretariat for Vulnerable Citizens and Institutional Protection and the National Emergency Response Mechanism. In general, there is agreement on the necessity of the social integration of unaccompanied minors, and specifically 59.6% (34 people) consider their inclusion important.

The second section of the third part follows, which is related to environmental refugees. While the majority of the sample is not familiar with the term environmental refugee, most believe that the climate crisis will increase the number of people who will migrate in the coming years. In this context, 52.6%9 (30 respondents) showing empathy consider it appropriate to provide these people with an "ecological" asylum. Regarding the question of the type of disaster that leads to the most population movements, a division of opinions is recorded, indicating a relative ignorance of the risk of each natural disaster. Finally, the vast majority, 82.4% (47 people) of the civil servants surveyed, believe that the Greek state is not operationally prepared for the possible need to relocate entire settlements to another safe location following a natural disaster.

The survey concludes with the third section, which concerns the knowledge and beliefs of the participants regarding the phenomenon of digital nomads. The majority of the sample, 54.4% (31 people), is unaware of digital nomads and the global trend of attracting them. Regarding the impact of the increase in their number on the Greek economy as well as the measures to attract them from Greece, opinions are divided across the board. Finally, 45.6% (26 participants) believe that broadband infrastructure, speed and price of "fast" internet, which are parameters for choosing a country by digital nomads, are not satisfactory in Greece.

8.8 Discussion of results

According to the survey results, the participants place the refugee-immigration issue in third place among the issues that concern them after the course of the economy and crime. They believe that the number of immigrants in the country is large, with a risk of altering the national identity. Their presence does not contribute to solving the demographic problem and, in addition, they increase crime without having a positive impact on the economy. For these reasons, estimating that in the coming years the flows will remain increased, they believe that Greece's stance and greater assistance from the EU are required. Regarding the living conditions in the RICs and the role of NGOs, there is a division of opinions, while the majority of the sample believes that the necessary actions are not being taken for the integration of people entitled to asylum. In the management of the migration-refugee issue as a whole, the contribution of local communities and ordinary people is recognized, while the role of the media is viewed with suspicion.

In the section of the research related to new types of refugees - migrants, initially a lack of information about the country's institutional tools regarding their protection, such as the General Secretariat for Vulnerable Citizens and Institutional Protection and the National Emergency Response Mechanism, is recorded for unaccompanied minors, and at the same time the necessity of strengthening their social integration is reflected. Then the belief is reflected that the climate crisis with the increased number of natural disasters will increase the number of people who will be displaced from their homes. These people are considered to be in need of increased protection, a view related to the belief about the lack of operational

readiness of the Greek state for the safe relocation of populations, if required. The study concludes with the knowledge and beliefs of the participants regarding the phenomenon of digital nomads. It is found that public opinion is unaware of their existence, the global trend of attracting them, as well as the positive impact they have on a country's economy. It also records the respondents' perception of the need to improve broadband infrastructure.

8.9 Conclusions - suggestions

In conclusion, it is stated that the research data highlight, with fluctuations of course, the beliefs of the civil servants in the sample regarding the management of the refugee-immigrant phenomenon in Greece as well as their knowledge and opinions regarding the new types of refugees-immigrants. Utilizing these research results, the study concludes with the formulation of specific suggestions. In particular, it is proposed:

Informing citizens about the institutional initiatives undertaken by the Greek state regarding unaccompanied minors, mainly through the establishment of the General Secretariat for Vulnerable Citizens and Institutional Protection and the action of the National Emergency Response Mechanism, in order for civil society to be further mobilized on the issue and, in synergy with the state, to proceed with actions to accelerate the assistance and integration of these children.

Educating and raising awareness among people about environmental refugees. Understanding the causes and impacts of this population movement, as well as designing effective policies and strategies to support them, is crucial for achieving sustainable solutions. The undertaking of initiatives by the relatively newly established Ministry of Climate Crisis, in order to promote collaborations at local, national and international levels for the protection of those affected and the preparation of operational plans for all natural disasters, which will then be communicated to citizens and tested periodically in the form of preparedness exercises.

The undertaking of the country's initiative at European and international levels for the establishment of legally binding legal rules regarding the protection of environmental refugees.

The preparation of a national strategy to attract digital nomads with specific measures, such as zero taxation, reduced income criteria for granting a residence permit while simultaneously improving infrastructure (price and speed of the internet).

The creation of a campaign to promote Greece at an international level, highlighting the country's advantages as a working environment, as with the arrival of more digital nomads, the Greek economy will incorporate innovation in forms of work and high-level employees.

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RETHINKING RESEARCH PARTICIPANT COMPENSATION IN URBAN SETTINGS: A SOCIAL EXCHANGE PERSPECTIVE ON SUSTAINABLE DEVELOPMENT

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Abstract
Urban and peri-urban communities are increasingly central to global research agendas due to their dense populations, diverse demographic composition, and proximity, which make them accessible and resource-rich sites for health, social, and development studies. These communities often host multiple studies, making them "over-researched," which can lead to participant fatigue, distrust, and disengagement. This paper addresses the ethical and sustainability challenges associated with research participant compensation in urban settings, emphasizing that fair and equitable recognition of participants' contributions is essential for sustaining urban research ecosystems.

Drawing on Social Exchange Theory, participation is conceptualized as a reciprocal process, where fairness, respect, and dignity are critical for sustaining trust and long-term engagement. Research exceptionalism—expecting participants to contribute without appropriate recognition—creates structural exploitation that threatens both ethical legitimacy and community willingness to participate.

The paper offers insights into how ethical, inclusive, and compensatory practices contribute to urban sustainability by strengthening social trust, reciprocity, and resilience. The intended benefits for readers include understanding the intersection between ethical research practices and sustainable urban development, recognizing over-researched communities as a critical consideration for planners and researchers, and providing practical recommendations for compensating participants in ways that enhance fairness and community engagement.

Key words: Research participant compensation; Social Exchange Theory; Urban sustainability; Ethical research practices; Over-researched communities; Community resilience

THE ENVIRONMENTAL PHILLIPS CURVE: A CROSS-COUNTRY ANALYSIS OF UNEMPLOYMENT AND ENVIRONMENTAL DEGRADATION

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Abstract
The concern about climate change and its impact on human life and economic activity has been steadily increasing in recent years and one big question that keeps coming up in policy discussions is how we can balance a robust economy with protecting our environment. A new idea called the Environmental Phillips Curve (EPC), mainly based on an older economic concept, the Phillips Curve is trying to tackle this challenge. In traditional economic theory, when unemployment goes down, inflation tends to go up, and vice versa. The EPC revises the original interpretation to address environmental concerns. The main idea is that when more people are unemployed, there's less economic activity, which means fewer emissions and less pollution, on the other hand when we try to create more jobs and boost the economy, we might end up hurting the environment in the process. It's like being caught between a rock and a hard place, do we prioritize jobs or the planet? This study attempts to test whether this Environmental Phillips Curve holds true across different European Union countries. To do this, we're using a sophisticated statistical method called cross-sectionally augmented autoregressive distributed lags (CS-ARDL), a tool that helps us analyze complex economic and environmental data patterns across multiple countries over time.

Keywords: Environmental Phillips Curve, climate change, unemployment, economic growth, ARDL

1. INTRODUCTION

There is no doubt that the prosperity and welfare achieved by the developed world, especially after the Industrial Revolution, entails a significant cost, that may have been initially overlooked until it grew so large that its negative consequences could no longer be ignored.

The impact of human activity on the environment is a matter of constant concern, and rightly so, as it is now evident that these consequences stand in direct contradiction to the achievements of the modern world and threaten not only its prosperity but also its security. The initial optimism that technological development could address the problem of resource scarcity has gradually given way to deep concern for the very existence of life on the planet. Climate change is nowadays a constant refrain at a scientific and political level, converting climate cost as an important parameter in any serious system of political and economic decision-making.

The main factor of concern is the increase in carbon dioxide (CO_2), which contributes nearly 80% of total greenhouse gas emissions and steadily rises over the last 100 years, making climate actions a urgent priority and to this end governments and international organizations are taking action to reduce emissions (Adamopoulos, 2021; IPCC, 2023; Karsiotis & Adamopoulos, 2025). According to NASA[40] the last 10 years are the warmest years on record and therefore transforming the global economy into a green economy must be our priority. But balancing economic growth with environmental sustainability is a great challenge, especially when taking into account traditional and unsolved economic problems like unemployment.

Can we reduce emissions without sacrificing employment? Although there is no direct link between environmental degradation and employment, there is great concern if the emergence of "green jobs" can contradict losses in carbon-intensive industries. While energy transition threatens job losses in carbon-intensive sectors, it simultaneously creates substantial opportunities in emerging green industries putting pressure on the labor force to adapt to new skills, which requires time and effort. Apart from that new green jobs may not be located where job losses occur as losses are often geographically concentrated, creating regional unemployment.

In economic theory, unemployment and full employment are topics that have preoccupied and will continue to concern economic thinking and political debate. As new challenges and societal priorities emerge economic theory must seek new tools of analysis, to answer old questions in a new framework. Under these circumstances, traditional frameworks, such as the famous Phillips curve, which originally described an inverse relationship between unemployment and inflation, can be adapted and reframed in modern contexts by incorporating additional variables and mechanisms that reflect today's economic reality. The Environmental Phillips Curve (EPC) is an extension of the classical model, which attempts to link unemployment to carbon emissions. If there is empirical evidence of a tradeoff between those two, that is very important information for policymaking.

2. LITERATURE REVIEW

The relationship between economic growth and environmental degradation is well established in the literature, as higher production is associated with higher pollution (Kashem & Rahman, (2020), Azimi & Rahman, (2024)). Additional employment increases as production increases and thereby income increases as well. This concept is not new in economic literature and finds its theoretical background in Okun's law (1962). If production generates employment and production generates pollution, then employment and pollution become indirectly linked through their common source. In such a framework, higher employment typically reflects higher levels of productive activity. The fact that pollution and employment move together

[40] https://climate.nasa.gov/vital-signs/global-temperature/?intent=111

does not necessarily mean one causes the other. Empirical evidence should be provided to avoid a spurious regression.

How does unemployment be linked to environmental quality? According to Bhowmik et al., (2022) the connection between those two can be established through two contradicting channels, the "growth channel" and the "preference channel". Increase in unemployment indicates decline in economic growth and reduction in energy consumption, and therefore it is logically expected to decline carbon emissions. The "preference channel" reflects the reluctance of consumers, as unemployment increases and therefore income decreases to purchase improved environmental quality but costly goods. The idea of an inverse relationship between pollution and unemployment equivalent to the traditional Phillips Curve is a relevant new context, initially explored by Kashem and Rahman (2020). By using data from 30 industrialized countries for period 1991 to 2016, they confirmed that these inverse relationships does hold true in most of the cases and according to their findings, fighting environmental pollution without innovation and enforcing alternative technologies to be less polluting but employment friendly, employment could suffer severe reduction. Since then, various studies have confirmed the validity of this hypothesis including different models and techniques.

Anser et al., (2021) affirmed a significant trade-off between unemployment and environmental degradation for BRICST economies (Brazil, Russia, India, China, South Africa, and Turkey) from 1992 to 2016, employing ecological footprint as an environmental indicator and the PMG-ARDL model. Same confirmation with the same model by Tariq et al., (2022) validated the EPC in South Asian countries (Pakistan, India, Bangladesh, and Sri Lanka) from 1991 to 2019, showing that renewable energy and unemployment reduced environmental pollution. Ng et al., (2022) adopted a second-generation panel unit root and cointegration test to account for the presence of cross-section dependence (CSD) for 36 OECD countries between 1995 and 2015 and their findings suggest that investment in innovative green technologies is important for achieving sustainable growth and better environmental quality.

Bhowmik et al. (2022) attempted to distinguish between the long and short run impact by employing a dynamic ARDL model and concluded that EPC is valid in the long run but not in the short run for the USA (1985-2018). Teeli et al., (2025) confirmed the EPC validity for India using annual time series data from 1991 to 2022 and various econometric methods, including the ARDL model. The findings confirm the validity of the EPC in both the long and short run, suggesting that increased employment is associated with higher environmental degradation.

Using an Augmented Autoregressive Distributed Lag (A-ARDL) model with a Fourier term, Yavuz et al., (2023) confirmed a cointegration relationship between LCF and its determinants. The findings indicate that the EPC is valid in Turkey: unemployment improves environmental quality, while gross domestic product, natural resource rents, and primary energy consumption accelerate environmental degradation. The authors conclude that concurrent achievement of employment and environmental policies is difficult, proposing environmentally friendly production methods like renewable energy as a solution to foster both employment and environmental improvement. Daştan et al., (2023) also confirmed both EKC and EPC hypotheses for Turkey, by employing the augmented autoregressive distributed lag (A-ARDL) model and using ecological footprint as a comprehensive environmental indicator. Koyuncu Çakmak et al., (2025) using a novel dynamic ARDL simulation approach and found the EPC valid in upper and lower middle-income countries but not in high-income economies in Turkey (1990-2020).

Azimi and Rahman (2024) investigated the EPC hypothesis in G7 nations from 1990 to 2022 using CS-ARDL, wavelet coherence, and wavelet causality techniques. An inverse relationship between unemployment rate and CO_2 emissions was found and thus validating the EPC hypothesis for the selected sample. As expected, findings suggest that economic growth increases CO_2, while renewable energy and technological innovations mitigate it, which leads to the conclusion that creative policy solutions to balance CO_2 reduction with employment by implementing green technology and sustainable practices is essential for employment growth and environmental sustainability. Djedaiet, (2023) investigates the asymmetric effects of unemployment and inflation rates on environmental quality in African OPEC countries from 1990 to 2019 by utilizing a panel NARDL model (PMG-NARDL) and confirmed the EPC in the long run. Shastri et al., (2022) included gender in their analysis using time series data and econometric models (ARDL, FMOLS, DOLS) and find that higher male unemployment correlates with lower CO_2 emissions, while no similar relationship exists for women.

3. METHODOLOGY AND DATA ANALYSIS

This study examines the relationship between environmental quality and unemployment through the lens of the Environmental Phillips Curve (EPC), which extends the traditional Phillips curve framework to incorporate ecological dimensions. Following the work of recent environmental economics literature, we model the tradeoff between carbon emissions and labor market outcomes. As already mentioned, the theoretical foundation rests on the hypothesis that stricter environmental regulations and the transition to a low-carbon economy generate both creative destruction effects by simultaneously eliminating jobs in carbon-intensive sectors while creating employment in green industries. Our baseline empirical specification takes the following form:

$$\ln\left(\mathrm{CO2}_{i,t}\right) = \beta_0 + \beta_{1i}\ln\left(\mathrm{GDP}_{i,t}\right) + \beta_{2i}\left(\ln \mathrm{REN}_{i,t}\right) + \beta_{3i}\left(\ln \mathrm{EC}_{i,t}\right) + \beta_{4i}\left(\ln \mathrm{UNM}_{i,t}\right) + \mu_{i,t}$$

The variables of this equation are presented in Table 1.

Table 1-Variables – Summary of data

Variable	Brief description	Unit of Measurement
CO2	Annual CO_2 emissions from agriculture, energy, waste and industry (excluding LULUCF).	Mt CO_2e (Million tonnes of CO_2 equivalent)
UNM	Unemployment	% of total labor force
REN	The share of electricity generated from renewable sources.	% of total electricity production
GDP	The total income from the production of goods and services.	Current US Dollars ($)
EC	Primary energy use per unit of GDP.	kg of oil equivalent per $1,000 GDP

In this study, a comprehensive study is conducted to explore the determinants of ecological footprint for the 7 European countries (Spain, Netherlands, Italy, Greece, Latvia, Germany, Finland), spanning the period 2000-2019. Statistical data obtained from World development indicators statistical database (World Bank, 2025).

Table 2 offers some descriptive statistics and figure 1 the correlation matrix.

Table 2- Descriptive Statistics

	CO2	REN	GDP	EC	UNM
count	126	126	126	126	126
mean	268,33	28,03	1,11E+12	78,03	10,50
std	264,62	16,99	1,14E+12	21,15	5,64

min	7,43	3,53	8,19E+09	50,95	2,12
25%	66,03	14,33	2,33E+11	64,06	7,09
50%	176,26	25,15	7,86E+11	72,95	9,04
75%	368,35	38,41	1,84E+12	81,64	11,59
max	885,82	72,52	4,05E+12	142,42	27,69

Figure1- Correlation Matrix

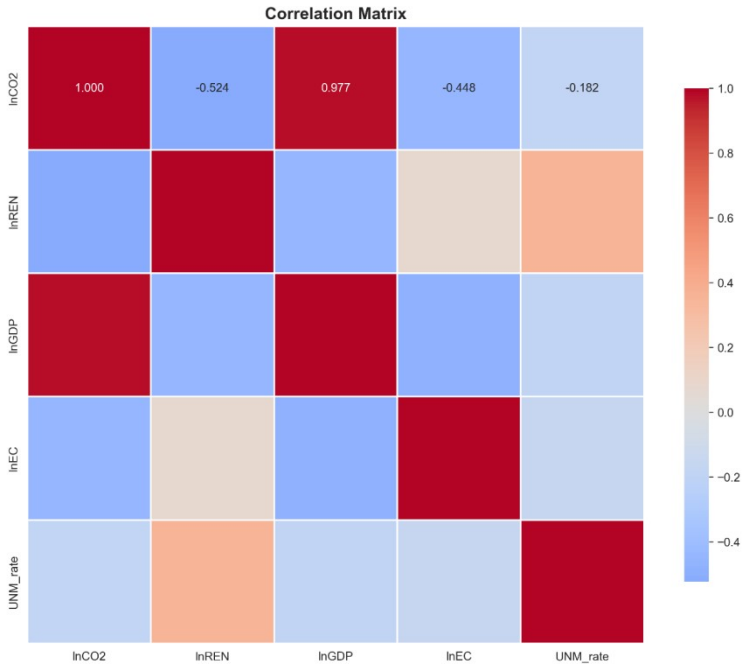
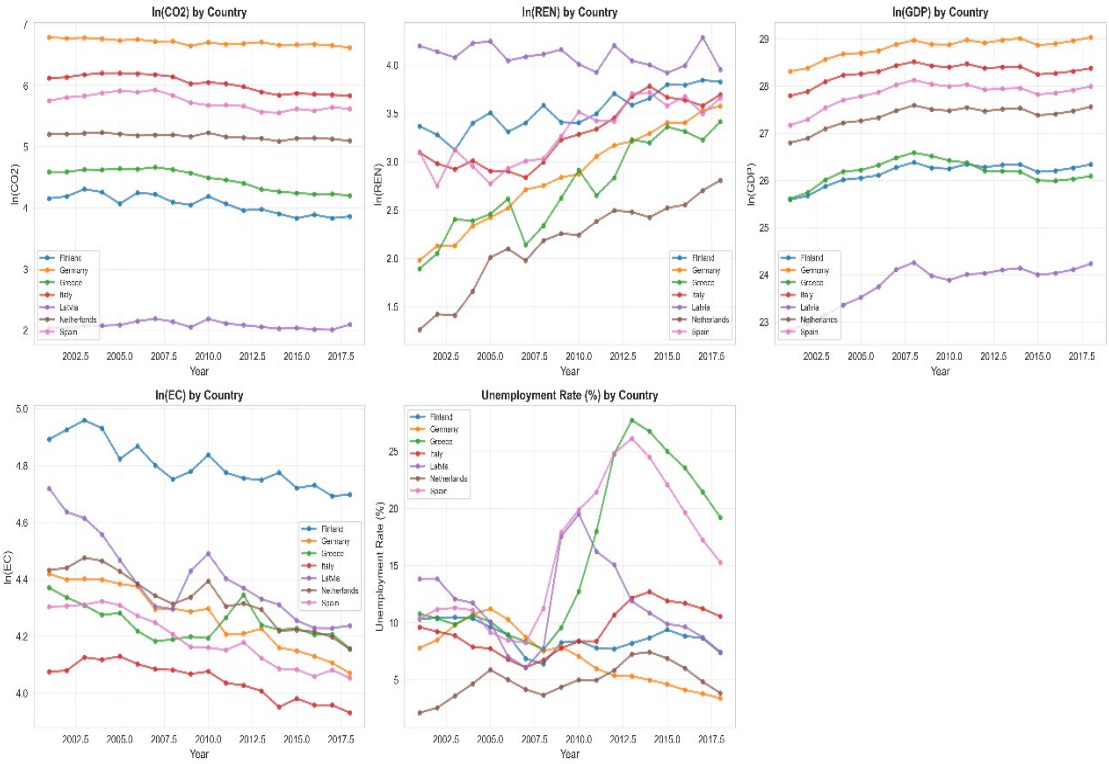


Figure2- Time Series plots



The data reveals a complex interplay between economic performance and environmental impact, characterized by distinct regional and structural differences. From Figure 2, which represents the time series of variables, we can see that the sample of countries selected is quite representative of the diversity that prevails in the European Union. There are industrialized countries with consistently high carbon dioxide emissions such as Germany, but also countries with a small footprint such as Latvia. In most countries, carbon dioxide emissions are clearly declining, because of the concerted efforts of the European Union institutions. In the use of energy from renewable energy sources, Latvia and Finland maintain the highest historical levels, while Germany demonstrates a steady upward trend, reflecting aggressive transition policies. Economic growth remains steadily upward over the period under review, as does energy consumption. Unemployment, on the other hand, is relatively uneven, and the data includes countries that suffered great damage from the debt crisis of the previous decade.

4. EMPIRICAL RESULTS

To investigate the validity of the environmental Phillips curve for sample countries using panel data, we employ the cross-sectional Panel Autoregressive Distributed Lag (CS ARDL) model proposed by Chudik and Pesaran (2015). The advantage of this model is that short-run and long run elasticities of the variables utilized are directly provided by the CS-ARDL model (Ullah et al., 2023).

The panel ARDL approach offers several methodological advantages: it accommodates both short-run dynamics and long-run equilibrium relationships, allows for heterogeneous cross-sectional units, and remains robust regardless of whether the underlying variables are integrated of order zero I(0), order one I(1), or mutually cointegrated.

The first step is to test cross-sectional dependence as based on CD Test proposed by Pesaran (2021). Table 3 shows the cross-sectional dependence analysis and the results reveal that a variation does exist in the coefficient of the variables. The validation of CD as suggested by the results means that any change in one country either in economic growth, renewable energy, energy consumption, or unemployment rate on carbon dioxide emissions has a ripple effect on each other.

Table 3- Results of cross-sectional dependence analysis

Variables	Test Statistic	P-Values
LnCO2	11.521*	0,0000
LnRNE	7.363*	0,0000
LnGDP	15.864*	0,0000
LnEC	14.515*	0,0000
LnUNEM	5.028*	0,0000

In the presence of cross-sectional dependence, we conducted CADF second-generation unit root testing at the level and first difference. Table 4 displays the findings from the CADF tests. At levels the result is mixed, but the first difference is for all variables stationary at significance level 5% and as a result all variables at first difference had integrated of order one, I(1).

Table 4 -Results of CADF unit root tests

Variables	**Level**	**Level P-value**	**First Difference**	**First Difference P-value**
lnCO2	-3.129	0.000	-5.130	0.000
lnGDP	-0.789	0.998	-2.191	0.050
lnGDPSQ	-0.778	0.998	-2.185	0.050
lnREN	-2.449	0.000	-4.758	0.000
lnEC	-3.294	0.000	-5.252	0.000
lnUNM	-0.945	0.998	-2.029	0.050

Table 5 presents the results of the Westerlund panel cointegration test (Westerlund, 2007). The outcomes of the cointegration test are demonstrated by both the statistical and panel groups (Gt, Ga) and (Pt, Pa). The findings indicate that the dependent and independent variables examined are significantly cointegrated over the long term. Consequently, the null hypothesis is rejected in favor of the alternative hypothesis. Once cointegration between the dependent variable and independent factors was established, the study advanced to panel data analysis. Accordingly, the CS-ARDL test was applied following stationarity and cointegration assessments to analyze short-term and long-term relationships among economic growth, renewable energy, energy consumption, unemployment rate and CO_2 emissions.

Table 5- Westerlund cointegration test results

Statistic	Value	Z-value	P-value	Robust P-value
Gt	-3.52***	3.9	0.09	0.00
Ga	-0.15	3.41	1.00	0.81
Pt	-4.61***	-0.31	0.06	0.00
Pa	-0.90	2.32	0.99	0.59

Table 6 presents the results obtained from the CS-ARDL model. A significant negative ECT term indicates that the speed of adjustment is -0.84, meaning the ECT will return to long-run equilibrium at this rate. The empirical findings indicate that unemployment rate and energy consumption are the primary significant drivers in both the short and long run. Specifically, unemployment rate holds a negative relationship with the dependent variable, significant at the 10% level in the short-run and the 5% level in the long-run, suggesting that as unemployment rises, carbon dioxide emissions tend to decrease. Energy consumption exhibits a strong positive and statistically significant impact. Renewable energy and GDP show negative and positive coefficients respectively, but fail to reach statistical significance. The negative and statistically significant coefficients for unemployment rate in both the short-run and the long-run lend support to the existence of an Environmental Phillips Curve within the context of this study.

Table 6- CS-ARDL results

Variable	Short Run			Long Run		
	Coefficient	P-Values		Coefficient	P-Values	
REN	-0,1190	0,1931		-0,1745	0,3248	
GDP	0,1274	0,1987		0,0592	0,4336	
UNM	-0,0140	0,0646	*	-0,0072	0,0239	**
EC	0,7301	0,0012	***	0,6001	0,0395	**
ECM	-0,8469	0,0004	***			

5. CONCLUSIONS

The purpose of this paper is to investigate the effect of employment on environmental degradation, in the context of the Environmental Philips Curve framework for the countries members of the European Union. For this reason, we used a sample of seven European countries for the period 2000-2019. The panel data estimation models was based on CS-ARDL and Westerlund's cointegration test. The empirical validation of the Environmental Phillips Curve in this study presents a significant policy challenge for the European Union. The finding that higher unemployment is associated with lower carbon emissions in both the short and long- run confirms that, historically, emissions reductions have often been a byproduct of economic slowdowns rather than structural reform. This suggests a fundamental conflict where prioritizing jobs can inadvertently hurt the environment. While the transition to a low-carbon economy aims to foster green jobs, it simultaneously triggers a process of creative destruction that eliminates roles in carbon-intensive sectors.The fact that renewable energy was found non-significance in the results suggests that current green initiatives have not yet reached the scale necessary to decouple employment growth from emissions. In order to break the EPC trade-off, innovation must ensure that new production methods are both employment-friendly and less polluting. Governments should implement national reskilling programs specifically designed for workers in the energy, waste, and industry sectors. These programs must focus on the technical skills required for renewable energy maintenance and green manufacturing to reduce the "time and effort" lag currently hindering labor adaptation.

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SESSION

"Social Architecture – Environment and Health"

Chaired by **Prof Dimelli Despina** and
Asst Prof Poli Maria

DOES GENDER MATTER IN CONSPIRACY BELIEFS VACCINATION HESITANCY? EVIDENCE FROM COVID-19 VACCINATION IN UGANDA

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Abstract
Whereas countries have made strides in getting citizens vaccinated, many still face the challenge of vaccination hesitancy. Evidence indicates that conspiracy beliefs among citizens influence hesitancy and that these beliefs are contextual; thus differing among individuals. Studies have examined the gender aspect and COVID-19 conspiracy beliefs but research is still limited on contextualizing the conspiracy beliefs among the genders and on whether such variations affect vaccination hesitancy differently.

This paper examines whether gender is a significant moderating factor between conspiracy theory beliefs and vaccination hesitancy in Uganda, using COVID-19 Vaccination

as a case. The study findings on which the article is based are part of a larger study on conspiracy theory and covid-19 vaccination hesitancy.

This was an explanatory sequential mixed methods study that included a cross-sectional survey and in-depth interviews. To establish the relationship between conspiracy belief and vaccination hesitancy across gender, Pearson Chi-square analysis was used to explore the gender differences in intentions regarding COVID-19 vaccination and conspiracy beliefs and mentality. There were 1201 participants in the study and 53% of these were females.

The findings show that women with strong beliefs in conspiracy theories were more likely to be undecided and unlikely to take up COVID-19 vaccine compared to men with similar beliefs. Men with similar beliefs were already vaccinated. Similarly, females with strong conspiracy mentality were less likely to take up COVID-19 vaccine compared to men with similar mentality. This implies that interventions to improve COVID-19 vaccination should be contextual and consider the gendered differences especially among women who are undecided and unlikely to take the vaccines due to conspiracy mentality.

Key words: Gender, Conspiracy Beliefs, Vaccination Hesitancy, COVID-19, Uganda

1. INTRODUCTION

Conspiracy beliefs and vaccination hesitancy have been increasingly recognized as intertwined phenomena, often influenced by exposure to misinformation and mistrust of institutions (Jolley & Douglas, 2014; Arce et al., 2021; Enders et al., 2022; Coelho et al., 2022; Caycho-Rodríguez et al., 2022). These beliefs encompass various aspects of the COVID-19 pandemic, including its origins, spread, countermeasures, and vaccination efforts (Douglas, 2021; van Mulukom et al., 2022). However, the extent to which conspiracy beliefs impact vaccination attitudes may vary across demographic factors, including gender (Balafoutas et al., 2021; Leonard & Philippe, 2021; Marcellino, 2021; Knobel et al., 2021; Romer & Jamieson, 2020; Gallè et al., 2021). While studies have explored demographic predictors of conspiracy beliefs and vaccination hesitancy, conflicting evidence persists regarding the role of gender in shaping these attitudes (Arif et al., 2022; van Mulukom et al., 2022; Cordina et al., 2021). This paper seeks to address this gap by showing how gender moderates the relationship between conspiracy beliefs and COVID-19 vaccination hesitancy, providing much needed information on how to mitigate the impact of conspiracy beliefs and vaccination in Uganda.

1.1. Gender and Conspiracy Beliefs

Amidst the growing body of research on COVID-19 conspiracy beliefs, there remains a notable gap in understanding the nuanced role of gender in this context (Cassese et al., 2020; Tulloch et al., 2021; van Mulukom et al., 2022). Since the onset of the pandemic, numerous conspiracy theories surrounding COVID-19 proliferated, positing that events are orchestrated clandestinely to cause harm (The Swedish Civil Contingencies Agency, 2021). While approved vaccines offer significant protection against COVID-19, not all eligible individuals were willing to receive them, contributing to vaccination hesitancy observed globally (Killgore et al., 2021; Sallam, 2021; Lazarus et al., 2021; Ackah et al., 2022).

1.2. Gender and Vaccination attitudes

Understanding the gendered dynamics of conspiracy beliefs and vaccination hesitancy is paramount for designing targeted interventions to address vaccine hesitancy effectively. While

women have been found to express higher levels of skepticism and concerns regarding vaccine safety, men may exhibit greater willingness to vaccinate (van Mulukom et al., 2022; Runciman et al., 2021; Galasso et al., 2020; Franceschet et al., 2021; Tulloch et al., 2021). This apparent gender paradox underscores the complexity of vaccination attitudes and emphasizes the need for tailored approaches to promote vaccination uptake. By elucidating the gender-specific influences on conspiracy beliefs and vaccination hesitancy, this paper accentuates the need for the development of more targeted and effective public health strategies in Uganda. The attitudes of women to vaccination is especially important since as mothers, daughters, wives and leaders of households, they determine the health care choices of families, especially those of their children's vaccination. This can have consequences for the success of these other vaccination efforts to address other diseases that affect the general population. The paper is structured as follows. Section 2 presents the COVID-19 management and gender context in Uganda. Section 3 describes the theoretical literature review and frameworks. Section 4 presents the methodology including data used and analysis. Section 5 presents the results obtained from the analysis. Section 6 presents the discussion, conclusion and implications.

1.3 COVID-19 Management Uganda

Uganda, renowned for its adept management of various infectious disease outbreaks such as Ebola, cholera, and HIV/AIDS, emerged as a notable success story in handling the COVID-19 crisis, particularly during the initial phases of the pandemic (Aceng et al., 2020; Ryan et al., 2020; Bwire et al., 2021). Prior to the detection of its first COVID-19 case, Uganda had already formulated a comprehensive preparedness and response plan, delineating roles for various stakeholders (Ministry of Health, 2020). The country registered its inaugural COVID-19 case on 21 March 2020, prompting the government to enact "The Public Health (Control of Covid-19) Rules, 2020," which outlined regulations for managing the pandemic (Republic of Uganda, 2020). In line with World Health Organization recommendations, Uganda swiftly implemented a series of preventive and mitigation measures, including the suspension of public gatherings, closure of educational institutions and businesses, border closures, and the imposition of lockdowns, among others (State House-Entebbe, 2020). These measures were rigorously enforced as the government awaited the arrival of recommended vaccines to commence vaccination efforts. Uganda received its initial batch of COVID-19 vaccine doses on 5 March 2021, with the president and Ministry of Health actively advocating for widespread vaccination (Ministry of Health, 2021).

Despite these efforts, Uganda faced challenges with vaccine uptake, characterized by hesitancy and sluggish adoption rates. Issues surrounding vaccine availability, distribution, and administration contributed to the slow uptake on the supply side (Ministry of Health, 2021). On the demand side, vaccination hesitancy stemmed from negative perceptions, limited awareness, and misconceptions (Kabagenyi et al., 2022). By the close of March 2023, only 42.60% of the eligible population had received at least one dose of the COVID-19 vaccine (John Hopkins University & Medicine, 2023).

1.4 Gender and Health-Seeking Behaviour in Uganda

In Uganda, where healthcare-seeking behaviors are often suboptimal and access to evidence-based COVID-19 information is limited, conspiracy beliefs and their impact are anticipated to be prevalent, particularly among different gender groups (Musoke et al., 2014; Babirye et al., 2011; Ssanyu et al., 2022). Studies indicate that women in Uganda are less likely to have access to adequate medical treatment because of the costs associated with it, such as

consultancy and transport (UBOS 2012). This implies that anything that is likely to affect their attitudes to health care such as conspiracy beliefs can have adverse effect on their health seeking. Men on the other hand make decision in the household and have better health seeking behaviours (UBOS 2012). In Uganda, efforts to mitigate the influence of misinformation on COVID-19 and other diseases and their preventive measures remain scanty. While existing studies have predominantly focused on identifying determinants of COVID-19 vaccination hesitancy in Uganda, there remains a critical gap in contextualizing these determinants within the broader socio-cultural and gender-specific contexts (Echoru et al., 2021; Kabagenyi et al., 2022). Recognizing the importance of context in devising effective vaccination strategies, this study explored the intersection of gender dynamics, conspiracy beliefs, and COVID-19 vaccination hesitancy in Uganda.

1.5 Theoretical framework

To comprehend the dynamics of vaccination intentions, it is essential to delve into the theoretical frameworks that underpin such behaviors. Given the multifaceted nature of vaccination attitudes and intentions, various theories and models have been proposed to elucidate the determinants behind them (Betsch et al., 2018; Barattucci et al., 2022. As posited by Larson et al. (2014), pinpointing a singular determinant of vaccination behavior's strength is challenging due to its intricate nature. Consequently, relying on a singular theory or model to explain gendered vaccination intentions might be inadequate.

The Health Belief and Theory of Planned Behaviour Models

This Health belief model offers insights into how an individual's vaccination behavior is shaped by their perception of susceptibility to disease, the severity of the disease, the benefits of vaccination, and the barriers to obtaining it (Rosenstock et al., 1988; Rosenstock, 2005; Barattucci et al., 2022; Zampetakis & Melas, 2021; Limbu et al., 2022). The Theory of Planned Behavior (TPB) on the other hand posits that intentions, influenced by attitudes, subjective norms, and perceived behavioral control, are fundamental in determining behavior (Ajzen, 2020). Both theories emphasize the importance of attitude, social norms, and perceived control in shaping vaccination intentions. The two models offer some explanation on the behaviours exhibited by women and men in relation to COVID-19 Vaccine and hesitancy.

The 3C-5A models

The 3C model of vaccination hesitancy expands on HBM and TPB theories, suggesting that confidence, complacency, and convenience play pivotal roles in vaccination decision-making (MacDonald & the SAGE Working Group on Vaccine Hesitancy, 2015). Subsequent models such as the 4C and 5C models further elaborate on these factors, incorporating elements like calculation and collective responsibility into the framework (Betsch et al., 2015, 2018). Moreover, the 5A model underscores the significance of access, affordability, awareness, acceptance, and activation in determining vaccine uptake (Thomson et al., 2016; Betsch et al., 2018). These factors collectively contribute to an individual's decision-making process regarding vaccination. In the context of this study, the vaccination willingness model integrates components from HBM, TPB, and the 5C model, emphasizing the influence of personal and socioeconomic characteristics, information channels, attitudes, perceptions, and social support networks on vaccination willingness (Van Espen et al., 2023). In the context of

this paper, the characteristic that is of interest is the gender of the person. While gender may not directly impact vaccination intentions, it can exert indirect influence through other predictors, hence our interest in showing how gender matters in conspiracy beliefs and vaccination.

Against this backdrop, this study aims to contextualize COVID-19 vaccination hesitancy in Uganda, with a specific focus on gender and conspiracy beliefs as key predictors. Evidence suggests that both demographic factors and conspiracy beliefs significantly influence vaccination intentions (Cordina et al., 2021; Arif et al., 2022; van Mulukom et al., 2022; Seddig et al., 2022). However, the relationship between gender and conspiracy beliefs is nuanced and varies across contexts (Cassese et al., 2020; Galasso et al., 2021; van Mulukom et al., 2022). Moreover, the framing of COVID-19 information has been shown to impact vaccination sentiments, underscoring the need to consider gendered impacts within specific contexts (Abdel-Raheem & Alkhammash, 2021). Additionally, generalizations regarding vaccination attitudes across genders may overlook intersectional perspectives, where variations exist not only between men and women but also within these groups (Franceschet et al., 2021). Addressing these nuances is crucial for equitable research and effective vaccination strategies (Vassallo et al., 2021; Heidari & Goodman, 2021). Thus, this study explores the extent to which gender influences conspiracy beliefs and COVID-19 vaccination hesitancy in Uganda, recognizing the intricate interplay between demographic factors, information sources, and socio-cultural contexts in shaping vaccination intentions.

2. DATA AND METHODS

2.1 Design

This was an explanatory sequential mixed methods study that included a cross-sectional survey and in-depth interviews. The choice of an online survey was consistent with COVID-19 operating procedures aiming to limit direct contact while targeting individuals more likely to be exposed to conspiracy beliefs. To ensure representativeness, the physical surveys were conducted to ensure that Ugandans without access to online resources also participated in study.

2.2 Setting

Data was collected from both online and physical respondents across the country. Quantitative data was collected online through email and using socio-media platforms. Qualitative data was conducted through in person interviews from eight purposively selected districts representing the country's four regions, Wakiso and Mukono in Central, Mbarara, Sheema and Kabale in Western and South Western, Kapchorwa in Eastern Region, Arua in North Western and Gulu in Northern Regions. This paper is based on the results of the quantitative part of the study.

2.3 Sample

The sample comprised of 1,500 participants with 1000 online and 500 respondents from in-person interviews. Out of the 1500 individuals targeted and questionnaires administered, 1201 responded, giving 80% response rate. The sample size was calculated using standard Cochran formula. The study adopted a convenient sampling approach using online data collection methods like email and social media. Despite potential selection bias threats associated with online surveys, evidence suggests their utility in addressing vaccine hesitancy, particularly among literate populations exposed to misinformation. Additionally, the online

literate population often has direct connections to wide-reaching networks, facilitating exposure to online vaccine conspiracies. However, information spillover effects associated with internet use were considered (Acheampong et al, 2021). Physical data collection was done in villages and participants that were randomly selected using stratified and simple random sampling methods.

2.4 Data collection

A self-administered online survey tool was used to collect data from individuals through emails, google forms, and social media platforms such as Facebook, WhatsApp and Twitter. The participants in the study were recruited from online users in Uganda. Evidence on conspiracy belief shows that the extent to which a person endorses one specific conspiracy theory is a good predictor of the extent to which that person will endorse others (Goertzel, 1994; Sutton & Douglas, 2014; Swami et al., 2011; Lantian et al, 2016). Measurement of variables involved assessing participants' propensity to believe in conspiracy theories using established statements and a Conspiracy Mentality Questionnaire based on a 5-item version of the CMQ (Atari et al, 2019). Additionally, data on gender, education level, and age were collected as relevant factors associated with COVID-19 risk perception. Vaccination hesitancy was measured using the Precaution Adoption Process Model, depicting psychological stages individuals undergo when deciding on behavior change.

2.5 Analysis

Descriptive analysis was conducted to detect patterns, with bivariate analysis using Chi-square analysis to establish associations between conspiracy beliefs, mentality, and vaccine hesitancy. Multinomial regression models with interactions were employed to explore the moderating effect of gender on the relationship between conspiracy beliefs, mentality, and vaccination hesitancy, controlling for socio-economic characteristics.

2.6 Ethical Approval

Ethical approval was obtained from Uganda Christian University's Research Ethics Committee and the Uganda National Council for Science and Technology, with permissions sought from district officials for physical data collection. Permission was also sought to conduct the research from district officials in those districts where data was physically obtained. During data collection, respondents' consent was obtained, and every effort has been made to ensure confidentiality.

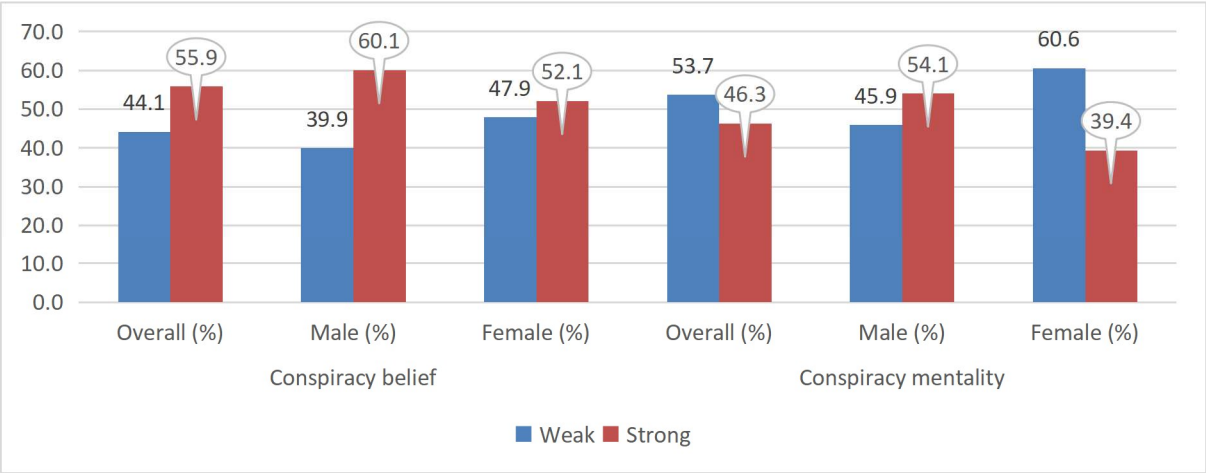
3.RESULTS

3.1 Overview

This section presents results comparing gender and conspiracy beliefs towards COVID-19 vaccines and mentality of respondents who participated in the study. Figure 1 shows a comparison of the relationship between gender and conspiracy belief towards COVID-19 vaccines and mentality of respondents. Later, bi-variate and multivariate results are presented to ascertain whether gender and conspiracy beliefs towards COVID-19 vaccines or mentality is related with vaccination hesitancy. The study's findings (Figure 1) indicate that men exhibit higher levels of both conspiracy-related beliefs toward COVID-19 vaccines and conspiracy mentality compared to women. Specifically, 60.1% of male participants demonstrated strong conspiracy beliefs, whereas only 52.1% of females did so. Similarly, regarding conspiracy mentality, 54.1% of males exhibited strong conspiracy mentality, whereas only 39.4% of

females did. These results highlights thatthere may be gender differences in attitudes towards COVID-19 vaccines and conspiracy beliefs.

Figure 1: Conspiracy beliefs and mentality by Gender



Source: Field data

The findings as shown in Table 1 suggest that women who strongly believe in conspiracy theories are more inclined to be hesitant or unwilling to take the COVID-19 vaccine compared to men with similar beliefs. However, it is notable that a significant proportion of both men and women with strong conspiracy beliefs ultimately choose not to receive the vaccine. Conversely, when examining individuals with weaker conspiracy beliefs, the results reveal that women (58.7%) are more inclined to accept the vaccine compared to men (48.5%) with similar levels of conspiracy belief. These findings underscore the complex interplay between gender, conspiracy beliefs, and vaccine acceptance, highlighting the need for targeted interventions to address vaccine hesitancy, particularly among individuals with strong conspiracy beliefs, regardless of gender.

Table 1: Gender, conspiracy belief and vaccination

Variable	Likelihood of taking COVID-19 Vaccine					
	Likely	Undecided	Unlikely	Already vaccinated	Pearson Chi (3)	P-value
Conspiracy belief (male)						
Weak	35 (50.7%)	9 (15.8%)	19 (18.3%)	163 (48.5%)		
Strong	34(49.3%)	48 (84.2%)	85(81.7%)	173 (51.5%)	47.86	0.000
Conspiracy belief (female)						
Weak	31 (51.7%)	26 (29.2%)	10 (13.2%)	237(58.7%)		
Strong	29 (48.3%)	63 (70.8)	72 (87.8%)	167 (41.3%)	73.44	0.000

Source: Data collected from the field

3.2 Moderating effect of gender and conspiracy belief on vaccination hesitancy

Table 2 presents the multinomial logistic regression results to establish the moderating effects of gender on the relationship between conspiracy belief towards COVID-19 and likelihood of taking a COVID-19 vaccine. Vaccination likelihood was categorized into four levels: 1) Likely to take the vaccine, 2) Undecided about taking the vaccine, 3) Unlikely to take the vaccine, and 4) Already vaccinated, with the latter serving as the reference category for comparison during analysis.

The results indicate that neither gender nor conspiracy belief significantly influence the likelihood of individuals choosing to take the COVID-19 vaccine or remaining undecided, as evidenced by p-values exceeding 5% at a 95% confidence level. However, strong conspiracy beliefs exert a statistically significant effect on individuals who are undecided or unlikely to take the vaccine compared to those already vaccinated, suggesting that strong conspiracy beliefs increase the propensity to refrain from vaccination.

Moreover, the interaction between gender and strong conspiracy beliefs significantly affects individuals unlikely to receive the COVID-19 vaccine. Specifically, females, when compared to males, exhibit a reduced likelihood of vaccine acceptance, particularly among those with strong conspiracy beliefs. This underscores that women are inclined to refuse the COVID-19 vaccine than men, particularly in the presence of strong conspiracy beliefs. Notably, even after adjusting for education level, marital status, religion, socioeconomic status, and age group, the interaction remains significant, emphasizing the enduring impact of gender and strong conspiracy beliefs on vaccination decisions. The detailed results where education level, marital status, religion, socioeconomic status, and age group are controlled for in model estimation are presented in appendix.

Overall, these findings highlight the detrimental effect of conspiracy beliefs, particularly on females, and underscore the need to shield women from exposure to such misinformation. Consequently, proactive measures should be implemented to mitigate the adverse influence of conspiracy beliefs, especially among women, to promote vaccine acceptance and public health outcomes.

Table 2: Multinomial logistic regression model results

COVID-19 Vaccination decision (Base outcome: Already vacinated)	Variables	Relative risk	Std Error	Z	P-value
Likely	Female	0.609	0.163	-1.860	0.063
	Strong Conspiracy belief	0.915	0.242	-0.330	0.738
	Interaction (female# strong conspiracy beliefs)	1.450	0.556	0.970	0.332
	Constant	0.215**	0.040	-8.260	0.000
Undecided	Female	1.987	0.795	1.720	0.086
	Strong Conspiracy belief	5.026**	1.906	4.260	0.000
	Interaction (female# strong conspiracy beliefs)	0.684	0.312	-0.830	0.406
	Constant	0.055**	0.019	-8.460	0.000
Unlikely	Female	0.362**	0.146	-2.520	0.012
	Strong Conspiracy belief	4.215**	1.164	5.210	0.000
	Interaction (female# strong conspiracy beliefs)	2.424**	1.085	1.980	0.048
	Constant	0.117**	0.028	-8.870	0.000
N (No. Observations)	1,201				
LR chi2(9) = 144.20 * p<0.05; ** p<0.01 Prob > chi2 = 0.0000 Log likelihood = -1228.6493					

4.DISCUSSION

The degree to which people endorse conspiracy beliefs is greatly attributed to their personal characteristics such as personal and socioeconomic characteristics, information channels, attitudes, perceptions, and social support networks (Van Espen et al., 2023). In this study we discovered that all those individual attributes contribute to the level of vaccination willingness

in the population, specifically emphasizing the mediating relationship between gender, conspiracy beliefs and Covid19 vaccine hesitancy in Uganda. We found out that gender is significantly associated with the likelihood of endorsing conspiracy beliefs among men compared to the women. Our results revealed that a greater proportion of men exhibited "strong" conspiracy-related beliefs and mentality toward COVID-19 vaccines compared to women. These results have revealed thatthere may be gender differences in attitudes towards COVID-19 vaccines and conspiracy beliefs in Uganda which is similar to a few studies in the US by (Cassese et al., 2020) where it was found that men we're more likely to endorse CTs than Women. While another study in the US showed that men had a higher likelihood to endorse conspiracy beliefs in comparison to the women. In this study men were more likely to agree with the statement that "I am convinced there is a conspiracy behind many things in the world." However, in another study women scored higher on an index of conspiratorial thinking and an index of conservative conspiracy theories in Federico, Williams, and Vitriol's (2018). In our study gender is associated with vaccine hesitancy that results from beliefs in conspiracy theories among men and women. Among the already vaccinated, women with weak beliefs in conspiracy theories are more likely to accept the covid 19 vaccine compared to the men, while men with strong beliefs in conspiracy theories are more likely to accept the covid 19 vaccine compared to the women. This result is a clear indication of how the belief in conspiracy theories among women can influence their decisions to get vaccinated, and yet among the men they would still embrace vaccination even with a presence of strong beliefs in conspiracy theories. This result is similar to what was discovered in a systematic review study by (Zintel et al., 2022), where the men were associated with a greater likelihood of intending to accept a COVID-19 vaccine in 35 studies. Despite that, in some other studies women have been found to have more likelihood of believing in conspiracy theories when compared to men, a study in Turkey that measured psychological correlates and covid 19 preventive measures found women endorsing a number of the conspiracy theories in comparison to the men (*Sinan.* et.al 2020).

In addition, there is a significant proportion of both men and women whose strong conspiracy beliefs ultimately affects their choice not to receive the Covid19 vaccine. Notwithstanding, there is a marked difference that women are less unlikely to get vaccinated compared to the Men. This relationship was confirmed with the multinomial regression model which clearly showed that the interaction between gender and strong conspiracy beliefs significantly affects women's vaccination decisions. The women who reported strong beliefs in conspiracy theories were much more unlikely and undecided to get a Covid 19 vaccine compared to their male counterparts. This finding implies that the majority of women with strong beliefs in conspiracy theories are likely to resist covid 19 vaccination because of their fear for uncertain situations that can arise after the immunisation especially when it involves other family members and children, (*Sinan. et.al* 2020). There are a number of reasons that have been identified in previous studies to explain the vaccine hesitancy among women. These include, the dismissal of women's reports of menstrual changes, the infodemic of fertility-related misinformation; and, the exclusion and confusing messaging regarding pregnant women – may have contributed to the patterns observed (Walcherberger et al., 2022). A study in Cameroon found majority of the women being less vaccinated compared to the men, (Amani et al., 2022).

A study in the US showed that majority of the women were more likely to be vaccine hesitant on the four categories scale which included, (I would definitely not get a COVID-19 vaccine; 13% I would not get a COVID-19 vaccine; probably I would get a COVID-19 vaccine; I would definitely get a vaccine(Morales et al., 2022). Similarly another study that

compared two surveys in Togo found women to report more vaccine hesitancy in comparison to their male counterparts (Akinocho et al., 2024). The mediating relationship of gender, conspiracy beliefs and vaccine hesitancy has been clearly articulated although there a few studies which showed no obvious gender differences in Covid19 vaccine hesitancy (Lee et al., 2022, Tulloch 2021, Jolley and Douglas - 2014).

5. POLICY IMPLICATIONS

The study results have shown that despite the fact that both men and women hold similar strong beliefs in conspiracy theories, the women reported higher levels of vaccine hesitancy precipitated by their underlying reasons for conspiratorial thinking. Therefore, the negative effects of beliefs in conspiracy theories is more damaging to women in comparison to their male counterparts. To address this, it is imperative that gender considerations be made throughout the continuum of vaccine development throughout to curb any gender biases in uptake of the inoculations. Applying an intersectional gender lens at each step of the process will help identify potential sex differences, and gender-related inequities, and support tailored vaccination programmes that can effectively respond to the diverse needs and experiences of women, and men thereby ensuring vaccination of 'everyone, everywhere'. Government and policymakers must tailor vaccine communication strategies to meet the informational needs of both genders. By implementing gender-sensitive interventions, they can prevent gender disparities in vaccine acceptance and utilization, thereby promoting equitable access to vaccination services for all segments of the population.

6. CONCLUSION

In conclusion, our study highlights the differential impact of Gender, conspiracy beliefs and vaccine hesitancy among men and women in Uganda. Our study sheds light on the gendered dynamics of conspiracy beliefs and vaccine hesitancy in Uganda. While men exhibited higher levels of conspiratorial thinking regarding COVID-19 vaccines, this did not significantly affect their willingness to be vaccinated compared to women. Conversely, women were more susceptible to the damaging effects of conspiracy beliefs, leading to greater vaccine hesitancy. This highlights a notable gender disparity in the impact of conspiracy beliefs on vaccine acceptance. These results underscore the importance of tailored vaccine communication strategies that address the concerns of both genders. The stakeholders and policy makers need to ensure that vaccine information and education initiatives consider the gendered nuances of conspiracy beliefs to foster equitable vaccine acceptance and uptake.

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Appendix 1: Multinomial logistic results control for other factors

Outcome (base outcome Already vaccinated	**Variables**	**relative risk & Z values**
1__Likely	2.gender	-0.378
		-1.33
	1.conspiracy_c	-0.085
		-0.3
	2.gender#1.conspiracy_c	0.142
		-0.35
	2bn.age_group	-0.503
		-1.74
	3.age_group	-0.77
		(2.20)*
	4.age_group	-0.947
		(2.32)*
	5.age_group	-0.316
		-0.78
	6.age_group	-0.304
		-0.63
	7.age_group	-1.917

		-1.79
	1.mstatus	0.262
		-1.08
	2bn.educ_level	-0.375
		-0.45
	3.educ_level	-0.718
		-0.82
	4.educ_level	1.32
		-1.69
	2.religion	-0.003
		-0.01
	3.religion	0.031
		-0.11
	4.religion	-0.411
		-1
	2perceived_wealth	-0.625
		(2.54)*
	3.perceived_wealth	-0.351
		-0.88
	Constant	-1.53
		-1.73
2__Undecided	2.gender	0.706
		-1.73
	1.conspiracy_c	1.486
		(3.85)**
	2.gender#1.conspiracy_c	-0.457
		-0.98

	2bn.age_group	-0.21
		-0.81
	3.age_group	-0.165
		-0.53
	4.age_group	-0.694
		-1.78
	5.age_group	-0.944
		-1.92
	6.age_group	-2.321
		(2.22)*
	7.age_group	-1.313
		-1.64
	1.mstatus	-0.13
		-0.58
	2bn.educ_level	-0.679
		-1.07
	3.educ_level	-0.803
		-1.25
	4.educ_level	0.258
		-0.43
	2.religion	-0.121
		-0.43
	3.religion	0.085
		-0.33
	4.religion	-0.326
		-0.85

	2.perceived_wealth	0.009
		-0.03
	3.perceived_wealth	-0.053
		-0.13
	_cons	-2.317
		(2.95)**
3__Unlikely	2.gender	-0.959
		(2.34)*
	1.conspiracy_c	1.379
		(4.85)**
	2.gender#1.conspiracy_c	0.89
		-1.96
	2.age_group	0.085
		-0.33
	3.age_group	0.293
		-0.97
	4.age_group	0.398
		-1.23
	5.age_group	-0.128
		-0.31
	6.age_group	-1.107
		-1.68
	7.age_group	-1.154
		-1.42
	1.mstatus	-0.087

		-0.43
	2.educ_level	-0.799
		-1.62
	3.educ_level	-0.391
		-0.8
	4.educ_level	0.021
		-0.05
	2.religion	-0.029
		-0.12
	3.religion	-0.598
		(2.38)*
	4.religion	0.015
		-0.05
	2bn.perceived_wealth	-0.145
		-0.53
	3.perceived_wealth	0.33
		-0.97
	constant	-1.759
		(2.72)**
N		1,201
	* p<0.05; ** p<0.01	

NEIGHBOURHOOD PHARMACIES OF THE FUTURE: LOCAL NETWORKS FOR PERSONALIZED, 3D-PRINTED MEDICINES

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Abstract
Cities are where pharmaceutical demand, environmental externalities, and health inequities intersect. The 3D-SustainDrugs project explores how sustainable three-dimensional printing can localize and personalize medicine production to better serve citizens while advancing circular-economy goals. Building on our project's bibliometric mapping of the 3D-printing-in-pharma landscape, we identify a maturing toolbox that directly supports urban deployment. We translate these technical themes into an urban implementation model; distributed micro-manufacturing hubs across hospital pharmacies, community health centres, and accredited university labs, coordinated by municipal health authorities. The model shortens supply chains, reduces overproduction and transport emissions, and enables individualised dosing for diverse populations, improving adherence and tolerability. To guide decision-making, we propose an impact dashboard for cities that tracks energy and material intensity per dose, lead time, wastage, access and equity indices, and patient-reported outcomes. The contribution is twofold: (a) an evidence-based synthesis of where the science is heading, and (n) a practical, citizen-centred blueprint for piloting circular, on-demand personalized medicines within urban health systems. The work is funded within the framework of the "SUB1.1: Clusters of Research Excellence (CREs)" Programme of the National Recovery and Resilience Plan 'Greece 2.0', and co-financed by the Greek State and the European Union (project code: ΥΠ3ΤΑ-0560854).

Key words: Personalized medicine, 3D printing, urban health networks, sustainable pharmaceuticals.

ACCESSIBLE HOUSES FOR PEOPLE WITH DISABILITIES IN GREECE: A CRITICAL VIEW

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Abstract
Accessible housing for people with disabilities (PwD) poses a significant issue within a complex building system that involves both social and economic aspects. Despite the existence of accessibility standards and legal frameworks, practical implementation is limited, and many homes fail to meet the requirements for mobility and independence. This study highlights the ongoing challenges and emphasises the need for comprehensive planning, inclusive design, and policy enforcement to ensure equitable housing opportunities for individuals with disabilities in Greece. These issues were discussed in a focus group meeting with twelve experts (n=12). Participants identified that bedrooms, kitchens, and bathrooms should provide specific services according to the needs of each type of disability. Additionally, accessible services outside the home, in the neighbourhood and city contexts are similarly important. Enhancing inclusive housing and infrastructure in Greek cities could also boost accessible tourism, thereby strengthening the country's strong tourism industry. Considering the environmental and social inputs of accessible housing seems to lead to higher sustainability. To address these issues, it is essential to require the close cooperation of all stakeholders.

This study offers valuable insights to enhance accommodations for individuals with disabilities, benefiting both practitioners and policymakers.

Keywords: Accessible Housing; People with Disabilities (PwD); Accessible Tourism; Inclusion; Accessible Infrastructure.

1. INTRODUCTION

Approximately 1.3 billion people globally live with some form of disability, representing 16% of the world's population. This figure increases when the elderly population is included, as the population over 60 years old is expected to reach 2.1 billion by 2050 (World Health Organization, 2022). These people have specific needs in their daily lives, including accommodation. Only 5–10% of housing worldwide is fully accessible, having ramps, suitable doors, elevators, and other infrastructure, with 30% of people with disabilities (PwD) living in non-accessible homes in the EU (Eurostat, 2020; WHO, 2022). In recent years, property prices worldwide have been rising, particularly in major cities (e.g., New York, London, Shanghai), and housing affordability has become a critical issue, leaving many households unable to access the market. Climate change impacts global habitation, especially in coastal areas, which are vulnerable to climate-related events such as floods, storms, and

rising sea levels. This factor must be considered in house construction. The provision of accessible housing to reasonably accommodate the needs and preferences of PwD should be a priority for governments, and this issue is highlighted in the United Nations Sustainable Development Goals (United Nations, 2018). Thus, the United Nations Convention on the Rights of Persons with Disabilities (2006) emphasises in Articles 9 and 28 that access to adequate, safe, secure, accessible, and affordable housing is a fundamental human right.

Housing accessibility for PwD is a critical issue connected to architecture, urban planning, and social policies (Goldsmith, 1976; Leventi et al., 1998). Architects, as professionals engaged with housing and urban environments, can significantly contribute by proposing solutions integrating the needs of PwD into housing design and urban infrastructure (Leventi et al, 1990). In addition, the active involvement and cooperation of all stakeholders are required to provide the proper accommodation services in a safe, healthy, and suitable manner, according to PwD needs, which include access to affordable housing and low-cost residences that align with the financial capacities of this group. Furthermore, housing should promote social inclusion, prevent marginalisation, and contribute to the social integration of residents (United Nations, 1994). More accessible housing contributes to improved health outcomes and quality of life (Bentley et al., 2011; Greiman & Ravesloot, 2016), leading to lower depression, mortality rates, falls and injuries and higher social participation (Carnemolla & Bridge, 2014; Cho et al., 2016), improving independence, safety, privacy, and self-confidence for PwD (Goodwin et al., 2022), and minimising costs for the provision of health services and other government resources (Vaughan et al., 2021). To achieve these benefits, it is essential to remove barriers that limit access to housing. We need to develop and implement effective policies, introduce necessary interventions to improve accessible housing, and recognise the significant impact that adequate accessible housing has on the health and well-being of PwD (Lindsay et al., 2024).

In this environment, Greece has made significant progress in implementing policies that enhance accessible housing. Nevertheless, additional initiatives are needed to meet the genuine needs of PwD. This study confidently presents practical solutions to strengthen accessible housing, employing a holistic approach grounded in the extensive expertise of professionals in the field. A focus group was conducted with twelve participants (n=12), guided by the first author, yielding valuable information.

The main findings of the study show that more accessible housing primarily requires important interventions within houses, particularly in bedrooms, kitchens, and bathrooms, as well as in the outside environment, in neighbourhood and city contexts. Therefore, a more comprehensive approach is suggested to improve the daily experiences of PwD. The lack of enforcement of legislation regarding access to workplaces, entertainment venues, public buildings, and public spaces is also a critical issue. Smart technologies provide valuable services more for technology-oriented PwD. The benefits of the Country's tourism industry, providing accessible housing services and attracting PwD from various countries, a significant market segment, can be important. To achieve all these, the cooperation of all parties involved in the specific subject is essential.

Policymakers, practitioners, and academics can gain valuable insights from the current study, which provides significant knowledge that can influence decision-making and practices in their respective fields.

2. LITERATURE REVIEW

Global urbanisation is reshaping social, economic, and spatial structures. The urban population is projected to reach 5 billion by 2028 and 6 billion by 2041, shifting the centre of economic activity and services from rural to urban areas (United Nations, 2018, a). This trend reflects not only the increase in the number of city dwellers but also the gradual shift of the centre of economic activity, innovation, and social services from rural to urban areas. Accessible housing for PwD remains limited worldwide, representing the weakest aspect of social inclusion (World Health Organization, 2022). The following table 1 presents interesting figures on a global and European basis, which show that a large number of PwD and an ageing population face significant problems mainly related to accommodation.

Table 1
Global and European Statistics on Disability, Housing, and Socioeconomic Indicators

Indicator	Global Statistics	European Statistics
Population with disabilities	15% of the global population (~1.3 billion people)	16% of the EU population (~80 million people)
Ageing population	The population over 60 is projected to reach 2.1 billion by 2050	20% of the EU population is over 65 years old
Housing &PwD	40% of PwD lack accessible housing	30% of PwD in the EU live in inaccessible homes
Energy poverty	10% of the global population experiences energy poverty	15% of PwD and 20% of the elderly in the EU face energy poverty
Unemployment of PwD	Unemployment is 50% higher than in the general population	The unemployment rate of PwD in the EU is nearly double that of the general population

Note. Data compiled from global and European disability, housing, and socioeconomic reports (World Health Organization, 2022; Eurostat, 2024).

However, this explosive growth of vulnerable and PwD citizens' numbers raises significant challenges related to housing adequacy, environmental sustainability, social cohesion, and, most importantly, the need to ensure equal access to essential infrastructure and services for all residents (United Nations, 2018, b). Statistics on accessible housing worldwide and in Europe highlight a growing need for accessibility, as the populations of older adults and PwD rapidly increase. In contrast, the necessary infrastructure to meet these needs remains underdeveloped in many regions. It is important to understand the most promising practices, policies, and interventions that facilitate accessible independent housing for PwD (Lindsay et al., 2024). In this process, PwD, builders, policymakers, architects, and research institutions must collaborate effectively to construct and deliver housing that is genuinely accessible. Initially, identifying the specific needs of various PwD groups, as each group has distinct requirements, and providing them with the proper services accordingly, is vital (Poli & Malagas, 2024). Environmental and functional issues are related to adaptations; therefore, households from larger cities, wealthier regions, and those with significant disabilities tend to spend more on adaptations (Alonso-Lopez, 2020). The following four dimensions influence decision-making regarding modifications: a) personal (including safety,

privacy, sense of freedom, and independence), b) societal (such as costs, limitations of service providers, and government standards for public access), c) physical (like the available space within the home), and d) temporal (which encompass health status and family conditions) (Aplin et al., 2013).

To improve accessibility, it is essential to implement suitable interventions that address home characteristics (Norin et al., 2021). Universal design, flexibility, simplicity, and minimal physical effort are the fundamental principles of creating accessible housing that can be used by everyone, regardless of their physical abilities (Primior Team, 2023). Eliminating specific barriers significantly improves accessibility for individuals with more complex functional profiles (Pettersson et al., 2018). The essential design features for housing include step-free access to the living space, spacious step-free showers, ground-floor bedroom accessibility, and reinforced bathroom walls to support the installation of grab rails after construction (Wellecke et al., 2022). Additionally, key considerations for an accessible house include step-free entrances for wheelchair access, wider hallways and doorways for more effortless movement, and eliminating barrier hazards to prevent tripping (Primior Team, 2023). Additionally, proper modifications are necessary to facilitate cleaning, improve mobility within the home, enhance safety, and enhance the home entrance (Greiman et al., 2022). Bathing adaptations enhance key aspects, including usability, safety, independence, choice, control, confidence, and overall quality of life (Whitehead & Golding-Day, 2019). Bathroom modifications are often accompanied by changes in entryways, living areas, interior stairs, doorways, bedrooms, kitchens, and flooring, all of which require significant attention and effort (Lindsay et al., 2024). A well-designed space layout should avoid the need to turn around in small enclosed areas; it should eliminate differences in floor levels; minimises the number of interior doors; avoids sharp corners in circulation paths; special attention should be given to the placement of door handles, bathrooms and communal areas should be spacious enough to accommodate a walker; kitchens should be L-shaped or I-shaped, and garages and parking areas must have sufficient space for a walker (Kuboshima & McIntosh, 2021). Lighting is crucial and must be appropriate, sufficient, easily adjustable, sustainable, energy-efficient, and adaptable (Fisk & Raynham, 2014). Ensuring good colour contrast on steps and proper lighting for light switches, along with underfloor heating, helps limit the risk of tripping and falling (Rooney et al., 2017). Protecting against humidity and temperature changes is crucial, especially in rural areas (Lee et al., 2018). The broader implementation of universal design promotes the availability of accessible housing (Imrie, 2003), which benefits all stakeholders.

Caregivers significantly impact the daily lives of PwD, although most prefer to live independently (Kuboshima & McIntosh, 2021). In addition, cohabitants participate in both recreational and daily activities while also impacting housing decisions and adaptations, though these appear to be just 'a piece of the puzzle' (Granbom et al., 2017). The involvement of PwD in the community is crucial and influences the home usability program (Greiman et al., 2022). These issues significantly contribute to

Education plays a crucial role in shaping students' understanding of universal design, fostering a mindset that embraces accessibility and inclusivity for all (Busby & Harrison, 2018). Architecture students must address these challenges by learning to design homes that are accessible and inclusive for people with diverse backgrounds and abilities. Therefore, interventions within the educational system to promote accessibility are crucial.

A smart home is equipped with advanced sensors and antennas that actively generate warning signals about obstacles, empowering users to navigate their living space safely and confidently (Poli et al., 2023). The home appliance control system offers convenience,

accuracy, and sanitation, enabling PwD to live independently (Chen et al., 2007). Assistive products serve various functions, especially those in the bathroom, which enhance independent performance (De-Rosende-Celeiro et al., 2019; Poli, 2021). With smart devices, users can control lighting, TVs, coffee machines, and shutters, making their lives easier and safer (Kosmyna et al., 2016). Therefore, smart homes enhance the independence and safety of PwD by providing essential services, and their effectiveness depends on the users' familiarity with technology (Ding et al., 2023; Poli et al., 2023; Poli & Malagas, 2024, b).

House builders often lack a comprehensive understanding of the needs of PwD and are hesitant to innovate or invest in the customisation of accessible homes (Tucker et al., 2022). Collaborative partnerships among all stakeholders—such as the disabled community, builders, lenders, landlord associations, and subcontractors—along with ongoing dialogue, can promote accessible housing with significant benefits (Heller et al., 2022).

Financial incentive policies for PwD, builders, and other stakeholders are essential for creating accessible housing (Lindsay et al., 2024). Housing vouchers that subsidise rental costs and enhance access to community services (Jenkins Morales & Robert, 2020), along with grants for housing adaptations (Fänge & Iwarsson, 2005), are essential.

Housing is not only a social or economic issue; it also has a profound environmental dimension. Accessibility addresses not only the immediate needs of PwD and older adults but also contributes to long-term social, environmental, and economic sustainability. In the modern era, sustainability, energy poverty, civil protection, and the protection of vulnerable groups, such as PwD, are central to housing discussions. Research on community resilience has demonstrated that inclusivity enhances social cohesion and facilitates community adaptation to challenges (Norris et al., 2011). On the environmental dimension, accessible housing often overlaps with sustainable design principles. Providing the required features allows buildings to accommodate diverse users across their life cycles, minimising the need for costly renovations or demolitions (Goldsmith, 1976). This adaptability contributes to resource efficiency and waste reduction, which are central goals of sustainable architecture and planning. Economically, accessible housing is a driver of economic sustainability, as it reduces long-term public spending on institutional care by enabling individuals to live independently. At the same time, universal design increases the market value of properties by making them adaptable to a broader demographic, including ageing populations (World Health Organization, 2022). Accessibility in buildings and public spaces is a fundamental value to ensure the rights of PwD and has important social benefits, such as higher and equal participation and inclusion. Sustainable housing aims to reduce the environmental footprint of buildings while simultaneously ensuring quality of life for residents and, of course, accessibility. Therefore, accessible housing is closely related to higher sustainability.

The provision of the proper regulatory framework that supports accessibility, housing, and social support of PwD and the elderly population groups is vital. In the European context, the European Disability Strategy (2021–2030) encourages investment in accessible housing and public services to promote social inclusion (European Commission, 2021). The 2021–2030 Disability Strategy aims to advance the social inclusion of PwD in Europe, with particular emphasis on housing accessibility, public services, and infrastructure. The European Directive 2019/882 also guides the accessibility of products and services (European Union, 2019). Countries implement international regulations and policies and adapt these to the local requirements, to ensure that PwD can live in accessible environments.

3. THE GREEK REALITY

In Greece, accessible building design has improved in recent years, but challenges remain. However, an important part, about 33%, of PwD face excessive housing costs, higher than in other EU countries (NEVRONAS, 2025). The majority of buildings—especially those constructed before 2000—are not accessible and require significant interventions to become suitable. Key issues include the lack of ramps, elevators, wide corridors, and ergonomic bathrooms, mainly due to insufficient standards in older buildings. This absence of appropriate standards hinders mobility during natural disasters, highlighting the need for specialised evacuation plans, and the inclusion of PwD in the early warning systems is vital (Poli & Malagas, 2025).

The implementation of the New Building Regulation (Law 4067/2012) and other regulations (Laws 4488/2017, 4674/2020; KYA (Joint Ministerial Decision) 52907/2009) established requirements for ramps, elevators, and ergonomic layouts (Ministry of Energy & Environment, n.d.; OpenGov, n.d.). Also, the European Directive 2019/882 (European Union, 2019) has been gradually incorporated into Greek law, concerning the accessibility of products and services. These laws and regulations require the construction of ramps, elevators, specialised sanitary facilities, and other infrastructure to facilitate access and use of buildings by PwD. In addition, the Greek Ministry of Infrastructureand Transport has issued technical accessibility guidelines, and there are state subsidy programs to upgrade homes to be accessible (e.g., the "Exoikonomo" program with a disability-focused extension), covering up to 90% of costs for projects such as ramps, elevators, bathroom renovations, etc. Beneficiaries must have an official disability certification fromthe Unified Disability Percentage Determination Table (KEPA) ≥67% (NewMoney, 2024).

In the majority of new buildings (both private and public), accessibility ramps are now mandatory, according to the Hellenic Organization for Standardisation (ELOT 1439, 2013)[41] guidelines. Additionally, new buildings must have at least one door per floor with a minimum width of 90–100 cm to accommodate wheelchair passage. Elevators in multi-story buildings must be accessible to PwD and meet specific dimensions and functions, such as a platform lift for wheelchair users. Modern designs should also incorporate visual guidance, utilising, for example, different floor materials or high-contrast markings on walls, to facilitate navigation for individuals with visual impairments. Finally, although legislation exists (New Building Code, KENAK (Regulation of Energy Performance of Buildings), etc.) and mandates accessibility, a large portion of the existing housing stock is not accessible in practice. The new constructions, to a large extent, often neglect accessibility needs due to cost or lack of awareness, leading to problems such as the absence of elevators, ramps, and ergonomic layouts.

Greece is making efforts to improve design and accessibility in public spaces, particularly in urban areas and transport networks. In major cities such as Athens and Thessaloniki, sidewalk and public space upgrading projects are being implemented to enhance accessibility, including the installation of ramps and wheelchair-accessible parking spaces. Accessibility in public transportation has also improved, with the introduction of accessible stops, lifts, and designated areas on buses and the metro. Nevertheless, Greece remains a poor example of an accessible country within the EU, and much more should be done.

[41]The ELOT 1439:2013 standard, entitled "Disability-friendly organization – Requirements and recommendations", sets out the criteria for evaluating organizations with regard to the conditions of unhindered access and service to people with disabilities. Its aim is to ensure respect for the rights of people with disabilities and the provision of equal services to all citizens.

4. METHODOLOGY

The focus group method was utilised in this study. This well-known qualitative approach has the potential to capture genuine, qualitative data through the participants' candidness and spontaneous interactions in a dynamic group setting (Jamieson & Williams, 2003). The roles of the moderator and observer are critical for guiding the discussion and gathering both verbal and non-verbal information (Acocella, 2012).

In the current study, twelve experts (n = 12) convened in a lecture room at the University of West Attica. Four of these experts joined the discussion remotely via Zoom. The participants included an architect, a builder, an interior designer, a professor of architecture, a professor of social sciences, a person with mobility challenges and his caregiver, a visually impaired individual, a high-ranking manager from the Ministry of Energy and Environment, a city mayor, a manager of social issues in a town, and a business owner who constructs assistive devices. All participants were purposefully selected for their extensive knowledge of the subject matter. The first author of the study led the three-hour meeting. Following a productive discussion, the group generated valuable insights.

5. THE FOCUS GROUP MEETING OUTCOMES

All participants agreed that accessible housing is essential and should be made available to PwD. They noted that specific housing requirements depend on the type and severity of the disability, the location of the housing, and the condition of the house, whether it is rented or owned by the individual. Life for PwD is especially challenging in rural areas due to inadequate infrastructure. Additionally, individuals with severe mobility issues face further challenges, as their mobility can be minimal. Bedrooms, kitchens, and bathrooms are the most demanding areas in homes and require specific adaptations to meet the needs of PwD. All these spaces must be on the same level to avoid the challenges of using stairs, which can make movement difficult. Appliances and cabinets should be positioned at a height that allows for easy accessibility. In addition, the flooring should be designed to minimise slipping, as slippery surfaces increase the risk of falls. Proper lighting and colour contrasts between the floor and walls are recommended for the visually impaired.

Outside the home, sidewalks are often in poor condition, with potholes and uneven surfaces that make movement difficult. Even if a house is accessible, the neighbourhood may not be; for example, a lack of ramps, inadequate public transportation, and public buildings can present challenges. Accessible housing located far from essential services, shops, or social opportunities can lead to isolation and hinder independence. In recent years, there has been a growing focus on improving mobility for individuals who are blind in public spaces, enabling them to navigate more easily with the aid of specialised canes. The recent implementation of personal assistant services by the Greek government for PwD has dramatically improved their daily lives. Smart solutions provide valuable services to young and technology-oriented PwD. They highlighted that increasing the accessibility of housing on Airbnb can have significant benefits for the country by attracting PwD tourists from abroad. It is essential to address environmental concerns by recognising the significant role accessible housing plays in sustainability, given its considerable economic and social impacts. It is crucial for all stakeholders—including the PwD community, builders, research institutions, and policymakers—to collaborate closely to create solutions and services that address the needs of PwD. Ultimately, everyone noted that individuals with severe disabilities and mobility issues need more modifications in their homes. Finally, all highlighted that Greece has made

significant progress in addressing disability issues; however, more can be done within and outside the home, such as improvements in sidewalks, public transportation, and public buildings.

A person with mobility issues emphasised the necessity of government financial support for making adaptations and constructing new homes. He added that the required turning space for a wheelchair of a minimum diameter of 1.50 meters, wide doors for easy access, especially in places with non-straight paths, comfortable corridors, and low light switches at an average height of 80 cm are essential. Narrow elevators, entrances with uneven floor steps, places that, with a smooth ramp, facilitate anyone using a cane, having a baby carriage and people with permanent or temporary disabilities.

Additionally, the two professors noted that university curricula should incorporate more content on accessible housing to better prepare students for future challenges, and this should apply to architects, civil engineers, and social and economic scientists.

6. DISCUSSION AND CONCLUSIONS

Contemporary housing production is primarily dominated by the private market, with limited state intervention. Housing construction often serves investment purposes (e.g., tourism Airbnb units, luxury apartments) rather than addressing the actual needs of residents. However, the state's role in introducing relevant regulations and policies is vital.

The number of citizens with some form of disability is steadily increasing, and they require particular housing services. Housing today is not merely a matter of shelter; it is a multifaceted issue encompassing politics, social concerns, environmental considerations, and ethical implications. The concept of accessible housing is intrinsically linked to the broader framework of sustainability, laying the foundation for resilient, inclusive, and sustainable communities.

Apart from the environmental and economic issues, home modifications to become more flexible increase safety, boost confidence, enhance mobility, and promote independence and community participation, leading to positive societal outcomes (Carnemolla & Bridge, 2014), help overcome stigma, redefine family roles, and provide opportunities for sensory development (Costa et al., 2020).

Architects today are required to balance aesthetics, technical competence, and social responsibility, proposing innovative solutions for sustainable and affordable housing. They play a key role in shaping housing standards that are fair, accessible, and sustainable. In Greece, architects are making efforts to design accessible buildings and public spaces; however, implementing these regulations faces challenges. Most daily activities take place in bedrooms, kitchens, and bathrooms, so these spaces should be fully accessible for PwD (Lindsay et al., 2024; Sukkay, 2016). Outside the home, accessible neighbourhoods and cities, with proper sidewalks, public buildings, transportation means, and other facilities, are essential. Both within-home and outside-home services are interrelated and are necessary to provide a more comprehensive approach. Although progress has been made, further steps are needed in education, enforcement of regulations, and infrastructure upgrades to fully integrate accessibility into daily life.

An extensive dialogue and cooperation among all stakeholders is needed to provide sufficient services to the disabled people's community in both housing and non-housing contexts. In particular, PwD, architects, builders, sub-contractors in building houses, research institutions, and policymakers at all government levels may work together to plan, design, and implement services and policies that make those people's lives easier and safer within and

outside the home through the promotion of accessible housing (Lindsay et al., 2024). Ongoing assessment and awareness of the needs of PwD is crucial, and it is imperative to adjust the provision of services accordingly (Malagas et al., 2023).

The literature presents conflicting perspectives on housing adaptations among individuals with different levels of disability. On the one hand, Tsuchiya-Ito et al. (2022) suggest that individuals with lower disability levels, lesser lower extremity impairment, or poor balance are more likely to implement housing adaptations. Conversely, Bishop et al. (2015) found that individuals with severe mobility limitations are more likely to make such adaptations, which aligns with the current study.

It is recommended that higher education programs be strengthened by integrating accessible housing design into the curricula of architects, civil engineers, economists, and social scientists, thereby ensuring that future professionals are equipped to create inclusive and sustainable living environments.

In conclusion, all stakeholders must work together more efficiently to create accessible housing, neighbourhoods, and cities, as these concepts are interrelated, and a more holistic approach should be applied. Bedrooms, kitchens, and bathrooms are fundamental spaces that should cater to the specific needs of PwD. Smart technologies can provide valuable services to those who use them. Policies that protect and address the needs of PwD are necessary and should be encouraged. The higher education system must better address the need for accessible housing. The continuous monitoring of the real needs of PwD and their active participation in designing a more accessible environment is imperative. Greece should do more to improve the PwD's daily lives both at home and outside the home.

Those involved in providing accessible housing gain valuable insights from the current study.

Limitations of the study and recommendations for future research

The study offers a general overview of how accessible housing can meet the needs of PwD in Greece. However, to gain deeper insights, more focused research on specific types of disabilities—such as mobility impairments, visual impairments, and cognitive disabilities—would be highly beneficial. Understanding the unique challenges and requirements of these groups can lead to more effective housing solutions that are tailored to their specific needs. Furthermore, conducting quantitative studies with larger sample sizes is recommended to provide more comprehensive and statistically significant data.

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BIOMIMETIC, SUSTAINABLE, AND ACCESSIBLE ARCHITECTURE: A HOLISTIC DESIGN PARADIGM

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Abstract
Architecture in the 21st century is influenced by the convergence of three essential approaches: biomimetic design, sustainable design, and accessible design. Biomimetic architecture draws inspiration from natural systems, sustainable architecture primarily focuses on minimising ecological footprints, and accessible architecture aims to ensure inclusivity for all citizens, including individuals with disabilities. This paper investigates the connections between these paradigms and incorporates insights from experts in the field.

Eight professionals (n=8) with extensive knowledge on the subject participated in the study. As a result, a new holistic model of architectural design has emerged, promoting resilience, equity, and long-term urban sustainability. This comprehensive approach offers significant environmental, social, and economic benefits. To enhance the integration of these three architectural concepts, strategies include fostering closer collaboration among stakeholders, efficiently utilising technology, and providing tailored education. This study offers valuable insights for practitioners and academics, helping them improve architectural design to better meet the needs of all citizens.

Keywords: Biomimetic architecture; sustainable architecture; accessible architecture; technologies in architecture; sustainability.

1. INTRODUCTION

Contemporary architecture is called upon to respond to multiple challenges related to the environmental crisis, social inequality, and the need for innovative housing and citymodels. Thus, the traditional approaches to building design are being replaced by paradigms that embrace ecological sensitivity and social inclusivity. The key concepts of the biomimetic, sustainable, and accessible architectures are shaping 21st-century architectural design. Although at first glance they may appear as distinct domains, in reality, they converge toward a common goal: the creation of buildings and spaces that respect the environment, empower social groups, and incorporate the principles of universal design. Biomimetic architecture has its roots in biomimicry, a concept that was initially defined and popularised by J. Benyus (1997) book and refers to innovation inspired by nature, studying it in-depth and imitating or taking ideas to adopt them in designs and processes to solve human problems; the main objective of biomimicry is sustainability. Sustainable architecture focuses on minimising the building's negative environmental impact through the proper use of materials, energy, development space, and the ecosystem at large ('green buildings'), and a crucial aspect of

sustainable architecture is its social dimension (Course Hero, 2020; Ragheb et al., 2016). Accessible architecture ensures that the built environment understands and responds to the diverse needs and abilities of all citizens, providing equal opportunities for persons with disabilities and other vulnerable groups, like children, elderly, pregnant women, and individuals with temporary impairments, among others (Singh & Saxena, 2023). This paper argues that the convergence of these three approaches is essential for the development of buildings and cities that are environmentally and economically viable, and socially equitable.

The above three concepts and their linkage were examined through discussions with eight experts (n=8) from various relevant fields. These experts brought a diverse range of perspectives and insights, which contributed significantly to the understanding of the topics at hand. Their collective knowledge and experience allowed the researchers to uncover valuable insights that can inform future research and practice.

The study's findings clearly highlight the importance of adopting a holistic approach that incorporates all three architectural types to achieve greater sustainability. By prioritising this approach, we can secure significant social, environmental, and economic benefits. Collaboration among all stakeholders, a focus on advanced technologies, and an emphasis on education related to these three types of architecture are essential for success.

Practitioners, policymakers, and academics will enhance their knowledge and understanding by engaging in collaborative research, sharing best practices, and accessing a variety of resources, and they can make more effective decisions and drive meaningful change in society.

2. LITERATURE REVIEW

Biomimetic, sustainable, and accessible architecture provides innovative solutions that greatly benefit everyone. The three concepts and their relationships will be presented briefly below.

Biomimetic Architecture

Biomimicry combines the Greek words 'bios', meaning life, and 'mimesis', meaning imitation. It refers to innovations inspired by nature, where one can study nature in depth and get ideas to design solutions for human challenges. Biomimicry serves as a bridge between ecology and innovation, with the primary goal of promoting sustainability (Benyus, 1997). The use of biomimicry is crucial for enhancing building efficiency and conserving energy. The Eastgate Centre in Harare, Zimbabwe, designed by Mick Pearce, is a notable example where termite mounds inspired passive cooling solutions, delivering up to 90% energy savings compared to conventional buildings (Turner & Soar, 2008). Similarly, the BIQ House in Hamburg employs microalgae façades, mimicking ecosystem dynamics for energy production (Speck et al., 2017).

The application of biomimicry as a design process falls into the following two categories: i) defining human need or a design problem and looking to biology to solve this, and ii) biology impacting design, identifying a specific characteristic, behaviour, or function and implementing this into human designs (Guild, 2007). In addition, designers can get ideas from organisms, behaviours, and the whole ecosystem. Finally, the following five possible dimensions from nature can be mimicked: a) its appearance (form), b) its composition (material), c) the method of its creation (construction), d) how it operates (process), and e) its capabilities (function) (Pedersen Zari,2007). It is crucial to replicate the role of an organism within the context of its broader ecosystem (Reap et al., 2005). This organism experiences the same environmental conditions as humans, understands the carrying capacity of its specific

habitat, and knows how to thrive within the limits of energy and materials available (Pedersen Zari, 2007). The construction behaviour of these organisms is known as 'animal architecture' (Hansell, 2005), and humans, as effective ecosystem engineers, can learn from them to enhance the well-being of ecosystemsand people, rather than their power, prestige or profit (Pedersen Zari, 2007). Eco-conscious architects, builders, and designersare focusing more on biomimicry as nature with 3.8 billion years of innovation, it may offer the following benefits: 1) energy efficiency and conservation; 2) water management and conservation; 3) improved air quality; 4) sustainable material sourcing; 5) reduced carbon footprint; 6) resilience to natural disasters; 7) enhanced aesthetic appeal; 8) connection to nature (biophilia); and 9) biodiversity support (A360 architects, nd).

Therefore, the benefits of biomimicry are important, and it serves as a tool to enhance the sustainability of human-designed products, materials, and the built environment (Biomimicry 3.8, 2021).

Sustainable Architecture

Sustainable architecture emphasises designing and constructing buildings and cities that minimise environmental impact while also providing social and economic benefits. This is achieved through energy efficiency, the use of renewable materials, and ensuring harmony with the surrounding ecosystem. In the last years, the terms eco architecture, green architecture, sustainable architecture, and, more recently, resilient architecture have been widely used (Donovan, 2018). The main characteristics of sustainable architecture include the following: 1. Energy efficiency; 2. Effective waste management; 3. Use of recycled and natural materials in construction; 4. Buildings that promote a superior indoor environment; 5. Efficient use of water; 6. Attention to design and orientation; 7. Incorporation of green roofs; 8. Integration with the surrounding environment; 9. Effective use of technology; 10. Adoption of more efficient systems; 11. Utilisation of natural lighting; and 12. Focus on durability (Mutuli, 2025).

Initially, applying sustainable architecture, significant environmental benefits are expected. In particular, sustainable buildings reduce carbon footprint and energy use (The AEC Associates, 2025), achieve more efficient use of materials and resources (Romero, 2024), water conservation and waste reduction (Nixon, 2024), and biodiversity, urban heat island, and ecosystem preservation (Auroma Architecture, 2024). The social benefits include a sense of safety through the design of safe spaces, increased flexibility by creating areas that can adapt over time, active participation by users or residents in decision-making, and the availability of shared spaces that promote socialisation (Lami & Mecca, 2021). In addition to enhanced safety and protection, factors such as comfort (thermal, visual, and ventilation), spatial organisation, spatial adaptability, and easier maintenance are emphasised. These elements are crucial for improving the user's quality of life (Nenadović & Milošević, 2022) and contribute to greater user satisfaction (Oberfrancová & Wollensak, 2021). Green roofs enhance place attachment, social well-being, and the collective identities of the frequent visitors to these locations (Nguyen Dang et al., 2022). Green buildings help raise awareness of relevant practices from an ideological standpoint, aim to establish benchmark projects, encourage the rapid adoption of green building methods, and enrich people's green lifestyles. These factors can lead to greater long-term benefits for society as a whole, which are important for the growth of the regional economy. In terms of cultural benefits, green buildings make people feel a sense of higher achievement, as well as increased livability, convenience, and comfort(Zhao et al., 2023).

Regarding the economic benefits of green buildings, Leisa (2021) noted that while green buildings may have slightly higher initial costs, the long-term savings from reduced energy consumption, maintenance, and operating expenses, along with increased marketability in terms of rents and occupancy rates, render them economically appealing. A study analyzed 33 LEED-certified buildings across California and found that, on average, green buildings cost only about 2% more to construct than conventional buildings. Over 20 years, the financial benefits of these green buildings outweighed their initial costs by a factor of 10, resulting in average net savings of $49 to $79 per square foot. The sources of these savings included reduced energy consumption, lower water expenses, enhanced productivity, and decreased operations and maintenance (O&M) costs. Interestingly, in the workplace context, the most significant economic benefit came from improved worker productivity and reduced absenteeism, rather than just energy savings (Kats et al., 2003). The U.S. Department of Energy, through the Federal Energy Management Program (FEMP) (2003), presented a strong case for incorporating sustainable design into federal building projects. It points out that strategies like energy-efficient systems, water conservation, and improved indoor environmental quality deliver substantial economic and operational advantages over the lifetime of federal facilities. Thus, lower operating costs, limited maintenance and replacement costs, improved asset value, enhanced employee productivity, and significant life-cycle cost savings are among the economic benefits of green buildings.

Consequently, sustainable architecture provides substantial benefits and should be prioritised.

Accessible Architecture

Accessible architecture involves the thoughtful design and organisation of the built environment to ensure that everyone can use it equitably, safely, and independently, regardless of their physical, sensory, or cognitive abilities. This approach is based on the principles of Universal Design, which aims to maximise usability and participation while minimising barriers and the need for specialised adaptations (Mace, 1985; Steinfeld & Maisel, 2012; Preiser & Ostroff, 2001). The application of universal accessibility standards—such as ramps, appropriately sized elevators, tactile paving for people with visual impairments, and ergonomic solutions—is not merely a technical detail but a fundamental element of social justice. In more detail, inclusive design effectively tackles essential elements such as colour, lighting, and room arrangements to ensure spaces are accessible to all, irrespective of gender, size, age, or disability. This comprehensive approach is recognised as Universal Design (Prasoon, 2023).The basic principles of accessible architecture include the following: a) Universal Design; b) physical accessibility; c) sensory considerations; d) easy wayfinding and orientation, e) wide implementation of ergonomics and user comfort; f) inclusive social spaces; and g) ongoing engagement and consultation (Chicago Architecture Center, nd).

Accessible architecture not only provides substantial social benefits but also offers important economic advantages. These include higher occupancy rates and increased property values, and in workplace settings, accessible design can attract a diverse range of tenants and employees (Prasoon, 2023), leading to improved employee productivity and reduced absenteeism (Story et al., 1998). Additionally, accessible architecture can reduce long-term costs by minimising the need for future modifications or retrofits, enhancing building value, marketability and user satisfaction (Story et al., 1998). Buildings that are more accessible contribute to smoother operations, reduce the need for staff assistance, and enhance the overall user experience. These advantages result in measurable operational savings and foster a positive public perception (Steinfeld & Maisel, 2012). Finally, they can lead to greater

loyalty in service-oriented facilities such as airports, universities, and hospitals (Zallio & Clarkson, 2021).

Identifying the real needs of individuals with various disabilities and incorporating them into buildings and urban environments is essential (Poli & Malagas, 2024, a). Adopting a more holistic approach that maps the user journey during the design phase, along with gathering and evaluating user feedback after occupancy, are complementary strategies that may enhance the design process by incorporating principles of inclusion, diversity, equity, and accessibility in the built environment (Zallio & Clarkson, 2021). Consequently, the active involvement of all groups of citizens is required to provide a more accessible environment.

The Relationship between Biomimetic, Sustainable, and Accessible Architecture

The three architectural types can be integrated to create a comprehensive framework that meets both ecological and social needs, resulting in inclusive and resilient built environments, while also considering economic benefits.

The following table 1 presents the common issues of the three architectural types.

Table 1. Common Features: Biomimetic, Accessible, and Sustainable Architecture

Aspect	Biomimetic Architecture	Accessible Architecture	Sustainable Architecture	Common Goal
Human-Centered Design	Draws inspiration from nature to enhance human life	Focuses on the needs of all users, without exclusion	Creates healthy, comfortable, and balanced living environments	Human well-being and comfort
Adaptability	Adapts to the environment, climate, and ecosystems	Adjusts to the individual needs and abilities of each user	Promotes flexible design based on environmental and social conditions	Dynamic response to both natural and human needs
Sustainability	Mimics natural processes to minimize resource consumption	Designs for durability and long-term usability	Utilizes eco-friendly materials and energy-efficient systems	Balance between humans, nature, and resources
Inclusion & Universality	Reflects the cooperation and harmony found in nature	Ensures equal opportunities for access and participation	Promotes social and environmental equity	Holistic design for all
Innovation & Technology	Applies natural patterns through advanced technologies	Employs assistive and ergonomic systems	Integrates green technologies and renewable energy sources	Smart and responsible buildings

Source: constructed by authors

Importantly, the chosen architectural style must address the extreme conditions primarily caused by climate change. Two key factors that can encourage the implementation of specific types of architecture are the role of technology in providing valuable services both within and outside the home (Ding et al., 2023; Poli et al., 2023; Poli & Malagas, 2024, b) and the importance of education. Education plays a vital role in shaping students' understanding of

universal principles and design, as well as fostering a mindset that values accessibility and inclusivity for all (Busby & Harrison, 2018).

Therefore, these three types of architecture can be combined to promote an inclusive, human-centred, and ecologically balanced architectural vision — one that aligns innovation, sustainability, and social responsibility.

3. METHODOLOGY

Qualitative research is a method of inquiry that seeks to understand human experiences, behaviours, and interactions by exploring them in-depth within their natural contexts, and often employing interviews, observations, and textual analysis to generate rich, descriptive data (Creswell & Poth, 2018; Denzin & Lincoln, 2018). Within this framework, an interview is a qualitative data collection method where a researcher asks participants open-ended questions to reveal their experiences, opinions, or perspectives on a specific topic (Brinkmann & Kvale, 2015). To gather reliable information, eight participants (n=8) with extensive experience engaged in a discussion about the examined issue with the lead researcher of the study. The group included an architect, an architect with mobility challenges, a social scientist, an economist, an ecology researcher, a professor of architecture, a high-ranking manager from a municipal organisation, and a representative for individuals with mobility issues.

4. THE STUDY'S FINDINGS

Initially, all the participants agreed that the concepts of biomimicry, sustainable, and accessible architecture are well interrelated and may provide useful solutions to current challenges, offering a holistic model of architectural practice, leading to higher sustainability. These three concepts correspond closely with certain United Nations Sustainable Development Goals (SDGs), specifically SDG 10 (Reduced Inequalities) and SDG 11 (Sustainable Cities and Communities). Cities and buildings designed under this triadic framework are better equipped to address climate resilience, demographic shifts, and equity challenges. For instance, eco-friendly housing that is both energy-efficient and universally accessible simultaneously addresses environmental and social sustainability. The intersection of these three approaches reveals a new architectural paradigm that views housing and public space not simply as constructions but as integrated systems of interaction between people, nature, and society. The economic impact of this comprehensive framework should not be overlooked. While the initial costs may be higher, the potential savings and the ability to meet the diverse needs of different groups, alongside the social benefits, provide significant economic advantages. All participants noted that spaces outside buildings, such as pavements, squares, public amenities, and public transport, could benefit from services based on the three types of architecture. They pointed out that these outdoor areas play a crucial role in the overall urban experience and can significantly enhance community interaction and accessibility, and improve the quality of life for residents and visitors alike. The chosen architectural design must take extreme physical phenomena into account. The collaboration between public and private sectors, along with an appropriate regulatory framework, can significantly strengthen the connection among these three types of architecture. By fostering effective partnerships, stakeholders can leverage resources, expertise, and innovative solutions to enhance the design, functionality, and sustainability of architectural projects. The widespread adoption of technology can enhance the integration of three types of architecture. Specifically, virtual reality (VR) and augmented reality (AR) enable architects and clients to

visualise and experience designs before construction begins, improving decision-making and user engagement. Additionally, 3D printing, AI, and machine learning contribute to design optimisation, energy efficiency analysis, and predictive maintenance, resulting in smarter and more sustainable buildings. Furthermore, the use of smart materials and green technologies promotes eco-friendly and energy-efficient architecture.

The architecture professor emphasised the importance of education, which should place greater focus on integrating the three types of architecture in the design of buildings and outdoor spaces, including more social and economic perspectives. Finally, the individual with mobility challenges requests greater involvement in the planning and decision-making process for the building and surrounding areas.

5. DISCUSSION AND CONCLUSIONS

Biomimetic, sustainable, and accessible architecture provides innovative solutions that greatly benefit everyone. Thus, biomimetic architecture offers innovative frameworks inspired by natural systems, promoting efficiency, adaptability, and regenerative design principles. Sustainable architecture provides the environmental and material basis for enduring designs while minimising ecological footprints.Accessible architecture ensures that the proposed designs are inclusive, equitable, and responsive to diverse human needs, integrating universal design as a core value rather than a post-design adaptation.When combined, these approaches form a holistic architectural paradigm that aligns technological innovation with ethical responsibility. This integration not only advances the aesthetic and functional dimensions of design but also reinforces architecture's role as a catalyst for social inclusion, environmental stewardship, and cognitive well-being. In addition to the building design, outdoor spaces such as pavements, squares, public buildings, and public transportation are essential and should draw inspiration from the three types of architecture examined.

Adopting a holistic approach that integrates the three architectural types examined in this study promotes the achievement of numerous Sustainable Development Goals (SDGs) established by the United Nations for the benefit of all (U.N., nd). In addition to the environmental and social benefits, the economic advantages are also significant, ranging from energy savings to increased efficiency, job creation, and long-term cost reductions for businesses and citizens alike. Consequently, implementing a holistic approach that incorporates the three types of architecture results in greater sustainability and should be applied effectively. The technology of smart materials, AI, and machine learning offers valuable solutions for architecture. Technology provides valuable services to manage extreme physical events such as earthquakes with early warning systems (Poli & Malagas, 2025) and severe weather conditions. Additionally, smart devices enhance independence and safety both inside and outside the home (Poli et al., 2023; Poli & Malagas, 2024, b). Education at all levels is essential for promoting specific types of architecture, incorporating relevant issues into their curricula, and hiring qualified teaching staff. The close cooperation of all stakeholders—such as governments, policymakers, educational institutions, professionals, and communities with specific needs—is essential for promoting architectural design that respects all citizens and the environment, while also delivering significant social and economic benefits.

In conclusion, adopting a holistic approach that encompasses biomimetic, sustainable, and accessible architecture requires the cooperation and active involvement of all stakeholders, along with contributions from technology and the educational system. This framework should

be emphasised as it greatly promotes sustainability by providing substantial environmental, social, and economic benefits.

6. LIMITATIONS OF THE STUDY AND RECOMMENDATIONS FOR FUTURE RESEARCH

Future research should further explore interdisciplinary methodologies—drawing from neuroscience, environmental psychology, and digital design tools—to develop measurable frameworks that assess how biomimetic principles and accessibility guidelines can co-evolve within sustainable systems. By deepening these intersections, architects and designers can move beyond conventional practice toward an architecture that is not only inspired by nature but also designed for all people and future generations. In this study, participants from Greece provide a general overview of the subject under examination. However, this could be considered a limitation of the research. Applying this study to other environments and countries while incorporating local characteristics would be beneficial for future research. Additionally, increasing the number of participants and/or utilising quantitative methods may provide more insights.

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SESSION

"Urban and Regional Sustainable Development"

Chaired by **Prof Lalenis Konstantinos** and **Dr Economou Agisilaos**

OPEN-AIR CITIES OF DEAD - WALKING, MEMORY AND THE CITY OF THE DEAD: THE FLANEUR BETWEEN URBAN SPACE AND THE NECROPOLIS

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Abstract
This paper explores the interrelation between walking as an urban practice and the spatial condition of the cemetery within the evolving fabric of the modern city. Drawing on Michel de Certeau's theory of walking as a performative act of reading the city, Walter Benjamin's flâneur, and Guy Debord's notion of dérive, it investigates how the figure of the urban wanderer engages with spaces of the living and the dead. The study traces the historical evolution of cemeteries—from central churchyards to peripheral necropolises—highlighting the socio-spatial and legislative processes that led to their exile from the urban core during the 19th century. Using Père Lachaise in Paris and the Taxiarchon Cemetery in Volos as case studies, the paper argues for the reintegration of the "city of the dead" within the living urban fabric. Ultimately, it suggests that reuniting these spaces restores collective memory and a deeper sense of humanity in contemporary

Key words: cemeteries, cities, flâneur, necropolis, sustainable environment - development.

Michel de Certeau, in *The Practice of Everyday Life*, describes walking as a practice of "a primary form of experience of the city." It is a process of reading the urban space, as the bodies of pedestrians follow the written traces inscribed in the urban text. The network of these moving and intersecting inscriptions, along with the multiple layers of events and trajectories, compose the city's palimpsest (De Certeau, 1984). De Certeau argues that the practice of walking transcends the geographical two-dimensional or even three-dimensional nature of the urban landscape, shifting instead into another spatial dimension—one defined through anthropological experience.

Walter Benjamin's *wanderer* is the "archaeologist of the city" and serves as a crucial methodological tool for the socio-spatial understanding of the urban landscape. The contemporary city is a place in constant transformation, characterized by both conflict and harmony. It is a pulsating organism of flows, tensions, and tendencies (Psarras, 2014). Through walking and wandering within the urban fabric, individuals appropriate space, recognize its uses, accumulate experiences, and participate—consciously or not—in urban design. According to De Certeau, "the walker moves within an existing spatial organization of the city, but chooses, or even condemns, certain places to inertia, to obscurity—or the opposite" (De Certeau, 1984, p. 99).

Michel de Certeau, Walter Benjamin, and Guy Debord—the latter as a founding figure of the Situationist movement (1957–1972) with the concept of *dérive*—were all influenced by Charles Baudelaire's *flâneur*. In his 1863 essay *The Painter of Modern Life*, Baudelaire introduced the figure of the *flâneur*, an artist inspired by the anonymity of the crowd and the endless flow of urban movement (Psarras, 2015). The *flâneur* emerged in the 19th century,

alongside major transformations of the urban environment and the rapid evolution of metropolises. His figure is intrinsically linked to the modern city, which moves at a fast pace, while he observes and creates his own sense of time within it.

In 19th-century Paris, the *flâneur's* essential setting was the *arcade* (Benjamin, 2006). The Parisian arcades were miniature cities in themselves, offering passersby shelter from noise, movement, and the weather. They were spaces of consumption and spectacle, reflecting the new needs of the industrial age. Within them, goods and shop windows became objects of fascination, turning passersby into spectators, dazzled and dreaming before the displays (Stavridis, 2007).

However, in the 1860s, as the *flâneur* wandered through the Parisian arcades, he might have crossed a threshold into another kind of urban landscape—a space of the dead—the famous Père Lachaise Cemetery, established in 1804 by urban planner Nicolas Frochot. Spaces of the dead have historically been referred to as graveyards, churchyards, burial grounds, God's acres, or cemeteries. Yet, the dead possess their own streets, mansions (mausoleums), poor neighborhoods, single-family houses or apartment buildings (columbaria), public buildings (gates, chapels, offices), as well as communal spaces and parks. Collectively, these form their own urban plan. For this reason, perhaps the most fitting term is *necropolis*, literally meaning "the city of the dead"—an urban landscape deeply intertwined with the city of the living.

Père Lachaise was groundbreaking in transforming the image of burial spaces. It evolved from a macabre burial ground into a landscaped garden—a peaceful resting place rather than a frightening one. Cemeteries were intended as places of walking, contemplation, and education, where planting, embellishment, and the architectural quality of monuments offered a rich and elevated experience.

However, the cemeteries of the 19th century also marked the beginning of their exile from the urban core. Historically, from around the 6th century, cemeteries (churchyards) were located within cities, functioning as central landmarks and urban landscapes. The public rituals performed within them made the cemetery an essential public space. With the post-medieval increase in population, industrial growth, and accelerated urbanization, serious public health problems arose. Cemeteries were blamed for the deterioration of sanitary conditions, and their very image became stigmatized. Society's attitude toward death shifted, and cemeteries became visually and symbolically unpleasant. Walls were erected, visually isolating them from the city.

Legislative acts such as the *Decree of 23 Prairial, Year XII* (1804, Paris) and the *Burial Act* (1851, London) formally exiled cemeteries from cities while simultaneously beautifying them. The 19th century institutionalized the displacement of the dead from churches and, consequently, from urban centers—on sanitary, philosophical, and urban-planning grounds. As Vovelle (2000) observes, this movement of relocation beyond city limits transformed cemeteries into "places of exile for the dead," hidden from the gaze of the living.

Meanwhile, large-scale urban interventions restructured cities to restore order and accommodate commercial expansion. When Père Lachaise was established, it lay nearly two kilometers beyond Paris's limits and was considered remote. As the city expanded, it soon became one of its most central cemeteries—an integral part of the 20th arrondissement. During the same decade in which the *flâneur* roamed the streets, Baron Haussmann—Paris's great urban reformer—sought once again to "relocate" the dead outside the city. Yet, despite having demolished and redesigned vast portions of Paris, Haussmann failed to move the dead. As Worpole (2003) notes, his plans faced strong opposition under the slogan *"Pas de cimetière, pas de cité."* This resistance reflected not only scientific advances that dispelled

earlier fears of miasma and contagion, but also the cemetery's new role as a domesticated and assimilated necropolis within the city itself.

Many 19th-century cemeteries followed a similar fate, gradually absorbed by the expanding urban fabric and now appearing as urban cemeteries. A parallel example is the *Taxiarchon Cemetery* in Nea Ionia, Volos, founded in 1882 (shortly after the city's liberation in 1880) in the area of Xirokampos, well outside the then-approved urban plan (Yasirani-Kyritsi, 1996; Polymenidis, 2019). Today, through successive postwar expansions, the city has enveloped it entirely.

Nevertheless, the tension between the city and the cemetery persists. The legal framework established in the 19th century continues to push burial spaces beyond the boundaries of the living. New cemeteries are founded on the peripheries, adhering to strict regulations. In Greece, the 20th century produced peripheral necropolises—bleak, decentralized, and devoid of funerary monuments, epitaphs, and familial references. As Worpole (2003, p. 56) observes, many contemporary cemeteries appear designed in the spirit of mass production, formed not to evoke spirituality but to accommodate industrial materials (marble, granite, stone) and achieve economies of scale. The cemetery has ceased to function as a space of recreation or reflection, becoming instead a utilitarian necessity.

If the *flâneur* were to wander through a modern Greek city such as Volos today, he would find no urban space of the dead within walking distance. The old Taxiarchon Cemetery remains inactive, while the new cemetery—established in the early 21st century—lies five kilometers from the city center, inaccessible on foot. The genuine experience of walking and drifting through an urban landscape of the dead has thus become impossible without the mediation of the automobile.

Even if the *flâneur* managed to reach this peripheral cemetery, he might experience the same sense of estrangement as in 1860s Paris—a cityscape marked by consumption and spectacle (Psarras, 2014). Yet, in searching, he might also discover "the curious fusion of the archaic with the ultra-modern … that is, modernity itself" (Pensky, 2004).

Returning to the separation of the city and the cemetery, it is worth noting that modern science has never proven that pre-19th-century cemeteries were responsible for urban epidemics. Sanitary conditions in contemporary cemeteries have improved significantly, eliminating any such threat. Nevertheless, the perception of cemeteries as sources of disease persisted, and most Western legal frameworks—founded upon this misconception—remain in force today (Koonce, 2011). In the contemporary era, the relationship between the city and the cemetery—the city of the living and the city of the dead—has become increasingly polarized. The institutional framework that continues to be produced in Western culture maintains a distance between the city and the cemetery, while at the same time sustaining contemporary society's dissonant attitude toward death.

In the post-industrial city, burial sites have been relegated to the periphery, often inaccessible and detached from the lived experiences of the communities they serve. Ultimately, the urban fabric of modern cities and suburbs denies the mortality of their inhabitants.

Robert Harrison (2010), in *The Dominion of the Dead*, writes: "As long as we think of our cities as places simply for the living and not for dying, they can never truly become our homes." On a personal scale, if people cannot be buried—or visit their dead—in a place they call "home," can they truly claim it as such? The bonds of a community are strengthened by both life and death, yet these ties often weaken or disappear after death in today's urban public realm. Case studies have demonstrated that reintegrating cemeteries into the urban

core—by providing accessible and functional public open spaces—can greatly benefit the community (Basmajian & Coutts, 2010; Koonce, 2011).

Worpole (2003) warns that if planners and spatial theorists fail to address the question of the cemetery seriously, and to design new types of burial spaces within contemporary cities, we risk creating "cities without memory"—urban environments that deny death and, ultimately, humanity itself. When it comes to the "housing" of the dead—whether through burial, cremation, or other means—the living desire to remain close to their loved ones.

Perhaps, then, the time has come to reunite the urban spaces of the living and the dead. Perhaps the necropolis should return to the city, even in a new form. Perhaps we should once again envision the *flâneur* walking through the city, crossing the threshold into the space of the dead, continuing to "read" the unified urban landscape of both the living and the dead.

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RELIGIOUS INSTITUTIONS: AN ANALYSIS OF THE LEGAL AND INSTITUTIONAL FRAMEWORK GOVERNING ZONING, CONSTRUCTION, AND BUILDING REGULATIONS AND THEIR INTEGRATION INTO SPATIAL PLANNING IN GREECE -A COMPARATIVE OVERVIEW WITH OTHER EU COUNTRIES

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Abstract
The study explores the interaction between religious institutions and urban planning in Greece through a detailed legal and comparative perspective. While religious freedom is constitutionally guaranteed in article 13 of the Greek Constitution, in article 3 of the Greek Constitution the Eastern Orthodox Church is recognized as the official religion. The historically privileged institutional position of the Eastern Orthodox Church has shaped spatial planning, licensing procedures and enforcement practices concerning places of worship. The study analyses the evolution of the regulatory framework governing the land - use, construction and operation of religious buildings, focusing on the institution of "Naodomia" (Law 590/1997) up to the subsequent integration of religious construction into the general urban planning system, and the continuing existence of differentiated regimes between Orthodox and non-Orthodox communities.

Particular emphasis is placed on the phenomenon of illegal construction, the expansion of religious buildings in environmentally sensitive areas, and the selective enforcement of planning law. At the same time, the research investigates the administrative barriers faced by minority religions, illustrated by the prolonged development of the Athens Mosque and related litigation before national courts and the European Court of Human Rights. The article demonstrates that institutional asymmetry produces tangible spatial consequences, including regulatory uncertainty, environmental risks and inequalities in access to lawful places of worship.

Through a comparative overview of selected European Countries— France, Germany, Spain (Catalonia), Italy and the UK (England) — the study identifies common principles of planning neutrality, technical zoning criteria and proportionality review in addition to Greek planning law for places of worship. The article argues that Greece continues to operate within a hybrid institutional framework that only partially aligns with these principles. It concludes by proposing reforms aimed at strengthening neutrality, transparency, environmental protection and the rule of law, thereby ensuring equal treatment of religious communities within a coherent urban planning system.

Keywords: urban planning, religious freedom, ecclesiastical institutions, planning law, institutional asymmetry, illegal construction, comparative planning law.

1. Introduction

The relationship between religion and urban planning in Greece has received limited systematic academic attention despite its significant legal and spatial implications. Constitutional provisions recognise religious freedom and equality, while also acknowledging the historical role of the Eastern Orthodox Church (article 13 and 3 of the Constitution). In principle, these provisions do not appear to give precedence to religious neutrality in the Constitution[1].This dual constitutional structure has influenced planning practice, licensing procedures and the distribution of regulatory authority.

Article 13 of the Constitution guarantees freedom of conscience, worship and religious association, subject to public order, morality and compliance with the law. International instruments, including the European Convention on Human Rights, the International Covenant on Civil and Political Rights and the EU Charter of Fundamental Rights reinforce these guarantees and form part of domestic law. Nevertheless, the coexistence of religious freedom with constitutional recognition of the prevailing religion has produced a distinctive regulatory environment.

Historically, the establishment of places of worship was characterised by institutional asymmetry. Orthodox ecclesiastical construction operated through specialised mechanisms, while non-Orthodox communities faced administrative requirements that included prior authorisation and, in practice, dependence on the dominant religious authority. In the past, even under the 1975 Constitution, which enshrined religious freedom in article 13, its free exercise was particularly problematic for citizens of different religions or different non-Orthodox Christian communities, especially those who were unable to perform their religious duties in places of worship. The maintenance for many decades of the legislation on "Naodomia" (Church Building Authority), between 1937-1939 remained the same until at least in 2006. Judicial intervention, particularly by the European Court of Human Rights[2], gradually prompted legislative reform. Yet structural differences persist.

The central hypothesis of this study is that Greece maintains a dual planning regime: A relatively flexible framework for Orthodox institutions and a more restrictive, bureaucratically demanding framework, politically fragile, and disproportionate framework for minority religions. This duality affects urban sustainability, environmental protection and the effective exercise of fundamental rights.

[1]Manitakis, A., (2001): 'There is disagreement among both Greek and foreign scholars that the separation of state and church in the Greek state is not institutionally and constitutionally established and that the secular character of the Greek state does not clearly emerge from the Constitution', The religious neutrality of the state in a pluralistic (and multicultural) society', Presentation at the Goethe Institut Thessaloniki, 19.11.2001, dikastes.gr. Furthermore, according to the provisions of articles 3, 13 and 16(2), it does not appear to be a religiously neutral state. Since the first Constitution (1822), Orthodox Christianity has been the dominant religion, linked to the country's national history, even though the principle of popular sovereignty applies (Article 1(2) of the Constitution). According to Venizelos, E. (2016) 'In places where there is a secular state, there is a secular state, in the sense of secular, laic, even a state that may have anti-clerical tendencies and traditions, or there may be a state with an official state religion, but with religious liberalism, as is the case with the evangelical Scandinavian states. 'The constitutional and international legal framework for religious education and the right to opt out of *it'* http://blogs.auth.gr.

[2]The two landmark decisions in which Greece was found guilty of violating the right to religious freedom, among others, are Kokkinakis and others v. Greece (25 March 1993 ECHR, Manoussakis and others v. Greece (26 September 1996). https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-58071%22]}.

The institutional asymmetry creates legality gaps, environmental degradation, and social tensions.

The study therefore examines the historical evolution of the legal framework, identifies contemporary challenges and evaluates comparative European approaches (France, Germany, Spain (Catalonia), Italy and UK (England) in order to formulate policy recommendations.

The structure of the study follows seven chapters, which record the European framework, Greek legislation on religious institutions through the analyse of the institutional framework of "Naodomia", the legislation on non-Orthodox communities, illegal construction with a special reference to the Islamic Mosque of Athens, monastery extensions and, finally, through a comparative overview and finally the conclusions and proposals.

2. The European framework and national practices

At European level, no specific Directive regulates land use planning for religious institutions. Competence in matters of spatial planning and building regulation remains primarily with the Member States. However, national authorities are bound by European and international human rights obligations, which impose substantive constraints on the regulation of places of worship.

The applicable normative framework derives principally from the European Convention on Human Rights[3] and the European Union system of fundamental rights protection, both of which require non-discrimination, legality and proportionality in administrative decision-making affecting religious exercise.

Freedom of religion is also guaranteed under universal human rights law. Article 18 of the Universal Declaration of Human Rights (10 December 1948) recognises the right to freedom of thought, conscience and religion, including the freedom to manifest religion or belief in teaching, practice, worship and observance.

At EU level, Article 10 of the Charter of Fundamental Rights of the European Union explicitly safeguards freedom of thought, conscience and religion. That provision corresponds to Article 9 of the European Convention on Human Rights and, pursuant to Article 52 of the Charter, has the same meaning and scope. The European Convention on Human Rights (Articles 9 and 11) guarantees freedom of religion and freedom of association, from which the right to establish and operate places of worship is derived.

The European Court of Human Rights (ECHR) has developed extensive jurisprudence concerning restrictions on religious practice, including limitations on the establishment and operation of places of worship. The Court recognises that Member States enjoy a 'margin of

[3]According to Javier Martínez-Torrón (2012): 'The notion of State neutrality described so far seems an appropriate and even necessary instrument to ensure the protection of religious freedom for all individuals and communities on equal terms. In recent years, however, it has been possible to see some signs suggesting that a new and different concept of State neutrality might be gaining momentum in the case law of the ECHR – a concept close to the French-style notion of laïcité, i.e., to a constitutional principle of secularism that would require a separationist attitude in the State. In other words, some decisions of the Court might be confusing the religious neutrality of the State understood as incompetence to take positions in religious matters, and to interfere in churches' internal affairs, with strict State separationism, thus paving the way for a sort of European "constitutional" principle of secularism, which in turn would be presented as a necessary consequence of or condition for freedom of thought, conscience and religion', Universal Rights in a World of Diversity. The Case of Religious Freedom Pontifical Academy of Social Sciences, Acta 17, 2012, pp.334, www.pass.va/content/dam/scienzesociali/pdf/acta17/acta17-martineztorron.pdf.

appreciation' in regulating religious matters within their constitutional traditions. Nevertheless, any interference with Article 9 rights must satisfy the cumulative conditions of legality, legitimate aim and necessity in a democratic society. Restrictions must therefore be 'prescribed by law', pursue one of the legitimate aims enumerated in Article 9 ECHR (such as public safety, protection of public order, health or morals, or protection of the rights and freedoms of others), and be proportionate to the objective pursued.

In planning contexts, this means that zoning restrictions, planning permission requirements or building controls affecting religious facilities must be grounded in objective urban planning considerations rather than religious preference, theological evaluation or majoritarian pressure. The Court has repeatedly emphasised that state neutrality and impartiality constitute essential components of religious freedom.

A leading authority is Manoussakis and Others v. Greece (23 September 1996), in which the ECHR found a violation of Article 9 where Greek authorities refused permission for a place of worship for Jehovah's Witnesses. The Court held that the discretionary planning permit system, combined with the involvement of ecclesiastical authorities of the dominant religion, created an unjustified obstacle to religious exercise. The judgment clarified that preventive administrative control cannot be exercised in a manner that renders the effective enjoyment of religious freedom illusory.

Following this decision, Greek legislation was amended—albeit after considerable delay—by abolishing the requirement for prior approval or opinion from the ecclesiastical authority of the Orthodox Church of Greece (Article 27 of Law No. 3467/2006). The reform sought to align domestic law with the requirements of neutrality and non-discrimination established by the Convention system.

Despite the existence of a coherent European human rights framework, urban planning and planning permission practices remain shaped at national and local levels, reflecting constitutional traditions, church-state arrangements, administrative structures and socio-political particularities.

In most European Union Member States, religious buildings are classified as facilities of public or community interest. They are typically incorporated into land-use categories covering public services, social infrastructure or community amenities. The designation of such uses in local plans is subject to neutral, technical and objective criteria.

Across jurisdictions, the most common planning considerations include:

- **Zone compatibility:** Places of worship are generally permissible in residential, mixed-use and urban zones, subject to compatibility with surrounding uses.
- **Accessibility and parking:** Authorities assess traffic impact, peak attendance periods and adequacy of parking provision.
- **Environmental protection:** Noise control (including bells or calls to prayer), waste management and impact on neighbouring properties are evaluated.
- **Safety and fire protection:** Strict compliance with building codes applicable to public assembly spaces is required.
- **Cultural heritage protection:** Construction or alteration within protected areas is subject to additional constraints under heritage legislation.

Thus, while financing models and institutional relationships between church and state vary considerably, the methodology of land-use planning tends to converge toward a framework based on technical neutrality and proportionality review.

2.1 *Comparative examples*

As observed by Ewing (2000), 'church-state systems in Western Europe have traditionally been classified into three models: separation, concordatarian and national-church systems. Although formal constitutional arrangements differ, there is a marked convergence towards a cooperative and flexible model in which religious freedom is protected within a neutral regulatory framework'. The comparative overview below illustrates both convergence and distinctive national features concerning zoning and construction of places of worship.

France: France embodies the model of formal separation grounded in the principle of laicism (laïcité), as codified in the Law of 1905. This legislation guarantees freedom of conscience and worship while affirming the neutrality of the Republic. Although the constitutional principle of secularism remains foundational, contemporary practice reflects pluralism rather than rigid exclusion of religion from public life.

Religious buildings are subject to the same urban planning regime as other public- interest facilities. Local Urban Plans (Plans Locaux d'Urbanisme – PLU) designate permissible zones, and building permits are granted on the basis of technical assessment, public consultation and compliance with safety and environmental standards. Judicial review by the Conseil d'État and other administrative courts consistently affirm the equal application of planning rules without religious exemptions.

Zoning assessments rely exclusively on neutral criteria: land-use compatibility, parking provision, architectural integration, accessibility, environmental impact, safety and fire protection. Considerations relating to religious identity, theological doctrine or numerical strength of believers are impermissible. Specific operational issues—such as peak attendance during Friday prayers in mosques—may require traffic impact analysis. Public calls to prayer are generally prohibited on grounds of noise regulation. Capacity standards and monument protection rules apply uniformly.

A distinct regime persists in Alsace-Moselle, where the 1905 separation law does not apply. The State recognises certain religions and finances clergy salaries. Municipalities bear obligations concerning maintenance of recognised religious buildings. Nonetheless, planning controls remain subject to administrative legality and equality principles. The Conseil d'État recognises freedom of worship as a fundamental liberty requiring public authorities to avoid unjustified obstruction of religious establishment.

Germany: The German Basic Law (Grundgesetz), incorporating principles from the Weimar Constitution, establishes a model of cooperative separation. Article 137 affirms the absence of a state church while permitting religious communities to obtain public law corporation status. Germany is frequently characterised as a system of moderate secularism.

Under the Federal Building Code (Baugesetzbuch – BauGB) and the Land-Use Ordinance (BauNVO), religious buildings are categorised within public-interest uses. Municipal land-use plans may designate areas for public facilities, including churches and other religious institutions, to meet community needs. Planning criteria are technical and predictable, encompassing building height, density, parking, traffic impact, environmental protection and heritage conservation.

Monument protection legislation at Länder level governs historically protected buildings. Noise regulation may address bell ringing, but such restrictions must satisfy proportionality standards.

Judicial review focuses on administrative legality and proportionality rather than theological evaluation. In Johannische Kirche & Peters v. Germany (2001), the ECHR held that refusal to authorise construction of a cemetery did not violate Article 9 where the

decision was based on neutral planning and environmental considerations.The Court accepted that the restriction pursued legitimate aims and fell within the state's margin of appreciation.

Spain (Catalonia): The Spanish Constitution guarantees freedom of religion and prohibits discrimination on religious grounds, subject to limitations necessary to maintain public order.

Although Catholicism retains historical recognition, Spain operates within a framework of liberal neutralism.

Catalonia has adopted an active regulatory approach. The Statute of Autonomy (2006) and subsequent legislation, including Organic Law 7/1980 and Law 16/2009 (as amended), establish the right of religious communities to create places of worship.[14] Municipalities are required to facilitate such establishments through urban planning instruments that ensure equality and prevent informal or unlawful worship spaces.

Planning permissions vary between municipalities but must be reasoned and transparent. Where requests to use public land are denied, authorities must justify their decision. Religious groups are also subject to administrative notification requirements following the opening of worship premises.

Controversies frequently arise where religious communities seek to establish worship spaces in industrial zones or premises not specifically designated for religious use. Litigation often centres on zoning definitions and proportionality. The Catalan model illustrates an attempt to reconcile equality of religions with structured urban planning oversight.

Italy: Italian constitutional law reflects the historical relationship between the State and the Catholic Church. The Constitution of 1948 (Articles 7, 8, 19 and 20) affirms mutual independence and equality of denominations while safeguarding religious freedom.[15]

National planning standards under Law 1444/1968 categorise religious facilities as public interest infrastructure within mandatory urban standards. Although no specific per capita quota is allocated exclusively to worship, religious facilities fall within the broader category of public service areas. Municipal plans (PRGC) designate such areas in accordance with national and regional planning law.

The National Planning Act of 1942, as amended, remains foundational. The Consolidated Building Code (DPR 380/2001) applies uniformly to all constructions, including places of worship, requiring compliance with zoning, safety, hygiene and structural regulations. The Cultural Heritage Code (2004) governs protection of historic religious buildings. Fire safety, seismic compliance and accessibility are particularly emphasised.

The Constitutional Court decision No. 254/2019 invalidated provisions of a Lombardy regional land management law that imposed disproportionate and discriminatory requirements on religious facilities. The Court reaffirmed that religious freedom constitutes an inviolable constitutional right and that public authorities must not create unjustified obstacles to access suitable spaces for worship. Planning regulations may impose necessary land-management conditions but must avoid arbitrary or excessive restrictions.

United Kingdom (England): In England, religious freedom derives from statutory law, judicial precedent and the Human Rights Act 1998, which incorporates Article 9 ECHR into domestic law.[17] The Equality Act 2010 prohibits discrimination on grounds of religion and belief. Although the Church of England retains established status, planning law operates on principles of neutrality and equal treatment.

The National Planning Policy Framework (NPPF) requires authorities to "plan positively" for community facilities, including places of worship. Religious buildings are assessed within the broader category of community infrastructure. Decisions must balance community benefit against potential adverse impacts such as noise, traffic or environmental effects.

Judicial review focuses on procedural fairness, rationality and proportionality. Courts do not engage in theological assessment but examine whether planning authorities have lawfully exercised their discretion. The overarching principles are neutrality, proportionality and reasoned justification.

The comparative analysis demonstrates a significant degree of convergence across diverse constitutional models. Notwithstanding historical differences in church-state relations, European jurisdictions increasingly regulate places of worship through neutral, technical and proportionate planning criteria. This convergence provides a normative benchmark against which the Greek legal framework may be critically assessed in subsequent sections.

3. Historical development of church building in Greece - "Naodomia"

For decades, the construction of Orthodox churches was governed by the institution commonly referred to as "Naodomia". This mechanism granted the Church a central role in licensing, design approval and project supervision, effectively creating a parallel planning process. Municipal authorities exercised limited control, primarily verifying technical compliance.

3.1. *Historical origins and legal basis*

The legal basis for this regime emerged through post-war legislation and the constitutional charter of the Church of Greece (Law 590/1977). Applications originated within ecclesiastical structures, and the assessment of 'religious need' was determined internally. The result was substantial institutional autonomy, which contributed to spatial expansion but also to concerns regarding transparency, environmental impact and regulatory consistency.

3.2. *Reforms and partial integration*

Reforms beginning in the 2010s sought to integrate ecclesiastical construction into the general planning system. Law 4030/2011 (A' 249) introduced a new, more unified system for issuing building permits. Furthermore, following the issuance of Opinion No. 148/2012 of the Second Section of the State Legal Counsel[4] , in which the Ministry of Environment, Energy and Climate Change, regarding the issue of jurisdiction and which service should issue building permits and carry out checks on the execution of works and issue the corresponding administrative acts (such as, for example, the suspension of construction works, the drafting of reports on unauthorised constructions). Unified building permit procedures, electronic licensing and supervisory mechanisms expanded state oversight. Advisory architectural bodies were established, and urban planning services assumed formal responsibility for permits and enforcement.

Subsequent legislation created specialised ecclesiastical building services operating within the broader planning framework. Article 53 of Law 4178/2013 (A' 174), the Central Council of Ecclesiastical Architecture (KE.S.E.A.) was established within the Church of Greece with an advisory role on architectural designs for churches and monasteries. The most radical reform took place with the enactment of Law 4495/2017 (A' 167) (Building Regulations Code). The law promoted the creation of special Building and Settlement Services for the Church of Greece, the Church of Crete and the Metropolises of the Dodecanese (Article 32). These services issue permits following municipal pre-approval and remain subject to state supervision.

Although this represents significant progress, the coexistence of specialised procedures with general planning rules continues to generate complexity.

[4]See Opinion 148/2012 Second Section of the State Legal Counsel, NOMOS.

3.3. *Current situation and concerns*

Today, a mixed system applies. Religious (ecclesiastical) legal entities benefit from specialised procedures, whereas private religious buildings follow standard municipal processes. While formal integration has increased, historical practices and institutional culture continue to influence implementation.

Despite this institutional integration, questions remain regarding transparency, consistency of inspections and effective enforcement against illegal construction. The long tradition of autonomy in church building continues to influence the relationship between Church and State in spatial planning, raising doubts about the transparency, the objectivity of controls and the actual balance between religious needs and urban planning rationality.

4. Legal Status for Non-Orthodox religious communities: Administrative obstacles and practical difficulties

In marked contrast to the constitutionally entrenched and institutionally autonomous status of the Eastern Orthodox Church of Greece, non-Orthodox religious communities have historically operated within a fragmented and restrictive legal framework. This asymmetry has generated structural impediments to the effective exercise of religious freedom as protected by Article 13 of the Constitution and Article 9 ECHR.

4.1. *The Old regime and structural difficulties*

For decades, the establishment and operation of places of worship for heterodox or non-Christian communities were governed by Compulsory Law 1363/1938, enacted during the Metaxas regime. The regime required prior administrative authorisation and, in practice, involved the decisive participation of the Orthodox ecclesiastical authorities. This system subordinated minority religious communities to the dominant Church and imposed disproportionate constraints upon their institutional autonomy.

The requirement of prior authorisation operated cumulatively with urban-planning controls, as a building permit under the General Building Regulations (New Building Regulations) constituted a prerequisite for the lawful establishment of any place of worship[5]. In practice, however, licensing was frequently withheld or delayed, resulting in systematic interference with religious activity, notably affecting Jehovah's Witnesses and other minority groups.

The European Court of Human Rights, in Manoussakis et al. v. Greece (1996) and Pentidis et al. v. Greece (1997), held that the Greek system violated Article 9 ECHR, finding that the discretionary and burdensome authorisation procedure amounted to a disproportionate restriction on freedom of religion[6].

[5] See I. Konidaris, G. Androutsopoulos (2017), Article 13, Constitutional Interpretation by Article, 217, pp. 297-298.

[6] JURISTRAS State of the Art Report Strasbourg Court Jurisprudence and Human Rights in Greece: An Overview of Litigation, Implementation and Domestic Reform, https://www.eliamep.gr/wp-content/uploads/en/2008/05/greece.pdf

4.2. *Recent Reforms: Unreliable Progress?*

Following repeated condemnations by the Strasbourg Court and sustained domestic criticism, the legislature initiated reforms. Law 4301/2014 introduced the status of 'religious legal entities', granting non-Orthodox communities formal legal personality. Law 4446/2016 curtailed the decisive role of local Metropolises in planning permission procedures, while Law 4559/2018 effectively removed the requirement of prior church (ecclesiastical) consent, transferring competence to the Ministry of Education and Religious Affairs and framing assessment criteria in administrative and urban-planning terms.

Most recently, Law 5224/2025[7] expressly repealed the 1938 regime and related provisions, rationalising the licensing framework and centralising supervisory powers, including revocation, sanctions and administrative measures concerning construction, alteration or operation of places of worship.

Notwithstanding these legislative advances, implementation remains procedurally complex and protracted. The Greek Ombudsman has documented persistent delays and administrative uncertainty, indicating that formal reform has not fully eradicated structural dysfunction.

4.3. *Practical Obstacles and Socio-political Reactions*

Beyond formal bureaucracy, minority communities encounter practical and sociopolitical barriers. Difficulties in securing permits often lead to the use of informal premises lacking adequate safety standards. Local opposition—particularly in relation to Islamic places of worship—frequently invokes urban-planning arguments that mask religious animus. Moreover, governmental reluctance to confront conservative resistance perpetuates regulatory inertia.

4.4. *The Case of the Islamic Cemetery in Athens*

The protracted failure to establish an Islamic cemetery in the Schisto area of Attica exemplifies enduring administrative inertia. Despite repeated governmental commitments, the absence of a dedicated burial site for the Muslim community raises concerns not only under freedom of religion but also in relation to human dignity and equality (US Department of State, 2023).

In sum, although the statutory framework has undergone significant reform, substantive equality remains imperfectly realised, as administrative dualism and local pressures continue to circumscribe the effective enjoyment of religious freedom.

5. The case of the Athens Mosque: a symbol of obstacles and institutional delay

The construction and operation of the official Mosque of Athens constitute the most emblematic and protracted example of the dysfunctions of the Greek institutional and administrative framework governing the licensing of non-Orthodox places of worship. Its century-long trajectory offers a compelling case study of how bureaucracy, political indecision and social resistance may shape – and hinder – spatial planning policy.

[7]Article 64 of Law 5224/2025: Article 64 - Repealed provisions - From the date of entry into force of this Law, the following are repealed: a) Article 1 of Law 1363/1938 "On the ratification of the provisions of Articles 1 and 2 of the Constitution in force" (A` 305), b) the
royal decree of 20 May/2 June 1939 (A` 220) "On the implementation of the provisions of Law 1673/1939 amending Law 1363/1938 on the ratification of Articles 1 and 2 of the Constitution in force" and c) Article 27 of Law 3467/2006 (A` 128) on the non-obligation to obtain a permit from the ecclesiastical authorities for the establishment, construction and operation of a church.

5.1. *Historical context and timeline of delays*

The need for an official mosque in Athens was formally recorded as early as 1890 yet the city remained the only European capital without one for more than 130 years. Key milestones include:
2000: An initial attempt to construct a mosque in Paiania collapsed amid strong local and ecclesiastical opposition.
2006: Law 3512/2006 established a state-controlled model, providing for public funding and the appointment of the imam by the Ministry of Education and Religious Affairs (Greece, 2006). Although intended to prevent foreign influence, this approach generated further legal and administrative complications.
2013–2016: Residents and the Metropolitan of Piraeus lodged multiple appeals before the Council of State (STE), delaying implementation. In decision 2399/2014, the Court upheld the constitutionality of the legislative framework. During the same period, four public tenders proved unsuccessful.
November 2016: The Votanikos site was cleared of squatters, enabling construction to commence.
3 November 2020: The mosque was inaugurated, though its operation was almost immediately curtailed by Covid-19 restrictions (Guardian, 2020).

5.2. *Analysis of obstacles: A web of adversities*

The prolonged delay reflects the interaction of several structural factors:
Institutional framework: The restrictive legacy of Law 1363/1938 created significant obstacles. Although Law 3512/2006 (A' 164) offered a practical solution, its provision for state funding and oversight raised concerns regarding religious neutrality and reinforced perceptions of Islam as a 'foreign' faith requiring special regulation.
Political hesitation: Successive governments treated the issue as politically sensitive, often deferring decisive action due to anticipated reactions from conservative constituencies and segments of the Church.
Church and social reactions: Opposition from ecclesiastical figures, notably the Metropolitan of Piraeus, and related legal challenges amplified local mobilization and tensions, further impeding progress (Delidaki, 2023).

5.3. *The final model and its symbolic significance*

The adopted model differs markedly from the regime applicable to the Orthodox Church:
State control: The mosque is administered by a private-law legal entity whose chair is appointed by the Ministry of Education, Religious Affairs and Sport.

Operation: The imam is appointed by ministerial decision.

Architecture: The building lacks a dome and minaret, reflecting an intentionally austere design described by some as neutral and by others as suppressing visible religious identity (Associated Press, 2020).

The Athens Mosque illustrates a broader pattern of institutional asymmetry. Whereas the Orthodox Church enjoys substantial autonomy, non-Orthodox communities have been required to accept a distinct, state-controlled framework in order to exercise their right to worship. The case demonstrates how bureaucracy, political caution and social contestation can collectively undermine the effective realization of fundamental rights within the rule of law.

6. Illegal Construction by Religious bodies: Legal Framework, practical tolerance and environmental impact

Illegal construction constitutes a central dimension of this study. The expansion of religious buildings, particularly in peri-urban and environmentally sensitive areas, reflects structural weaknesses in Greek planning enforcement. Selective tolerance, repeated regularisation schemes and amnesty legislation have shaped both private and ecclesiastical development. The interaction between institutional autonomy and enforcement gaps has generated environmental degradation, tensions with heritage protection and spatial inequality. Minority communities, by contrast, often rely on informal worship spaces due to persistent administrative barriers in obtaining permits, thereby reinforcing regulatory fragmentation.

6.1. *Extent and nature of the phenomenon*

Illegal construction by ecclesiastical bodies is not confined to isolated incidents but forms a structured and recurring pattern. Between 2000 and 2015, forestry and planning authorities in Attica recorded more than 300 unauthorised religious structures, including chapels and monastery extensions. Nationwide estimates indicate hundreds of unauthorized chapels; many erected by private individuals and subsequently transferred to dioceses.

The gravity of the phenomenon lies not merely in its scale but in its location. Numerous structures have been established within forest areas, Natura 2000 sites and even archaeological zones. Such interventions risk irreversible environmental and cultural damage and undermine the constitutional protection of the natural environment enshrined in Article 24 of the Constitution. The cumulative effect weakens the integrity of spatial planning and erodes confidence in the protection regime safeguarding Greece's natural and cultural heritage.

6.2. *The legal framework: Regulations that reinforce tolerance of unauthorised religious institutions*

The general framework governing arbitrary construction is provided by Law 4495/2017. However, specific provisions applicable to religious institutions effectively mitigate the consequences of illegality.

- Article 100(4) permits the legalisation of small-scale unauthorised constructions (up to 50 m²) belonging to ecclesiastical legal entities through a simplified procedure requiring only an application to the municipality and an opinion from the competent Metropolis.
- Article 114 is more consequential. It provides that unauthorised constructions belonging to legal entities of "public interest", explicitly including the Church of Greece and other religious bodies, are exempt from fines and from the single special penalty. This exemption amounts to de facto financial immunity and removes incentives for compliance.

Earlier legislation, notably Law 4178/2013, also afforded favourable treatment to state and ecclesiastical bodies. The cumulative effect has been a weakening of criminal and administrative enforcement and a shift from demolition towards retrospective legalisation.

6.3. *Typical cases and failure to enforce the law*

Demolition orders have seldom resulted in actual demolitions. In several prominent cases, substantial unauthorised constructions were recorded in forest or protected areas, significant fines were imposed, and yet enforcement remained incomplete or contested. Even where administrative courts upheld demolition decisions, implementation proved uncertain.

These examples reveal systemic deficiencies rather than isolated failures. Political reluctance to act against widely supported religious structures, bureaucratic fragmentation, understaffing of enforcement services and the legal complexity generated by special provisions all contribute to a preference for regularisation over removal. The result is a persistent gap between judicial determinations and administrative practice.

6.4. *Monastery extensions and unplanned construction*

Unplanned construction has long challenged Greek spatial planning. In the context of monasteries, the issue is particularly acute. Monastic institutions frequently own extensive landholdings in forest or protected areas and exercise considerable local influence.

Judicial intervention has occasionally been decisive. The Council of State has annulled permits and ordered demolitions in cases involving reforest able land and protected cultural landscapes, affirming that environmental and heritage protection prevails over individual religious needs. Nonetheless, implementation has often lagged behind judicial rulings.

Comparative experience suggests alternative models. In Italy, monasteries within protected landscapes operate under detailed management plans specifying permissible interventions. In Spain, religious communities at World Heritage sites conclude binding agreements with the state to ensure landscape protection and public accessibility. Such mechanisms demonstrate that institutional autonomy can coexist with strict spatial governance.

6.5. *Consequences: Environment, Equality and the Rule of Law*

Systematic tolerance produces environmental, social and institutional consequences. Environmentally, it contributes to ecosystem degradation and pressure on protected habitats. Socially, it fosters perceptions of inequality and impunity. Institutionally, disproportionate leniency towards ecclesiastical bodies undermines the principle of equality before the law and weakens the credibility of the rule of law.

Addressing the phenomenon requires not only reform of special exemptions but also sustained political commitment to enforce existing planning legislation through transparent and independent control mechanisms.

7. Comparative overview: Greece versus other European countries

A comparative assessment of the institutional framework governing the building and licensing of places of worship in Greece, juxtaposed with selected European jurisdictions examined in the previous chapter—namely France, Germany, Italy, Spain (Catalonia) and the United Kingdom (England)—reveals substantial structural and normative divergences. The analysis is structured around five core criteria: (i) the institutional framework; (ii) the licensing procedure; (iii) land-use criteria; (iv) the legal and practical position of minority religious communities; and (v) the handling of arbitrariness in administrative practice. This comparative lens enables both the identification of regulatory good practices and an objective evaluation of systemic shortcomings within the Greek urban planning and administrative regime.

7.1. *Criteria for comparison and contrast*

- **Institutional framework:** Whether a single, religion-neutral urban planning framework applies to all denominations or whether differentiated institutional arrangements exist for specific religious bodies.

- **Licensing procedure:** The complexity, transparency and coherence of the authorisation process, including the existence of parallel or dual licensing channels.
- **Land-use criteria:** Whether siting decisions are grounded in objective, technical and proportionate planning standards or influenced by extraneous, non-urban planning considerations (e.g. "religious necessity").
- **Position of minority religious communities**: The extent of legal and practical equality, including effective access to authorisation procedures and remedies.
- **Handling of arbitrariness:** The uniformity of rule application, the availability of judicial review, and the absence of preferential treatment or selective enforcement.

7.2. *Comparative framework between Greece and Other European countries*

Table 1. Comparative framework for the land use and authorisation of places of worship in Europe

Criterion	Greece	Germany	France	Spain (Catalonia)	Italy	United Kingdom (England)
Institutional framework	Dual system. Specific institutional mechanisms for the Orthodox Church; other religions subject primarily to the general planning framework.	Cooperative model with public-law corporation status for recognised communities.	Strict secular model (laÃ¯citÃ©) Unified and neutral system.	Constitutional neutrality with regional competence (Law 16/2009).	Moderate secularism. Formal equality, historically privileged Catholic position.	Cooperative, recognition-based model under statutory law; no religion-specific planning regime.
Authorisation procedure	Dual regime for non-Orthodox communities (planning permission plus specific administrative authorisation). Simplified for Orthodox institutions.	Single planning procedure without religious differentiation.	Unified planning process; no religion-based criteria.	Municipal permission similar to other public-assembly premises; regional notification.	Planning permission within national and regional frameworks.	Standard planning permission under national policy and local plans; no religious differentiation.
Land-use criteria	Dual criteria; religious need may apply to Orthodox institutions.	Objective technical criteria (zoning, safety, heritage).	Strictly neutral technical criteria.	Equal treatment; technical standards and public consultation.	Classification as public facilities; safety and urban standards apply.	Neutrality and proportionality; traffic, design and amenity considerations.

Position of minority communities	Structural asymmetry; heightened administrative burden.	Legal equality and access to public-law status.	Institutional neutrality.	Formal equality; regional diversity management.	Legal equality with regional disparities.	Recognition through charity and equality law; discretion at local level.
Handling of planning irregularities	Specific regularisation mechanisms benefiting ecclesiastical buildings.	General enforcement rules apply equally.	Strict enforcement ; no religious exemptions.	Equal enforcement.	General amnesty schemes applicable to all constructions.	General enforcement subject to proportionality review.

7.3. *Fundamental differences*

The divergences reflect distinct constitutional philosophies concerning State–religion relations.

• In France, the principle of laïcité entrenched in the 1905 Law on the Separation of Churches and State precludes state recognition or financial support of any religion. Consequently, planning authorities assess proposals for mosques, synagogues or churches exclusively on technical planning grounds, such as environmental impact and traffic management, thereby ensuring strict institutional neutrality.

• In Germany, the Federal Building Code (BauGB) and the Federal Land Use Ordinance (BauNVO) expressly recognise places of worship as socially beneficial facilities admissible in certain zones. The procedure is uniform and grounded in objective planning criteria, reinforcing legal certainty and equal treatment.

• In Greece, by contrast, the historically entrenched relationship between State and Orthodox Church has produced a bifurcated system. The existence of specialised ecclesiastical planning bodies and the invocation of "religious necessity" as a siting criterion for Orthodox institutions introduce a normative asymmetry unknown to other European systems and raise concerns regarding indirect discrimination.

• In Catalonia, Law 16/2009 institutionalises equal treatment while imposing technical standards, accessibility requirements and public consultation procedures, thereby preserving administrative independence.

• In Italy, regional planning legislation governs authorisation through neutral technical standards, although constitutional jurisprudence has curtailed disproportionate burdens on minority communities.

• In England, planning decisions operate within the framework of proportionality, balancing development control with the right to freedom of religion under the Human Rights Act 1998.

7.4. *Conclusions from the comparative approach*

The comparative analysis demonstrates that the Greek model diverges markedly from prevailing European standards. Institutional asymmetry manifests through:

1. A dual institutional structure favouring one denomination;
2. A dual licensing channel imposing additional administrative burdens on non-Orthodox communities;
3. The incorporation of non-technical land use criteria

4. Differentiated enforcement practices and selective regularisation mechanisms;
5. A tangible gap between formal constitutional guarantees and practical implementation.

8. Conclusions

The analysis of the institutional and administrative framework governing religious institutions in Greece, together with a comparative overview of European practices, confirms the existence of deep-rooted structural imbalances and the need for substantial reform. The principal conclusion of this study is that a long-standing institutional asymmetry favours the constitutionally established Orthodox Church over other religious communities, with tangible implications for urban planning legality, environmental protection and the rule of law.

8.1. *Summary of main findings*

The review demonstrates that the Greek urban planning regime for religious institutions is characterised by:

A dual institutional framework: Special bodies and procedures applicable to the Orthodox Church create a two-tier system, diverging from the neutral and uniform models observed in several European jurisdictions.

Bureaucratic obstacles for non-Orthodox communities: The requirement of both planning and administrative authorisation for places of worship, coupled with political and social resistance, results in indirect restrictions on religious freedom, contrary to Article 9 ECHR and the jurisprudence of the ECHR.

Tolerance of illegal construction: Legislative provisions allowing exemptions or favourable treatment for religious legal entities undermine equal application of planning law and weaken regulatory credibility.

Socio-political pressures: The prolonged development of the Athens Mosque exemplifies how political hesitation and local opposition may impede the effective protection of constitutionally guaranteed rights.

These findings confirm the existence of a dual institutional reality that compromises legal certainty, environmental protection and equal treatment.

8.2. *Policy proposals for institutional reform*

In response, the following reforms are proposed:
Unification of the planning framework to eliminate institutional asymmetry and ensure equal treatment of all religious and private actors.

Integration of church-related building permits into ordinary municipal planning authorities. Adoption of neutral technical criteria governing the construction of religious buildings. Removal of the 'religious need' criterion, limiting assessment to objective planning considerations such as land-use compatibility, accessibility and environmental impact.

Equal enforcement against unauthorised construction, including repeal of preferential exemptions for religious entities. Establishment of an electronic register of religious buildings to enhance transparency and oversight. Simplification of procedures for small communities, reducing administrative burdens while safeguarding compliance.

8.3. *Final assessment and outlook*

The interaction between religious institutions and spatial planning in Greece reflects enduring church–state arrangements that continue to shape regulatory practice. Although reforms have been introduced, differentiated procedures persist, generating uncertainty and unequal access to lawful places of worship.

Comparative European experience demonstrates that neutral, technically grounded planning regimes can reconcile religious freedom with sustainable development. Aligning Greece with these standards requires coherent institutional reform, consistent administrative implementation and strengthened transparency.

Ensuring equality among religious communities is both a constitutional imperative and a prerequisite for effective spatial governance. A unified and neutral framework would reinforce the rule of law while promoting sustainable and balanced urban development.

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ONTOLOGICAL TRANSFORMATIONS THROUGH THE WORK OF GIOVANNI BATTISTA PIRANESI

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Abstract
The context of the twenty-first century is characterized by constant redefinitions of fundamental social structures. The development of multidimensional ecological and territorial changes, as a result of habitation practices, composes a landscape of renegotiation of human primacy, highlighting the need to include non-human entities in philosophical and architectural considerations. This research paper examines contemporary ontological approaches that distance themselves from rational definitions of existence, nature, and social issues. The fundamental objective is to explore the qualities that highlight architecture as an inexhaustible meaning-producing process.

The first section analyzes the key characteristics of philosopher Graham Harman's approach to the metaphysical substance of objects. Exploring these qualities reveals methods of coexistence with the entities that surround us, while at the same time reestablishing the ontological substance of human nature. Subsequently, Timothy Morton's ecological thinking is introduced in an attempt to interpret the forces that shape geological formations and aesthetics beyond one-dimensional anthropogenic explanations. Finally, the current context of architecture is defined, along with the expressive means it incorporates.

The second section explores the work of Giovanni Battista Piranesi as a multidimensional architectural perspective that represents a turning point in 18th-century Western thought. After exploring the Carceri and Campo de Marzio collections through architectural history analysts such as Manfredo Taffuri, an attempt is made to re-narrate the ontological approach expressed in Piranesi's work in contemporary terms, as a form of extensive metaphor that tends to interpret its hidden aspects.

Key words: Object-Oriented Ontology; Non-Human Agency; Coexistence; Cityscape Shaping; Spatial Narrative; Giovanni Battista Piranesi;

PARTICIPATORY MAPPING AND ASSESSMENT OF LANDSCAPES THROUGH CROWDSOURCING: FROM UNIVERSITY EDUCATION TO CROSSCULTURAL CITIZEN SCIENCE

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Abstract
Modern digital technologies offer powerful tools to bridge the gap between academia and society in landscape assessment and mapping. This research details the development and application of a new scheme for quantifying public perceptions of landscapes and architecture, utilizing crowdsourcing through a dedicated mobile application.

Initiated as an educational tool in the field of architecture and landscape design educations, university students across Italy, Greece and France, participated in active crowdsourcing for mapping and assessing landscape and architecture. Following this foundational phase of testing the methodology and digital infrastructure we proceed to investigating how to evolve the utilized scheme to a broader, multicultural citizen science initiative. The presented research investigates the inferences from the use of this methodology with both student and citizen participants in two distinct areas.

First, scientifically, it yields valuable quantitative data for analyzing architectural styles, urban typologies, and public perceptions thereof. By connecting crowdsourcing, Geographic Information Systems (GIS), and mobile development, the groundwork is set for improved research in culture and humanities, with initial results showing strong correlation with established landscape assessment methods. Second, socially, the project evaluates the integration of interactive digital tools to foster democratic citizen science and participation. It demonstrates a significant impact on engaging participants in meaningful discussions and critical thinking about urban landscape quality.

Overall, the findings highlight the potential of these technologies to enhance research and practice in areas associated with landscape perception. The project provides a scalable model for participatory mapping, creating new conditions for communication and interaction between universities and the broader public.

Keywords: Crowdsourcing, Participatory Mapping, Landscape Perception, Citizen Science, GIS (Geographic Information Systems), Mobile Application and University Education

BEYOND SHELTER: DISPLACEMENT AT THE THRESHOLD OF ECOLOGICAL CHANGE

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Abstract
Mass displacement and the establishment of large-scale refugee settlements generate consequences that extend well beyond humanitarian concerns, profoundly reshaping local environments. This occurs as the concentration of populations often exceeds the ecological carrying capacity of the surroundings, generating acute pressures on land, water and biodiversity. This paper does not seek to criticize the establishment of refugee settlements, which provide vital support to vulnerable populations that areat risk. Instead, its primary objective is to highlight the challenges that emerge from the often ad hoc development of these settlements, which frequently lack proper planning and inadequate infrastructure for waste management, sanitation and energy provision; such factors contribute both to ecological degradation and to increased risks to public health.

To address the research objectives, two case studies, one in Asia and one in Africa, were selected to examine how refugee settlements of varying dynamics impact local environments in differing ecological and socio-political contexts. The first case study examines the Kutupalong Camp in Cox's Bazar, Bangladesh, that now accommodates over a million Rohingya refugees in approximately 30,000 hectares, one fourth of which derived from deforestation, leading to the disruption of local flora and fauna, and increased vulnerability to floods and wildfires. Comparable challenges are evident in the Minawao Camp in Mayo Tsanaga Division, Cameroon, which hosts roughly 76,000 refugees displaced from Nigeria; in this case, land degradation and overexploitation of natural resources has also been observed.

The results highlight the urgent need to integrate sustainable management strategies into humanitarian assistance. Only then displaced populations as well as the urban and environmental systems entwined with their survival may be safeguarded and sustained in resilience. To conclude, the contribution of this paper lies in highlighting the compatibility between refugee settlements and environmental protection, emphasizing the imperative of implementing integrated strategies.

Key words: refugee settlements, environmental impacts, sustainable management, socio-ecological systems, humanitarian assistance, ecological resilience.

1. INTRODUCTION

Human mobility represents one of the most pressing challenges of the twenty-first century. Millions are displaced, at a global level (Eleftheriou, Kyriakidis & Potsiou, 2023),not only in pursuit of better living conditions and improved economic opportunities (Rondos, Nagopoulos & Panagos, 2017), but also as a result of armed conflicts (Anderson, 2020), environmental disasters, and climate variability (UN Development Program, 2015 in Wennersten & Rubbins, 2020).According to the United Nations High Commissioner for Refugees (UNHCR, 2023), the overall scale of forced displacement has more than doubled over the past decade. Refugees constitute a significant proportion of these mobile populations, with their number estimated at approximately 42.5 million people by the end of 2025 (UNHCR, 2025). As a result, substantial population concentrations have emerged within refugee settlements worldwide. This demographic concentration poses multifaceted social, economic, and environmental challenges, significantly impacting infrastructure, local ecosystems, and overall ecological resilience (Sakamoto, Ullah & Tani, 2024; Shen, 2024; Sarkar, Saroar & Chakraborty**,** 2023; Geofrey & Tumwine, 2023; Tafere, 2018), while prolonged displacement further intensifing these pressures by accelerating the degradation of natural resources (Black, 1994).

Within this context, academic literature has expanded considerably, in recent years. Early analyses, often influenced by neo-Malthusian -or environmental Malthusian- perspectives (see more in Istalince, 2023; Merchant, 2022), tended to interpret increased refugee presence as a primary driver of environmental degradation. However, more recent research challenges this linear causality (Hunter, Luna & Norton, 2015). Contemporary studies argue that environmental deterioration in host regions is rarely attributable solely to refugee influxes; rather, it is embedded in pre-existing structural vulnerabilities, institutional shortcomings, and unequal systems of natural resource governance (Dano, et al., 2025; Bose, 2024; Jacobsen, 1997). The field of political ecology has been particularly influential in advancing this reconceptualization, emphasizing power relations, land administration structures, and differential access to resources as decisive factors shaping environmental outcomes in displacement contexts. The shift reframes refugee settlements not merely as sites of ecological strain, but as complex socio-political urban systems (Al-Homoud & Samarah, 2025) where environmental change is negotiated and mediated through governance systems.

Contemporary research increasingly prioritizes the identification of sustainable and integrative policy solutions. Guided by the framework of the United Nations Sustainable Development Goals (SDGs), policymakers and scholars seek to integrate economic development, environmental resilience, and social inclusion, which is considered as the main pillar for the success of such a strategy (Eleftheriou, Kyriakidis & Potsiou, 2023).

Positioned within this evolving scholarly approach, this paper explores the complex relationship between forced migration and environmental impact, not to critique the essential humanitarian assistance provided, but to illuminate the complex challenges that emerge when settlements are established with limited planning and infrastructure. Rather than approaching refugee camps solely as temporary humanitarian spaces -as tended to be considered mainly in the past (Al-Homoud & Samarah, 2025)-, this study conceptualizes them as evolving socio-ecological systems, embedded within and interacting with broader environmental processes. Understanding these dynamics requires an examination of diverse contexts, as the effects of displacement are mediated by ecological, climatic, and socio-political factors. Accordingly, the main research question guiding this study is: *To what extent do governance structures and planning approaches determine whether large-scale refugee settlements function as drivers of environmental degradation or as potential catalysts for sustainable environmental adaptation?*

To this end, two refugee settlement contexts are examined as comparative case studies (Section 2). The findings derived from the analysis of secondary data are subsequently synthesized to draw broader analytical conclusions (Section 3). These conclusions are intended to inform and provide a conceptual foundation for future research focusing on the European context.

2. CASE STUDIES

KutupalongRefugee Camp

The Kutupalong Refugee Camp in Cox's Bazar, Bangladesh has emerged as the largest refugee settlement globally in response to the mass displacement of the Rohingya people, an Indo-Aryan, predominantly Muslim group (Alam & Uddin, 2025) who fled systematic persecution and statelessness in Myanmar (Bashar & Bernell, 2025), following violent military campaigns beginning in August 2017. The unprecedented influx, that expanded the existing camp, has placed extraordinary pressure on local ecosystems and has driven significant changes in land use patterns that have clear environmental and social consequences (Loncar & Cabral, 2021; Quader, et al., 2021; Benz, et al., 2019; Braun, Fakhri & Horchschild, 2019).

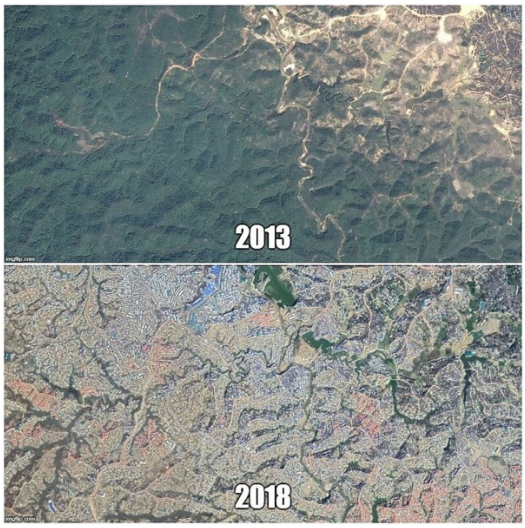

Figure 1. The Kutupalong Refugee Camp in Cox's Bazar, Bangladesh, before and after the 2017 Rohingya crisis. Source: Wikipedia (2025)

Satellite-based studies combining multi-temporal Landsat imagery (Bappa, et al., 2022) with radar data from Sentinel-1 and ALOS-2 (Braun, Fakhri & Horchschild, 2019) have documented how the rapid establishment and expansion of the camp have altered the physical landscape. According to their results, forested areas were progressively converted into built-up land as the camp expanded roughly ten-fold between 2015 and 2021. An estimated 1,500 hectares of vegetation were lost, partly for camp infrastructure and partly due to wider deforestation trends in the surrounding landscape (Braun, Fakhri & Horchschild, 2019). These changes have disrupted local ecosystems and altered land surface temperature patterns, signaling environmental stress beyond the immediate settlement footprint.

These landscape alterations have had profound implications on biodiversity. Habitat fragmentation and the loss of vegetation compromise ecosystem services such as carbon sequestration (Li, et al., 2022) and water regulation, due to the fact that vegetation plays a crucial role in the hydrological cycle (Wang, et al., 2018). Wildlife, including threatened

species like Asian elephant (Elephas maximus), face increased conflict as traditional migration corridors (Rahman, 2019) and feeding grounds are occupied by the expanding settlement areas. These anthropogenic pressures extend beyond the camp boundaries, intensifying stress on flora and fauna and accelerating ecosystem degradation.

The removal of vegetation, unstable soils, and steep slopes, combined with intense monsoonal rainfall, has markedly increased landslide and flooding risks, as Kamal, et al. (2022) support in their research focused on the Kutupalong Camp. In this research (Kamal, et al., 2022), advanced geospatial hazard assessments applied indicate that slope failures and flash floods are becoming more frequent, threatening both human settlements and adjacent ecosystems. This interplay between deforestation and extreme weather illustrates how rapid settlement expansion not only alters the landscape but also magnifies geophysical vulnerabilities, compounding environmental and socio-ecological risks.

Although most academic studies focus on remote sensing and hazard assessment, as focused above, there is a growing acknowledgment that environmental change in contexts like Kutupalong must be understood in conjunction with social and governance factors that shape resource use patterns. The findings from the above literature consistently indicate that rapid, unplanned settlement expansion can produce significant environmental consequences in host regions, particularly when local planning mechanisms, institutional capacities and environmental safeguards are limited or absent. In the case of the Kutupalong camp, limited access to clean energy, low adaptive capacity, unstable incomes, and lack of alternative livelihoods drive fuelwood dependence and reinforce a social conflict-deforestation cycle, intensifying pressure on forests and host communities (Ulah, et al., 2025).

In response to the environmental degradation, **participatory and sustainable-focused interventions** have been implemented at Kutupalong. UNHCR and partners have engaged refugees in **reforestation (**Chowdhury *et al.*, 2025) **and ecosystem restoration**, with thousands trained to manage nurseries and plant indigenous trees, stabilising slopes and enhancing vegetation cover (replanted on over 600 ha) (De La Portilla, 2021). **Complementing these ecosystem restoration efforts, solid waste management initiatives led by UNDP in partnership with Bangladesh Rehabilitation Assistance Committee (BRAC)have addressed another critical dimension of environmental risk within the camps.**Through the establishment and expansion of sanitary landfill facilities at Camp 20 Extension, embedded within an integrated waste management system, the programme has reduced public health and environmental hazards associated with unmanaged waste. At the same time, structured "Cash for Work" schemes have created livelihood opportunities for Rohingya refugees, demonstrating how governance-supported planning can align environmental sustainability objectives with camp management and socio-economic inclusion (UNDP Bangladesh, 2025a; 2025b).

Minawao Camp

In the south- eastern region of Cameroon, the Minawao refugee camp exemplifies the complex interplay between governance, planning and environmental outcomes in large- scale settlements. Originally constructed in 2013 to accommodate 10,000 persons fleeing Boko Haram insurgency in neighbouring Nigeria, Minawao now shelters roughly 76,000 people in a highly climate- stressed dryland environment (Magne & Aholou, 2024). This dramatic increase has exerted acute pressure on already vulnerable ecosystems, accelerating tree removal for firewood and daily cooking, exacerbating local desertification and provoking resource competition with indigenous pastoralists (Magne & Aholou, 2024; Kodji & Adamou, 2021). Field observations and remote sensing analyses indicate that the expansion of informal

settlements and the associated activities have resulted in patchy vegetation loss, increased erosion rates, and microclimatic changes within the surrounding savannah and woodland landscapes (Magne & Aholou, 2024). In the absence of integrated environmental planning and effective governance coordination, the camp's expansion has shifted from humanitarian relief towards an inadvertent ecological stressor.

Figure 2. Minawao Refugee Camp, then and now. Source: Good News Network (2021).

By contrast, continental initiatives such as the African Union's Great Green Wall (GGW) show how governance frameworks and multi-level planning can transform environmental degradation into opportunities for adaptation. Launched in 2007, the GGW brought together 18 African states (11 core countries along with 7 additional countries linked to the initiative) (Deng, Hao & Qu, 2024) and international partners with goals to restore 100 million hectares of degraded land (Mirzabaev, et al., 2022), sequester carbon, and create green employment by 2030 (UNCCD, 2020). Since the beginning of the Initiative more than 360,000 seed plants were planted in more than 100 hectares (area of around 26 football fields) (Bourgois, 2021). These trees provided shade for other plants, while fallen leaves acted as natural fertilizers, improving soil fertility. The emerging forest attracted rainfall and enhanced water retention, contributing to local ecological resilience. The initiative provides an illustrative model for cross-border collaboration, integrating local knowledge, scientific research, and policy mechanisms to enhance resilience as well as ecological restoration in terms of landscape (Goffner, et al., 2019). In Nigeria, for example, coordinated institutional support facilitated the establishment of contiguous windbreak corridors and reforestation activities, yielding measurable ecological benefits including 2,801 hectares of reforested land and enhanced local food and energy security through community gardens (UNCCD, 2020). To address ongoing firewood demand, alternative energy programs were introduced: camp residents process waste into "ecologic" coal at plants staffed by trained refugees, generating both sustainable energy and a steady income.

The contrasting trajectories of Minawao and the GGW initiative highlight the centrality of governance in shaping environmental outcomes. Refugee settlements often emerge rapidly with limited capacity for environmental planning, forcing refugees to rely on local biomass without sustainable alternatives. This can deepen degradation when governance structures fail to integrate environmental safeguards into site design, resource distribution and livelihood programmes. Conversely, initiatives with clear governance mandates and participatory planning generate enabling conditions for ecological restoration and socio-economic adaptation, notably when local communities are co-designed into decision-making and

benefit- sharing processes.Effective planning must therefore span humanitarian and environmental domains. This requires institutional frameworks that anticipate ecological limits, allocate sustainable energy alternatives, and embed monitoring systems capable of assessing landscape changes over time.

3. CONCLUSIONS

The analysis of Kutupalong and Minawao refugee settlements underscores the intricate relationship between forced displacement, environmental sustainability and governance frameworks. Refugee camps are not isolated humanitarian spaces; rather, they operate as dynamic socio-ecological systems embedded within larger environmental and urban contexts. Rapid, unplanned settlement expansion, as observed in Kutupalong, can amplify environmental pressures, triggering deforestation, habitat fragmentation, soil instability, and heightened vulnerability to hydrological hazards. These pressures extend beyond camp boundaries, threatening both biodiversity and the ecological services upon which local communities depend. Crucially, such outcomes are rarely attributable solely to refugee presence; they are amplified by pre-existing structural vulnerabilities, limited institutional capacity, and inadequate planning mechanisms.

By contrast, the Minawao case and complementary continental initiatives like the GGW initiative demonstrate that proactive governance, integrated planning and participatory approaches can transform environmental risks into adaptive opportunities. When refugee settlements are incorporated into broader ecological restoration frameworks, environmental degradation can be mitigated and socio-economic resilience simultaneously enhanced. For example, structured reforestation, sustainable energy programmes and waste management initiatives not only stabilise landscapes but also provide livelihoods, improve resource security and integrate displaced populations. These interventions illustrate that environmental protection and humanitarian assistance are not mutually exclusive but can be mutually reinforcing when strategically aligned.

The comparative analysis highlights that governance quality, policy integration and institutional foresight are decisive in determining environmental outcomes in displacement contexts. Effective planning must anticipate ecological thresholds, allocate alternative energy resources and embed monitoring systems capable of capturing both ecological and social dynamics. Furthermore, the inclusion of host communities in planning processes is essential, as it fosters equitable resource distribution, reduces potential conflicts and ensures that restoration efforts yield tangible benefits for all stakeholders.

Ultimately, the study emphasises that refugee settlements can either exacerbate environmental degradation or serve as catalysts for sustainability, depending on the governance and planning approaches applied. Integrating environmental objectives with humanitarian priorities is no longer optional; it is essential for safeguarding ecosystems, enhancing resilience and securing the long-term well-being of displaced populations. Future interventions must therefore move beyond temporary relief perspectives and embrace comprehensive, adaptive strategies that embed ecological stewardship into the core of humanitarian operations. In doing so, refugee settlements can become spaces of coexistence with the environment, demonstrating that human mobility and ecological protection can be mutually compatible rather than inherently contradictory.

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MAIN WOOD SPECIES USED IN GREEK WOODCRAFT: A HISTORICAL AND TECHNOLOGICAL STUDY

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Abstract
Woodcraft in Greece has long relied on indigenous wood species whose anatomical and mechanical properties determined their suitability for diverse artisanal, architectural, and industrial applications. This paper examines the principal species used in Greek woodcraft—olive (Olea europaea), walnut (Juglans regia), linden (Tilia spp.), oak (Quercus spp.), chestnut (Castanea sativa), pine (Pinus brutia, Pinus halepensis), and cypress (Cupressus sempervirens)—integrating historical usage with contemporary wood science. Through the analysis of density, hardness, dimensional stability, shrinkage behaviour, natural durability, fibre structure, machinability, and compatibility with modern CNC processing, we establish each species' technical performance profile and its historical relevance. The paper includes a comparative table of physical–mechanical properties and identifies optimal applications across carving, joinery, construction, furniture-making, turning, and decorative work. Findings demonstrate that Greek native woods retain significant technological and aesthetic

value, making them relevant for modern engineered products, high-precision fabrication, and sustainable material strategies in contemporary woodcraft.

Key words: Traditional woodworking, Greek woodcraft, Indigenous Greek wood species, Olive wood, Walnut wood, Linden wood, Mechanical and physical properties of wood

1. INTRODUCTION

Woodcraft in Greece represents a continuum of technical evolution influenced by material availability, environmental conditions, cultural practices, and advances in manufacturing technology. Indigenous Greek wood species possess a wide range of anatomical, mechanical, and physical characteristics that shaped their selection for specific uses from antiquity to the present day. For millennia, woodworkers intuitively understood differences in hardness, density, grain direction, workability, and durability, long before these properties were scientifically quantified.

Among the most important species for Greek woodworking traditions are olive (Olea europaea), walnut (Juglans regia), linden (Tilia spp.), chestnut (Castanea sativa), oak (Quercus spp.), pine (Pinus brutia, P. halepensis), and cypress (Cupressus sempervirens). These woods span an exceptional spectrum of technological behaviours. Olive is extremely dense and visually striking, making it suitable for decorative items and high-wear objects. Linden is soft, diffuse-porous, and extraordinarily uniform, making it the ideal species for carving and religious iconography. Walnut offers excellent dimensional stability, machinability, and colour, making it widely used in furniture and high-end joinery. Chestnut and oak provide durability and strength for structural components. Pine and cypress, abundant in Greek forests, have supported centuries of construction, shipbuilding, and vernacular furniture-making.

Modern processing technologies—including kiln drying, CNC machining, digital carving, high-precision joinery, engineered wood products, and advanced finishing systems—introduce new requirements and new opportunities for species utilization. This paper integrates historical knowledge with contemporary wood science to provide a comprehensive profile of Greek wood species and their relevance for modern craftsmanship and sustainable material strategies.

2. HISTORICAL USE OF WOOD IN GREEK WOODCRAFT

2.1 Antiquity

During antiquity, wood served fundamental roles in housing, shipbuilding, tools, weaponry, furniture, cult objects,and domestic items. Species selection was highly informed by mechanical requirements and the limitations of ancient bronze and early iron tools.

Pine (Pinus brutia, P. halepensis) and cypress (Cupressus sempervirens) were the dominant timbers for shipbuilding. Their low density (430–520 kg/m^3), high strength-to-weight ratio, straight fibres, and natural resin content made them resistant to moisture and biological degradation. These characteristics allowed ancient Greek ships—such as the penteconter and trireme—to achieve exceptional speed and manoeuvrability.

Olive wood (Olea europaea), with its exceptionally high density (900–1150 kg/m^3) and interlocked grain, was widely used for tool handles, spear shafts, and turned items such as bowls and cups. Its superior impact resistance and hardness allowed it to withstand repetitive stress, though shaping it required techniques such as controlled burning, scraping, and gradual removal of material due to its difficulty under early tool technology.

Linden (Tilia spp.), with its diffuse-porous anatomy and uniform texture, was used for fine carving, cult objects, and early forms of sculptural decoration. Even with primitive chisels, linden allowed precise, delicate detailing.

Chestnut (Castanea sativa), rich in tannins and naturally durable, was selected for exposed structural applications such as beams, roof elements, and agricultural implements.

Ancient artisans already displayed an intuitive anatomical understanding: straight-grained pine for long beams, dense olive for wear-resistant items, and fine-grained linden for detailed carving.

2.2 Byzantine Period

Byzantine woodworking incorporated highly refined techniques, particularly for religious art. Workshops in Constantinople and the monastic communities of Mount Athos developed specialized methods for seasoning, panel construction, and carving.

Linden became the principal wood for icons, bas-reliefs, and ecclesiastical carving due to its softness, low density, uniform fibre structure, and consistent cutting resistance. These properties allowed precise carving of drapery, facial features, and decorative motifs, essential in Byzantine iconography.

Walnut (Juglans regia) was used extensively in high-quality furniture, small shrines, doors, lecterns, and carved architectural elements. Its dimensional stability and predictable shrinkage behaviour made it well suited for complex joinery in humid monastic environments.

Cypress, naturally resistant to insects and decay, was preferred for painted icons and sacred objects. Its resinous heartwood ensured longevity even in poorly ventilated churches.

The sophisticated handling of wood in the Byzantine era—including panel bracing, moisture control, and preparation of glue and grounds—anticipates modern principles of wood engineering and conservation science.

2.3 Ottoman & Early Modern Period

During the Ottoman period, Greek woodworking combined local traditions with influences from the Balkans, Anatolia, and the Middle East. Regional craftsmanship flourished, with clear distinctions between species for structural, decorative, and functional uses.

Walnut emerged as the elite species for cabinetry, chests, carved panels, and fine architectural elements. Its excellent machinability, rich colour, and stable performance made it the preferred wood for high-value furniture.

Chestnut continued to serve as a primary construction timber, especially in western and northern Greece. Its durability and natural resistance to decay made it ideal for beams, floors, and outdoor structures.

Pine was the most widely used species for vernacular furniture, ceilings, doors, and painted folk-art pieces in regions such as Macedonia, Thessaly, and Epirus. Pine's easy workability made it compatible with hand tools such as frame saws, chisels, and foot-powered lathes.

Traditional woodworking tools—bow saws, adzes, chisels, lathes—were closely matched to species properties, demonstrating an enduring anatomical and mechanical understanding.

2.4 Modern Era

In the 20th century, industrial sawmills, mechanical drying, engineered wood products, and standardized adhesives transformed Greek woodcraft. Pine became the primary species processed in sawmills, while walnut and olive shifted toward high-value artisanal products.

Olive is now widely used for decorative items, turning, luxury interior elements, and small artistic objects due to its striking grain and extreme hardness.

Walnut remains the premium species for high-quality furniture, veneers, and interior applications thanks to its stability and excellent machining behaviour.

Linden continues to dominate wood carving and icon-making, especially in northern Greece and monastic communities.

CNC machining, laser cutting, digital carving, and modern finishing systems have expanded the potential of all species, enabling precision work with dense hardwoods previously difficult to process.

In parallel, sustainable forestry and circular bioeconomy strategies encourage renewed use of local Greek species to reduce dependence on imported hardwoods.

3. TECHNOLOGICAL PROPERTIES OF MAIN SPECIES

Olive (Olea europaea)
Density: 900–1150 kg/m³
Very high hardness; interlocked grain
High extractives; slow drying; susceptible to checking
Outstanding for turning and decorative applications
Requires carbide tools and slow CNC feed rates

Linden (Tilia spp.)
Density: 450–550 kg/m³
Soft; diffuse-porous; uniform texture
Excellent for carving, CNC machining, and fine detail
Low shrinkage and high dimensional stability

Walnut (Juglans regia)
Density: 580–680 kg/m³
Medium–high hardness; homogeneous structure
Excellent machining, gluing, and finishing behaviour
Ideal for furniture, veneers, and high-precision joinery

Chestnut, Oak, Pine, Cypress
Chestnut: durable, ring-porous, high tannins, ideal for beams and exterior structures
Oak: strong, dense, moderate shrinkage, excellent for flooring and heavy furniture
Pine: lightweight, straight-grained, easy to machine, widely used in construction and joinery
Cypress: resinous, durable, insect-resistant, ideal for icons and joinery work

Table 1. COMPARATIVE TECHNICAL TABLE

Species	Density (kg/m³)	Hardness	Shrinkage	Durability	Machinability	Best Uses
Olive	900–1150	Very High	High	Medium	Difficult	Turning, luxury craft
Linden	450–550	Low	Low	Low	Excellent	Carving, icons
Walnut	580–680	Med–High	Low–Medium	Medium	Excellent	Furniture, joinery
Chestnut	530–590	Medium	Medium	High	Good	Structural, beams
Oak	680–750	High	Medium	High	Moderate	Flooring, barrels
Pine	430–520	Low–Med	Med–High	Low–Med	Excellent	Joinery, furniture
Cypress	510–560	Medium	Medium	High	Good	Icons, joinery

4. MODERN PROCESSING

Modern processing of Greek wood species revolves around controlled drying, CNC machining, and advanced finishing systems.

Kiln drying is essential for dense species such as olive and oak to minimize checking and internal tension.

CNC machining allows precise shaping of both softwoods and hardwoods: linden and walnut machine exceptionally well, while olive requires slower feed rates but produces excellent surface finishes.

Modern adhesives (PVAc, PUR) provide strong bonding performance even for ring-porous woods, and advanced coatings improve colour stability, gloss retention, and moisture resistance.

Overall, technological advances have expanded the usability of Greek species in engineered and high-precision applications.

5. CONCLUSIONS

Greek indigenous wood species provide a rich combination of mechanical, anatomical, and aesthetic properties that shaped their historical applications and continue to define their modern relevance. Olive offers unmatched density and decorative potential; linden provides exceptional carving behaviour; walnut excels in stability and machining; chestnut and cypress offer durability; and pine remains foundational in construction and joinery. Technological innovations such as CNC machining and modern finishing systems have expanded the applications of these species, while sustainability priorities support increased use of domestic resources. Together, these woods constitute a technologically and culturally significant foundation for Greek woodcraft, bridging traditional craftsmanship with contemporary material science.

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TOURISM, CULTURE AND SUSTAINABLE DEVELOPMENT IN THE REGION OF BOEOTIA

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Abstract
The cultural heritage of our country is the reason for regional and local sustainable development. Greece is a country with characteristic customs and of course culture. To be more specific, an Orthodox feast that in its core contains historical elements from the Revolution of 1821, is an important tradition for Boeotia, and at the same time these elements include a mythological core from antiquity. This feast is called the "Panigiraki", which takes place every year on the celebration day of St. George in Arachova, the important township of Boeotia.

Due to the large turnout of the congregants, it is natural to mobilize the Regional Unit of Boeotia, the Municipality of Distomo in Arachova and the various local cultural-folklore clubs, on the one hand in order to give the celebrated Saint proper honor and on the other hand to have decency and safety as much as possible in the event. At the same time, local businessmen those days try to cover every possible need of the visitors, since Arachova is the most famous winter tourist resort in Greece.

In conclusion, the cultural dimension of the holiday is realized mostly in its finest form, which coincides with the protection of the environment, the development and the circular economy.

Keywords: cultural heritage, development, safety, protection

1. INTRODUCTION

Starting with the presentation of my theme on tourism, culture and sustainable development in Boeotia and beyond, I have to stress that the combination of these three pillars is the main economic force in Greece in recent years, because of the diverse history that each place has. It is a rare phenomenon abroad, to have a combination of history-culture and tourism, unlike our country. Politicians, scientists, historians and businessmen, discovering after excavations and research archeological sites, old myths based on sources and representing important historical trails, managed to make great progress, while taking advantage of a positive sign beyond the research and tourist "part" of our country.

My theme focuses on a custom called "Panigyraki" that takes place for many generations in Arachova, Boeotia, in honor of Saint George, patron saint of Arachova. The custom includes procession of the image, a three-day feast and racing events, while at the same time the pilgrims actively participate wearing the traditional costumes. This is exactly where the provinces and the public administration have assisted on the occasion of the custom, as they try in the safest way to ensure the smooth running of the custom. It is also important that these days a plan is carried out by the organisers and the public administrators, according to the European standards, that determines from the beginning to the end both from the side of the pilgrims and from the side of the organisers themselves how the procession of the image and the events will take place.

Concluding with the introduction beyond the customs and traditions of each place, it is remarkable that young children participate without feeling underestimated that they continue such an old tradition and this has been achieved, as advertisements are made with modern media and smart advertisements from the media and communication platforms. Only in this way will they continue and continue the customs with the culture that surrounds them to remain alive, because the people themselves do not keep them stationary but evolving, which is quite moving.

2. THE CUSTOM "PANIGYRAKI" HISTORICALLY

Each place has its own history, some areas have more and other areas have fewer customs and traditions. In this case, in the municipality of Boeotia since ancient times we meet famous legends and stories that characterize the place itself. Arachova is one of the villages that on the one hand are a winter destination for rest and good food combined with the magnificent view, but on the other hand the history and myths that exist for this place are really fascinating to the visitor.

In Arachova central place in the soul and heart of the people is St. George, the central church that dominates almost the top of the village. The custom is called "Panigyraki" and the whole story behind this custom has come from the battle of Arachova (18-24 November 1826) between Greeks and Turks. In this battle from the side of the Greeks we have the important hero Georgios Karaiskakis (1782-1827) and from the side of the Turks we have Mustafabei Pasha. This victory has been dedicated to St. George, as without his help the Greeks could not prevent the Turks. According to the sources, the Saint gave the vision to the captain to go with his henchmen to set up and wait for the Turks on the hill of Parnassos, located on the road of Zemenos to Arachova. Karaiskakis in exchange demanded from the Turks, holding hostages, Amfissa and Livadia. The great captain managed to block Mustafabbey and the Turco-Albanians, killing 600 soldiers. The victory was brilliant, as we no longer talk about a strategic plan, but about a miracle that St. George did once again, hence both phrases left in history by Andreas Zaimis, the one was "Where do you go, as if Karaiskakis is chasing you?" and the second was "Resurrection of the Revolution" (Dionisis Tzakis, 2021).

The "Panigyraki" is primarily a story, the story from the battle is described with some metaphors in the song itself accompanied by the traditional instruments, namely the daouli and the pipisa, in all the dances. The song is titled "Panigyraki" and describes the Dragon, who are the Turks that Saint George killed through the captain Karaiskakis and gave the water from the fountains, that is, the freedom to enslaved Greeks. There is also a reference to the three lygeres in one part of the song, implying the three great powers (England, France, Russia).

Concluding, there is also parallel to the historical events of the revolution a myth from antiquity, which describes a Python, that is, a large saurian monster which the earth had given birth to, which sat tied in a cave at the point where the church was located, at the location Anemoria and protected the sources "Mana" and "Kastalia" while he was pursuing Nymphs, creating winds and disasters. The God who managed to exterminate this mythical creature was Apollo, who then left Delphi to be purified. Of course, when he returned to Delphi he reestablishes his worship under the name Pythios (My Arachova, 2025).

3. THE CONDUCT OF THE CUSTOM BY THE LOCAL AUTHORITIES

The custom could not be performed without the help of the ecclesiastical, police and fire authorities, as they accurately coordinate the three days of the custom from the beginning to the end all the sequence of the procession, dance and events.

During the stay, the police have closed down specific streets - alleys with security mesh, in order to let the saint icon and the pilgrims to pass. More specifically, on the evening of the stay at five and a half, as the three cannons fall from the artillery of St. George, the church bells call the people to go up for the Vespers. The Feast begins. The narrow streets lead to the church become light white from the skirts and the sigkounia. The Arachovites of all ages, dressed in traditional costumes, come to the grace of Afentis Ai-Giorgis, in order to worship the icon. An hour later, after a crowd of people gathered, the vespers starts at six and a half, accompanied by distinguished chanters from all over Greece (Mauropoulos E. Christos, 1982).

At the end of the service begins with Byzantine priesthood the procession of the Holy icon of St. George flanked by hundreds of fustanelades and sigounoudes of all ages walk slowly and modestly, behind the Holy icon in two long rows, one behind the other, at the ends of the road. The icon of Afentis Ai-Giorgis proceeds on the shoulders of the fustaneloid men, and is accompanied by the "three lygeres" three Arachovitan women, according to the Arachovitan song. In front of the Holy icon, four young men holding the first revolted flag of Roumeli, which was the Arachovitic emblem of St. George and the words: Freedom or death. After the procession all the pilgrims end up in the village square, in order to have fun with a lot of dancing and wine.

On the first day the world is growing and Arachova awakens in an unusual way. The voice of a war trumpet sounds arousal. Meanwhile, the whole of Arachova is wrapped in the fumes (second time after Easter) by the fires in the "pits" of the neighborhoods for the roasting of the lambs in the Grace of Afentis Ai-Giorgis. Then three cannons from Ai-Giorgis' artillery disturb the place. It is the call to Matins and the Divine Liturgy. The Arakhovites will ascend the church and come to the grace of the Saint. As the liturgy is finished, the uphill road of young men and old men with skirts begins, in memory of the glorious battle in 1826 on the battlefield, on the hill above the church of St. George. It is the harmonious coexistence of generations, this unbearable, the very way of life, and Arachova rightly flaunts. In the meantime, the police in cooperation with the Distomo health center are alert, because in the first event, because of the high degree of difficulty, it makes sense for someone to falter or lose consciousness. Local authorities should therefore be involved, if necessary (Mauropoulos E. Christos, 1984).

After the uphill race follows a 5 km race from the church of Agios Minas to the central square of the village in memory of finding the historical icon of Agios Georgios. Then the youth of Arachova will set up a dance in the central square. After darkness falls, the need for human communication in the homes of the celebrants for the "happy birthday" is a given. The "Giorgades" have the words three days. Decorated with the Arachovitika carpies and handiworks, the houses offer a sweet "mygdalato" and "sarmades" (dolmades) to the visitors.

On the second day of the festival the trumpet and the cannons will sound again, serving as a call to the Divine Liturgy. When the liturgy ends, the athletic competitions, the kleftist events will begin. The courtyard of the Temple will also become a stadium of racing. Jumping simple, triple, height and lifting stone, as the thieves used to. The prize, a little lamb to the winners. The sun is darkening now, as the games are over and the world is descending from St. George's heave. Also there the participation of both the police and the health center Distomo, for any injuries is again necessary (Mauropoulos E. Christos, 1985).

On the third day, the trumpet will sound the third trumpet. The bells will sound the Divine Liturgy again. Everyone will gather again at the monument of Karaiskakis with the broken cannon, in the small garden of the courtyard of the church, it is the time of supplication for the heroes of the Battle of Arachova. The white Arachovian flag, a copy of the first rebellious Roumeli, flies high on the Heroo. The tribute shots from the duffel of the

fustanelophoros elder, are a tribute to the glorious fallen of the battle of Arachova. Immediately there is the beginning of the third day races: shot put, stoned, wrestling, tug of war. Kleftist events of ancient origin, as well as the events of the two previous days.

Finally, the "ruin" of the feast will take place at 03.00 at noon, when the common lunch will begin in the courtyard of Ai-Giorgis, where everyone participates. In the dish of hospitality, along with the roasted lamb there is cheese, feta of Parnassos and Arachovitic wine. Everyone is caught hand in hand, forming a circle that rounds the church. Singing the 'feast', they are rounding three times around the Temple of Ai – Giorgis. Three cannons drop from the gun, one for each round. In the third cannon, the bells begin to ring, which sends the message, that Arachova once again honored with a three-day celebration the patron saint, as every year.

The procession descends from the church with the pipizes and the daoulia. In front the fustanelades and the sigunoudes, in back the rest of the world, so many that overwhelms the entire length of the stairs of St. George. Thus the cycle of this custom closes, it is really moving that every year more and more people not only come to watch the "Panigyraki", but that they also take part wearing the traditional costumes.

4. THE DEVELOPMENT OF THE VILLAGE ITSELF

One of the most important effects that a custom could have anywhere is every year people to honor it with their presence in the place where it takes place. This really is the challenge that local authorities should have, in order to organize the traditions in the best possible way, together with the cultural clubs and the local communities, while respecting the resources that have been allocated for this purpose.

Furthermore, the custom is an advertisement for the village itself, as it attracts not only visitors, but also entrepreneurs, who aim to use their money by investing in dining areas, such as restaurants and hotels, or to rebuild houses for themselves. The economy is based on mobility both in terms of external and internal consumption (United Nations, 2025).

In addition, by providing archival material and funds to scientists, with a view to organizing conferences, we will attract the European Union, Unesco and several other international organizations, with a view to gaining their trust. So we will have a major impact as a country on these international organizations if we further our tradition of both material and intangible culture (Unesco, 2025).

The legacy that leaves the "Panigyraki" as a custom has to do with the element directly of people's faith in St. George. The Orthodox Church, in cooperation with the State, always strives to promote such traditions, which exalt the morale, love and spiritual strength, always combined with the faith of the Greeks. It is difficult many times to achieve both, however I believe that the Saint again with his contribution creates the necessary conditions for this custom to continue in Arachova.

Also a legacy is not only in the soul but also in the memory of people, recalling the heroic battles that took place during the Revolutionary period of '21 with many of the traditions and customs having direct correspondence with captains and fighters. In this case, the battle of Arachova (18-24 November 1826) between Greeks and Turks becomes more and more, as many locals decide together with the cultural associations to write books, books, to publish articles on social media and so that others can edit the useful information of the place (Apostolos B. Betsopoulos – Chrisoula Spireli, 2016).

Finally, it is useful for the effect the help of academic teachers because without them, no formal integration of this custom into the Pan-Hellenic dimension that has today the "Panigyraki" would have taken place. Because social media can be influential in the world,

but of course international factors beyond the offer of the world play an important help the books written by scientists and historians. For the simple reason, the book, when it is written by a series of approved scientists, is the same custom example of attention from society itself.

5. CONCLUSIONS

To sum up, the conclusion is considered by many the easiest point of a work, because it is a summary of the main points of the piece, but in this case, because of the emotional charge, the common factor that connects the intangible cultural heritage with the custom – tradition from my homeland is quite difficult to depict.

Customs and traditions are never going to end without exception of season, fame, culture, social media influence and many other factors for the simple and unprecedented reason, because the people who made and preserved them are our ancestors and our outward and inward appearance has been based on them. Many unfortunately doubt this view, as they rely solely on their logic on the fact and the theory of evolution, believing that what exists before them is considered obsolete to some extreme cases subculture.

Fortunately, the enlightenment and spiritual power that St. George exerts on believers is unsurpassed and unchanging. This is also demonstrated by the believers themselves, who every year grow more and more with their traditional costumes and costumes making, not only themselves, but also the Saint proud.

Finally, I would like to stress to the readers a sensible remark that I really hope will shake the new generation. We are the best generation that truly believes in the future, that has been realized today, it is a shame to find ourselves in the last place to be judged that we were unworthy to continue a tradition that really founded with great effort and sweat the sacred ground of our country.

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URBAN BUZZWORDS IN PRACTICE: RHETORIC, METHOD, AND THE POLITICS OF DIFFUSION

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Abstract
Urban planning discourse is increasingly saturated with labels that promise transformation while often rebranding long-standing practices. This paper investigates how such buzzwords emerge, circulate, and shape agendas across academia, policy, and markets. Drawing on terms such as smart city, resilient city, circular city, sponge city, digital twin, 15-minute city, creative city, and innovation district, it asks three interlinked questions: What is the pace of term introduction since 2000? Which actors drive diffusion? And how closely do these linguistic innovations align with substantive methodological or policy change?

Using a focused review of academic literature from 2000 to 2025 following PRISMA guidelines, the study traces the evolution and overlap of major city labels. It identifies recurring cycles of adoption, adaptation, and decline, reflecting broader shifts in funding priorities, technological optimism, and governance trends. Preliminary patterns suggest that certain concepts are propelled primarily by market and industry actors, while others gain traction through policy frameworks or academic discourse.

The analysis highlights how the rapid proliferation of labels produces both creative cross-pollination and conceptual fatigue, as terms are recycled faster than their underlying methods evolve. Through mapping these trajectories, the paper situates urban buzzwords as instruments of soft power that organize attention, resources, and legitimacy across competing visions of the city. The discussion exposes the fault line between novelty and rebranding, showing how shifting vocabularies quietly reorganize what cities pursue and how they define progress.

Key words: Urban planning, urban governance, buzzwords, terminology, innovation, communication in planning

THE CONTRIBUTION OF CULTURAL ASSOCIATIONS AND LOCAL AUTHORITIES TO THE PRESERVATION AND PROMOTION OF THE CULTURAL HERITAGE OF A REGION. AS A CASE STUDY: THE MUNICIPALITY OF DORIDA

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Abstract
The present paper explores the contribution of cultural and sports clubs, as well as local bodies, to the preservation and promotion of the cultural heritage of a region, with a case study of the Municipality of Dorida. Its aim is to highlight the role of culture in sustainable development, examining how cultural participation, values and needs of citizens can enhance cohesion, social well-being and local development.

The methodology was based on a combination of theoretical and empirical approaches. Initially, the theories of regional economic development and the integration of culture as the fourth pillar of sustainable development are presented. This is followed by the creation and implementation of a questionnaire that aims to capture the cultural participation, needs and values of the population of Dorida. The questionnaire included questions on the frequency of participation in cultural activities, the importance of the family environment, the relationship between culture and entrepreneurship, as well as citizens' perception of their own cultural involvement.

The data analysis was carried out using Ordered Probit statistical models (McCullagh, 1980; Green, 2003), as the responses were ordered categorical variables. These models allowed the assessment of the factors that influence citizens' attitudes towards cultural participation, with an emphasis on variables such as age and educational level.

The results show that the age groups 55-64 years old express the strongest interest in more cultural activities, which indicates high awareness and active cultural participation in this social category. Furthermore, it is found that educational level is positively related to the intention to participate, while cultural associations and local bodies are crucial mechanisms for strengthening cultural life and preserving local identity.

The paper concludes that culture functions as a social bond and a catalyst for sustainable development, broadening the horizons of the community, strengthening dialogue and promoting diversity. The need for systematic evaluation of cultural policies is also emphasized, as well as the strengthening of local cultural initiatives through institutional support and participatory planning.

Keywords: Cultural participation, cultural associations, sustainable development, Ordered Probit, Municipality of Dorida.

NAVIGATING INTEGRATED PLANNING IN SMALL MUNICIPALITIES: LIMITATIONS, PATHWAYS FORWARD EMERGING OPPORTUNITIES. THE CASE OF DIDYMOTICHO.

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Abstract
Over the years, the European Cohesion Policy has undergone significant transformation, with its targeting mechanisms and programming strategies being continuously adapted and refined to respond effectively to the changing needs and development challenges of regions.

During the 2014-2020 programming period a "place-based approach" had appeared while in the current programming period the policy seems to be in its "mature" era that meets integrated approaches and relevant financial mechanisms (such as Integrated Territorial Investment (ITI)). We are no longer talking about regional inequalities' recovery, we are able to emphasize on comparative advantages of areas to boost their growth potentials and build on its unique characteristics. The "core-periphery" approach builds our argumentation that small municipalities should change their development path with synergies and interconnection that do not work competitively but collaboratively. The conducted research shows that not only disadvantaged and remote areas face severe development problems with understaffed services without specialized staff and with lacks on basic infrastructures, but also some urban centers face some challenges as well. However, the networking of remote areas creates added value and multiplicative benefits rescaling growth potentials. Such approaches refer to the empowerment of small municipalities to follow integrated planning, find technical competence, political commitment to the partnership, and ability to implement projects on time. The reforms in Greek legislation assist further these efforts.

The case study of Didymoticho explains the theoretical assumptions that remote and /or disadvantaged areas are able to benefit from integrated development plans and collaborative structures that create opportunities and promote holistic intervention and funding.

Key words: European regional policy, territorial development, disparities, growth, "core-periphery", Integrated Territorial Investments, Municipality of Didymoticho,

SESSION

"Tourism and Sustainable Development"

Chaired by **Asst Em Panagiotis Patargias** and
Asst Prof Skoultsos Sofoklis

TOWARDS TO A NEW TOURISM MODEL ADJUSTMENT IN GREECE: SOME EMPIRICAL EVIDENCE FROM HOTEL EXECUTIVES

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Abstract
Tourism is commonly accepted as one of the most important economic sectors of Greece's development. Tourism is multidimensional, considering the psychology of the market and tourists is also multidimensional. Over the past years, the study of tourism and its dimensions from both the supply and demand sides has become more demanding, deeper, and even more specialized. At present, alternative forms of tourism (alternative tourism) arise, arguing that tourism is linked not only with the multidimensional psychology of tourists, but also with the uniqueness and distinctiveness of the destinations. Consequently, alternative forms are designed and developed to highlight the special dynamics of each destination and to satisfy the psychology of the potential tourism markets to which they are addressed.

As for the Mediterranean zone, the so-called Sun Belt, conditions have certainly changed for several years. New tourist destinations have come to the forefront of the global market, providing competitive and quality tourist goods. As a result, they provide the maximum possible satisfaction through the tourist experience (total satisfaction of the tourist experience). This research aims to investigate and statistically analyze the estimates of 478 managers and professionals of hotel tourism market through the use of electronic questionnaires on a Likert scale (1-7), regarding the necessity of readjusting the tourism development of Greece to a new, differentiated and sustainable model of tourism development, examining the degree of implementation (degree of performance) and the degree of significance in 27 different factors at the local and regional level.

The main objective of this research is to highlight the necessity of changing the tourism model in Greece and the importance of primary data in the field.

Keywords: Tourism Model, Sustainable Tourism Development, Particularity and Uniqueness, empirical investigation, CFA methods, SEM

CULTURAL TOURISM AS A CATALYST FOR SUSTAINABLE URBAN AND REGIONAL DEVELOPMENT IN GREECE

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Abstract
Cultural tourism represents one of the most dynamic and sustainable segments of the tourism industry, offering significant opportunities for economic growth, social cohesion, and heritage preservation. In Greece, a country with an unparalleled wealth of tangible and intangible cultural assets — from UNESCO World Heritage sites and archaeological landmarks to living traditions, festivals, and gastronomy — cultural tourism can serve as a catalyst for sustainable urban and regional development.

This paper examines how cultural tourism initiatives can balance visitor growth with the protection of cultural integrity, environmental stewardship, and community well-being. Drawing on case studies from historic cities, island settlements, and rural heritage areas, the research explores integrated approaches that combine heritage conservation, sustainable infrastructure, and participatory governance.

Special attention is given to the role of digital innovation in enhancing cultural experiences, extending tourism seasons, and dispersing visitor flows beyond overburdened destinations. By aligning cultural tourism strategies with the United Nations' Sustainable Development Goals, the study proposes a framework for Greek cities and regions to leverage their cultural capital as a transformation force for resilience, and long-term sustainability.

Public institutions — from municipalities to the Ministry of Culture — are investing in digital modernization, developing tools that have information on monuments, festivals, museums, etc. By connecting cultural heritage with innovation and open access, these initiatives enhance the visitor experience, promote local identity, and support the transformation toward vibrant, open-air urban environments.

Keywords: Cultural Heritage, Intangible Cultural Heritage, Digital Technology, Cultural To

TOURISM MUNICIPALITIES IN SPAIN

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Abstract
Tourism municipalities represent a relatively recent institution in Spain, which is optional rather than compulsory, depending on the political will of each Autonomous Community. National Law No. 7/1985 on the Bases of the Local Regime does not explicitly establish the figure of the tourism municipality, but leaves open the possibility of creating special municipal regimes for municipalities 'that gather other characteristics that make it advisable, such as their historical-artistic character or the predominance of tourism activities within their territory'.

This paper approaches this model as a potential brand for Spanish cities. From the limited number of Autonomous Communities that have adopted this mechanism, the Autonomous Community of Andalusia has been selected as a case study. A legislative and bibliographical survey has been carried out for the purposes of this research.

The findings reveal that there is no direct link between the right to the city and tourism municipalities, although the obligations imposed on the Tourism Municipality of Andalusia highlight the need to develop responsible tourism compatible with the rights of the city's inhabitants, in particular their right to their own city. It is also notable that there is no tendency to employ the expression 'right to a Tourism Municipality', although a new right has informally emerged for those municipalities awarded this status. Finally, the model of tourism municipalities has been subject to criticism, notably regarding the financing of such urban entities, yet it constitutes a pioneering city-centred value which should be institutionalised more widely, not only in other Autonomous Communities but also in other tourism-oriented countries of Southern Europe, including Greece, and elsewhere.

Key words: city-centred values, right to the City, Spain, Tourism Law, tourism municipalities

TOURISM POTENTIAL OF INDUSTRIAL HERITAGE: A STUDY OF TOBACCO WAREHOUSES IN KAVALA, GREECE

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Abstract
The present paper investigates the tourism potential of industrial heritage, with a specific focus on the tobacco warehouses of Kavala, Greece. Historically, Kavala was one of the foremost tobacco centers at the beginning of the 20th century, attracting visitors from both the surrounding region and internationally. Tobacco significantly shaped the city's identity during this period, with the warehouses serving as iconic landmarks. However, these structures have experienced a decline from the mid-20th century to the present.

The primary objective of the article is to assess the capacity of the tobacco warehouses to contribute to sustainable tourism development through a multidisciplinary approach that integrates heritage tourism theory and spatial analysis within the urban and regional context. Utilizing a qualitative research methodology, the paper focuses on the spatial, cultural and economic dimensions influencing the creation of touristic value associated with the warehouses. The results highlight a substantial gap between the evident potential of these sites and their current state, largely attributed to the absence of strategic planning, fragmented institutional frameworks and limited community involvement.

The paper contends that integrating industrial heritage within the broader tourism strategy of Kavala can, not only reinforce the city's historical identity, but also promote sustainable urban and regional development. To this end, targeted planning interventions are proposed to reshape these historic sites into lively cultural and tourism destinations, thereby simultaneously supporting urban regeneration and enhancing the touristic appeal of Kavala, while preserving its historical legacy.

Key words: Tobacco warehouses, Kavala, Tourism potential, Cultural heritage, Sustainable and urban development.

TOWARDS SUSTAINABLE TOURISM IN CRETE: DELPHI EVALUATION OF PRIMARY SECTOR SYNERGIES AND REGIONAL PATHWAYS

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Abstract
In this paper, we examine how the integration of tourism into the primary sector can generate opportunities for sustainable tourism development and seasonality management in the island of Crete. With a three-round Delphi with an eight-relay panel of experts, we also present and prioritize sustainability indicators and success factors in economic, social, environmental, cultural and governance terms. The study explores the following four research questions: (i) the key areas of sustainability focus that are driving synergies and tensions in relation to the confluence of tourism and primary sectors; (ii) whether an expert-based consensus methodology can succeed in prioritising these; (iii) the policy implications for Crete 2030 and strategies for collaboration, innovation and regional differentiation; and (iv)How can the integration of tourism and the primary sector serve as a means to build resilience against climate risks such as drought and extreme weather. Methodological transferability is based on international Delphi research focused on agritourism and ecotourism. It finds that intersectoral synergies—namely, agritourism, PDO-based value chain upgrading, producer–hospitality networks, and digital co-governance—emerge as crucial drivers of resilience, diversification and territorial cohesion. Results from Delphi offer consensus approaches based on expert perception over several sustainability lines on addressing Mediterranean island vulnerabilties. The role of institutional frameworks, local participation and innovation systems are also highlighted on the shaping of sustainability strategies in the paper. Climate resilience appears to be a common issue where water scarcity and extreme events demand adaptions both in agriculture and tourism. The conclusions are brought together in the Crete 2030 Roadmap, which connects forward-looking policies to EU and national strategies. Finally, the research adds to the conceptual and empirical development of the online Delphi for Mediterranean islands and provides a reusable prototype for the development of consensus-based sustainable tourism policy.

Keywords: Crete; sustainable tourism; primary sector integration; Delphi method; sustainability indicators; regional development.

CREATIVE TOURISM AND SUSTAINABLE DEVELOPMENT IN MOUNTAINOUS GREECE: THE VOVOUSA FESTIVAL, THE NOWSTALGISM PROJECT, THE LAKE STEFANIADA FESTIVAL

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Abstract
Numerous communities in mountainous Greece are depopulating and facing challenges related to their survival. Greek bibliography and policies focus mostly on planning and environmental issues, rather than heritage and creativity as resources for sustainable growth and prosperity of mountainous communities. The aim of this paper is to fill this gap, directing the attention to the creative possibilities for the development of these villages. The author examines under what conditions can creative tourism be developed in mountainous communities and if it can contribute to their sustainable development. The Vovousa Festival in Ioannina region, the Nowstalgism project in the village of Fanari in Karditsa region and the Lake Stefaniada Festival in Karditsa region were chosen as case studies. Semi-constructed interviews were conducted with the organizers of the events, members of the local cultural associations and representatives of the municipalities. The analysis of the case studies shows that creativity and intangible heritage can constitute resources for the development of mountainous Greece. The role of creative persons is particularly emphasized, for their insight and innovative approach to design creative products and services based on the intangible cultural heritage assets of the village. Creative tourism can act as a means for the sustainable development of mountainous regions in the sphere of culture, community, environment and economy, as it attracts visitors to the area, promotes environmental awareness, the preservation of heritage, the revival of cultural practices, strengthens collective memory and the collaboration between various stakeholders in the area, encourages creativity and investments.

Key-words: creative tourism, mountainous communities, sustainable development, festivals, cultural heritage

FROM ATTACHMENT TO INDIFFERENCE: RETHINKING TOURIST–DESTINATION RELATIONSHIPS

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Abstract
Attachment, loyalty, engagement and love rank amongst the most critical concepts in destination branding and tourist–destination relationships. Recent studies indicate that tourists may exhibit both low brand love and brand loyalty, being indifferent to places as destinations, approaching them simply as settings for leisure and consumption. This study aims to conceptually explore the shift from attachment to indifference in tourism and to analyze how shades of disengagement shape destination branding and marketing strategies. Drawing on literature on consumer–brand relationships, destination branding, and authenticity, the paper proposes a framework that contrasts emotionally engaged tourists with detached or indifferent ones, highlighting the key drivers of such a behavioral state like the standardization of tourism products while raising concerns for the pursuit of sustainable tourism.The conceptual framework outlines the implications of tourist detachment for place branding strategies, including challenges to loyalty-building and sustainable tourism development, opportunities for authenticity-driven differentiation, and the potential role of co-created experiences in establishing strong bonds between places and their stakeholders.

Keywords: tourist preferences, destination branding, digital marketing, loyalty, detachment

URBAN SPACE "ON THE MOVE": LITERARY, EXPERIENTIAL AND DIGITAL ITINERARIES FOR THE 21ST CENTURY TRAVELER LITERARY NARRATIVES & AUGMENTED DIGITAL REALITY

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Abstract
This research addresses the superficial engagement often experienced by contemporary travellers in complex historic cities, proposing a novel methodological framework that synthesizes literary narrative, Augmented Reality (AR), and advanced 3D visualization. Challenging the consumption of standardized tourist products, the study advocates for an experiential "reading" of the urban environment, where the city is perceived not as a static image but as a multi-layered palimpsest of memory, history, and myth. By integrating the narrative depth of renowned authors—Orhan Pamuk for Istanbul, Constantine Cavafy for Alexandria, and Nikos Kazantzakis for Heraklion—with the atmospheric capabilities of 3D Gaussian Splatting (3DGS), the proposed model transforms urban navigation into an emotional and embodied act. Unlike traditional geometric digitization, 3DGS is utilized to render the fluidity of urban memory, visualizing invisible layers and "spectral" architectural traces through an impressionistic aesthetic rather than rigid photorealism. The paper demonstrates that guiding AR interfaces with literary chronotopes shifts the user's role from a passive spectator to an active "walker-reader" who navigates the tension between the physical present and the narrative past. This interdisciplinary approach establishes a new epistemology for digital cultural heritage, where technology does not merely replicate the physical world but augments it with the intangible resonance of lived experience. Ultimately, the study highlights how the convergence of fiction and digital innovation fosters a profound, personalized connection between the 21st-century traveller and the dynamic, living archive of the city.

Key words: Spatial narratives, literary chronotopes, augmented reality, urban palimpsest, 3d gaussian splatting, digital cultural heritage, smart tourism.

1. INTRODUCTION

Urban places constitute for the modern traveller a fascinating realm in search for experiences, experiences and knowledge. In the essay "*On Tourism*" (Perec, 1974:64), the urban thinker Perec sarcastically remarks: "*Rather than visit London, stay at home, in the chimney corner, and read the irreplaceable information supplied by Baedeker (1907 edition)",* describing the schematic way in which the visitors attempt to familiarize themselves with a city, without

truly getting to know it or, better yet, inhabiting it. Today's travellers-visitors of modern, historic cities of the 21stcentury, such as Constantinople, Alexandria, or Heraklion on the island of Crete, face their complex and multifaceted physiognomy, which makes it difficult to uncover and embrace the "spirit of the place" during the brief duration of their trips. The combination of literature and the innovative possibilities of digital technologies, fictional texts about the city and the use of augmented reality, contributes to the art of viewing the city. It offers the modern traveller the opportunity to acquire his own experience through the mediation of narration and to attempt his own real and digital navigations of the urban space based on individual choices and interests. Drawing emotion from the experiential selective reception and the personal interpretation and reading of the place's special identity rather than the consumption of a standardized tourist product. Therefore, we propose a specialized, personalized, and interactive cultural tour of the living city, one that avoids a mass-market and homogenizing character. It encourages a meaningful engagement with the city, where fictional narratives enrich the range of personal choices and emotions. Contemporary strands of cultural-heritage theory reconceptualize the individual's essence (Muñoz-Viñas, 2005)), shifting from the notion of a passive recipient of content to that of an autonomous agent (Rancière, 2011) engaged in a multisensory, dialogic interaction with their immediate environment, within which they are fully immersed.

Digital technology is employed to retrieve cultural heritage, manage diverse fragmentary impressions, and alternate contemporary urban scenes throughout its metropolitan routes (Herold et al. 2018; Pepe et al. 2021; Fiorini et al. 2022). Within this digital-experiential framework, the traveller is provided with an easy-to-use, unique, and multi-layered mapping system that combines urban exploration walks with history, myth, and memory.

The city is a palimpsest of historical events, personal documents, and collective actions recorded in the urban space, shaping the unique character of a place (Massey, 2005; Delgado, 2001). It serves as a privileged and multifactorial field for the production of collective memory, which requires inventive highlighting and collaborative management to become the shared property of residents and visitors (Halbwachs, 1980; Boyer, 1994). The distinctive charm of historically rich cities—characterized by multiple focal points, symbols, and centres of power—stems from the concentration of diverse cultural assets. The cultural memory of the city is woven as a network of meeting places, where different pasts communicate and intersect in the same places. The creation of selected tours or routes within the urban fabric can leverage this multimodal territorial and political reality, making the syntactic structure and the historical, political, and social roles of the city more understandable and accessible.

We propose a novel methodology that combines the narrative depth of literature with the atmospheric aesthetics enabled by digital three-dimensional (3D) technology, specifically 3D Gaussian Splatting (3DGS) (Kerbl et al. 2023; Clini, et al. 2024; Yu et al. 2025). Unlike traditional solid 3D digital graphics (Ioannides, et al. 2017: Clini, et al. 2024), 3DGS operates 'impressionistically', allowing the visualization of urban memory as a nebula of possibilities, light, and colour. The research has two primary objectives: first to emphasize literary narrative as the primary mechanism for 'mapping' the city, revealing the invisible layers of the urban palimpsest. Second, to introduce 3DGS into the AR environment as an effective medium for visually rendering narrative fluidity, thereby transforming the user from a passive viewer into an active, embodied interpreter of the space. Through the study of the cases of Istanbul, Alexandria, and Heraklion, this work aims to establish a framework in which digital technology does not replace imagination but rather enhances it, creating experiential pathways that connect the historical past with the dynamic present.

2. LITERATURE AND THE CITY. THE WALKING PRACTICES

"*They 'mean', revealing the hidden contradictions and the social dialogue that develops within and around them*."
(Bakhtin, 1981)

The city—whether recognizable landmarks or unknown, unrecognized places; houses, rooms, private and public buildings; intimate and collective spaces; real and utopian, presented in multiple and ambiguous versions, intertwine in literary texts (Rohleder, Kindermann, 2020). These spaces revealing hidden contradictions and the social dialogue that unfolds within and around them, they 'mean' (Bakhtin, 1981). Literature produces, according to Bourdieu, (Bourdieu, 1995) a sense of 'real', which distances us from reality, as it "reveals by covering". *"There are many ways to navigate a city: you can set and follow precise routes or wander at random. You might systematically explore a neighborhood with a street map in hand, hop on the first bus that arrives and get off at its stop, or even try to travel from one part of the city to another using a different route than usual..*
You can create your own personal itinerary by setting self-imposed commitments and rules—arbitrary, yet highly effective—in supplementing traditional city guides point by point."
(Perec, 1974)

These are the tips from the lover of inventive itineraries, the writer Perec, who explored the city thematically, searching for its heart and soul in the random and the overlooked. Urban space, through the practice of walking, acquires a dimension distinct from the voyeuristic view from above or the experience of the city as a network of continuous traffic flows (De Certeau, 1984). The 'power' of a street differs depending on whether one walks along it or observes it from an airplane, as Benjamin notes in 'One-way Street' (Benjamin, 2016). When viewed from above, the landscape appears continuous, with the street the same laws as the space that surrounds it (Benjamin, 2006). Aerial photography of the urban landscape transforms the city into a map—and potentially a target. (Virilio, 2009: 16.)

For de Certeau, space becomes a place when it transforms into a field of action—that is, when it is inhabited in the broadest sense of the term. "*Thus, the street geometrically defined by urban planning istransformed into a space by walkers*." (De Certeau, 2010: 117). The moving masses "*that make some parts of the city disappear and exaggerate others, distorting it, fragmenting it, and diverting it from its immobile order*." (De Certeau, 1984: 102). de Certeau introduces the distinction between two different categories of city images (De Certeau, 1984: 92). On one hand, there are panoptic views that look from high up, a distant urban panorama—a model of the city map from a vantage point, a holistic gaze that constructs fictional narratives. These views transform the complex texture of the city into a visual artifact, turning viewers into voyeurs. On the other hand, there are views that look where ordinary city users live. At this level of gaze, illegible and hermetic images emerge, capturing the dark and poetic spatiality of the inhabited city—a city formed by fragments of urban objects, within which a past slumbers alongside the everyday practices of its people. These images reflect the unstable condition of the modern and postmodern city, highlighting aspects such as urban voids, contradictions, gaps, dystopias, political and economic crises, disrepair, and desolation. These factors directly and catalytically alter the image and function of public space, transforming the viewer from a voyeur into a walker and traveller. (De Certeau, 1984: 92-95).

The city is a place where social bonds are formed. It is only by walking through it that the city is experienced not as the homogeneous fabric depicted in tourist brochures, but

through contrasts and heterogeneities. Through union and social mixing, the city is realized as a space of the political.

"Not to find one's way around a city does not mean much. But to lose one's way in a city, as one loses one's way in a forest, requires some schooling. Street names must speak to the urban wanderer like the snapping of dry twigs, and little streets in the heart of the city must reflect the times of day, for him, as clearly as a mountain valley."

(Benjamin, 2006: 53)

Perhaps this is precisely the contribution of literature to the representation of the modern city. As Eco points out, contemplative walks through the forest of narrative—intended to reveal to the reader the invisible components of the urban condition—must allow for interactive engagement and stimulate participation. The forest of words and meanings must "*tangled and twisted like the forests of the Druids, and not orderly like a French garden*" (Eco, 1994: 128). Not to describe places realistically or imaginatively, nor simply reflect reality successfully, but rather serve as the driving force behind different routes through the city. It should act as an initiation, as Tsirimokou writes, into the topological variety that mobilizes vision—into the alternation, arrangement, and multiplicity of spaces that create life, traces, and history—"*revealing a living, dynamic, inventive city, with its needs and its luxuries, its practicality and its fantasies*." (Tsirimokou, 2000).

3. CITY VERSIONS: ISTANBUL, ALEXANDRIA, HERAKLION

"*...the traveller is invited to visit the city and, at the same time, to examine some old postcards that show it as it used to be ... Beware of saying to them that sometimes different cities follow one another on the same site and under the same name, born and dying without knowing one another, without communication among themselves.*"

(Calvino, 1974: 22-23)

Cities evolve over time and are constantly transformed. Urban space, the product of complex processes, practices, and fermentations, is neither unambiguous nor fixed, whether as an image or a representation. It embodies a field of experiences and vicissitudes, cultural encounters, and historical memory—a fluid condition shaped by social changes and aesthetic osmosis.

Literary narratives identify significant distinct points on the city map. These include observation points, highlighted by the authors and recognized through research; condenser points, where representations of urban space by various authors—both native and foreign—intersect, capturing the unique character of the city; and viewpoints revealing the invisible, the indistinguishable, and the residual aspects of urban character (Moira, 2018). It concerns the interaction of specific people with specific spaces and is spatially determined. The literary city is a spatial representation in which social impact, historical memory, the confusion of symbols, and their infusion and articulation into new contradictions are inscribed. It embodies the paradox of habitation and the subjectivity of the resident's gaze (Prieto, 2012; Pleßke, 2014). The city's syntactic structure is imbued with the events of memory, the pain associated with familiar places, and the rituals of everyday life. Unique emblematic "urban objects" are those that expand the present moment, as well as collective fantasies, social control, and private conversations that claim public space (Massey et al. 1999). Vector paths emerge as alien destinations from appropriated starting points, giving substance to the road; wanderings

demonstrate the fluidity of boundaries, while alternative observations playfully invert the inside–outside, known–unknown, and familiar–unfamiliar dichotomies. Literary narrative language records or translates the author's internal, explicit, or implicit discourse on habitation and urban experience, revealing individual and collective identities of citizens, selecting places of fundamental importance, gathering critical mythological, historical, and cultural elements, and inventing connections and interpretations between incompatible spatial fragments and traces (Erll, 2011). It constructs, through a process of stitching, a horizontal spectral network of movements within the existing urban fabric, indicating emblematic places, road axes and communication channels, as well as impenetrable boundaries invisible on the impartial political map—internal walls, intangible gates and passages in spaces of potential exclusion and solidified isolation, urban voids, and unexpected pockets of diversity (Harrow & Watts, 2012). It composes and constructs a hypertextual diagram that records the individual and collective expression of "dwelling" through the embodied management of the urban field (Moira, 2018). The literary representation of the city is detached from the synchronicity and illusion of a single "reality," a fixed and undifferentiated material event. It reveals to the reader-user atmospheres and aspects, both visible and invisible, as well as important elements of various urban chronotopes (Könönen, 2003; Makris, Moira, 2021). These alternative perceptions of different urbanities provide a distinct field for interpretation and understanding.

4. ISTANBUL - ORHAN PAMUK

Istanbul-Constantinople is a twin, multifaceted city with a centuries-old history and a distinctive character that spans two continents. Positioned at the crossroads of East and West, Asia and Europe, it embodies hidden contradictions, multicultural origins, and rapid development that continuously transforms it. The distinguished writer Orhan Pamuk chooses to highlight the land and sea routes of Istanbul to provide a vivid portrayal of the city and its transformations (Pamuk, 2005; 2015). He depicts his hometown as floating above the Bosphorus, often following his protagonist, the traveling vendor Boza Mevlut, on his nightly journeys through the neighbourhoods and alleys of Istanbul, observing the social, cultural, and spatial urban mutations (Pamuk, 2015).

"Mevlut had been in Istanbul for forty-three years. For the first thirty-five, every year that went by seemed to strengthen his bond with the city. Lately, however, he'd begun to feel increasingly alienated from it. Was it because of that unstoppable, swelling flood, the millions of new people coming to Istanbul and bringing new houses, skyscrapers, and shopping malls with them? He began to see buildings that had been under construction when he'd first arrived in 1969 already being demolished, and not just ramshackle houses in poor neighborhoods, but even proper buildings in Taksim and Sisli that had stood for over forty years. It was as if the people who lived in these old buildings had run out of the time they'd been allotted in the city. As those old people disappeared along with the buildings they'd made, new people moved into new buildings—taller, more terrifying, and more concrete than ever before. Whenever he looked at these new thirty- and fortystory towers, Mevlut felt that he had nothing to do with any of the new people who lived in them." (Pamuk, 2016: 573).

Sometimes, he focuses on the seafront and the bridges, which, like visible threads, tightly stitch the two parts of the city together. He describes the moving images seen from the sea, emphatically identifying what cannot be clearly seen from the beach.

"*Pushed along by its strong currents, invigorated by the sea air that bears no trace of the dirt, smoke, and noise of the crowded city that surrounds it, the traveller begins to feel*

that, in spite of everything, this is still a place in which he can enjoy solitude and find freedom. This waterway that passes through the centre of the city is not to be confused with the canals of Amsterdam or Venice or the rivers that divide Paris and Rome in two: Strong currents run through the Bosphorus, its surface is always ruffled by wind and waves, and its waters are deep and dark. If you have the current behind you, if you are following the itinerary of a city ferry, you will see apartment buildings and yalıs, old ladies watching you from balconies as they sip their tea, the pergolas of coffeehouses perched by landings..." (Pamuk, 2005: 124)

As the visitor moves along the sea roads of the Bosphorus, a panorama in kinaesthetic terms unfolds before him (mosques, minarets, apartment buildings, towers, gardens, remote neighbourhoods, hills) while at the same time a fluid field of view and observation is formed on both sides:

"*To travel along the Bosphorus, be it in a ferry, a motor launch, or a rowboat, is to see the city house by house, neighborhood by neighborhood, and alsofrom afar as a silhouette, an ever-mutating mirage...*"(Pamuk, 2005: 124)

The technology of 3D Gaussian Splatting (3DGS) emerges as an ideal medium for visualizing Pamuk's concept of "*hüzün*" (melancholy). 3DGS can effectively render the atmospheric ambiguity, fog, and fluidity of the Bosphorus. The proposed digital model does not depict the city as a static urban plan but rather as an impressionistic cloud of memory, where the ruins of the past and modern apartment buildings interpenetrate, allowing the user to experience the city as a "changing dream as the author describes it.

5. ALEXANDRIA – CONSTANTINE CAVAFY

Alexandria, located west of the Nile Delta and built on a long, narrow isthmus between Lake Mareotis and the Mediterranean Sea, was in ancient times the most important port and capital of Egypt. At its peak, it was the largest economic centre in North Africa and one of the most prominent cultural hubs in the world. Renowned for its library and lighthouse—one of the Seven Wonders of the Ancient World—it was founded by Alexander the Great in 331 BC. By the early twentieth century, multicultural and cosmopolitan Alexandria was home to a significant Greek community among other foreign residents, which flourished and dominated the city's cultural and economic life. Alexandria grows parallel to the seafront, having an extensive linear organization that exhibits alternations and variations.

In this context, the poetic creation of Constantine Cavafy, an illustrious intellectual native of this city, is inscribed. A poet deeply connected to and celebratory of Alexandria (Kolonas, 2024: 13), Cavafy was an absolute master of his expressive means. He engaged in a continuous and dialectical interplay of mythologizing and demystifying, 'strolling' comfortably real and historical times. He mythologized his modern, present, and even non-existent city, preserving it in memory capsules, while simultaneously demystifying one or many "*historical Alexandrias—cities that envied its greatness, imitated its example, and ultimately perished alongside it. By recalling these cities, the poet grants them a second, otherwise illuminated life, revealing the reverse side of the official narrative. Using the dual voice of the present and the absent, the living and the dead, he enters and exits these perforated memories, preserving something of their authentic presence within the deltas of History*"

(Tsirimokou, 2025).

"*Yesterday while strolling through a neighbourhood*
on the edge of town, I passed below the house
I used to go in when I was very young.. […]
And yesterday
as I passed along that ancient street,
suddenly everything was made beautiful by desire's spell:
the shops, the pavements, the stones,
and walls, and balconies, and windows;
there was nothing ugly that remained there"
(Cavafy, 2012 - Below the House)

"*Somehow, we should approach the urban atmosphere—real or imaginary—that permeates his poetry: alleys, streets, squares, suburbs, ports, beaches, houses, shops, cafés, taverns, and so forth. These elements stage a city with its bustling, market-like daily life, its diverse population, and the beauty found within its ugliness, repeatedly*" (Tsirimokou, 2025).

According to Kolonas (2024), the only exception to this modern urban anonymity is the prose poem 'In Broad Daylight' (Cavafy, 2012), which explicitly names neighborhoods, squares, and main streets of Alexandria (Ramli, Rossini, Aboukir, Sidi Gavir, etc.), as well as well-known landmarks such as the casino of Agios Stefanos, the café the theater the poet attempts to capture Alexandria's European identity, situating it within the pantheon of multicultural metropolises of the nineteenth century. Keeley, writing about Cavafy's Alexandria, reveals the image of an alluvial city stratified into at least four levels: the real city, the metaphorical city, the sensual city, and the mythical Alexandria (Keeley, 1996). These levels are not impermeable but porous; they interpenetrate and create a rare, perhaps unique, amalgam.

For Alexandria, the challenge of augmented reality lies in managing "absence." Since Cavafy's physical city has been lost, the AR system is tasked with functioning as a "spectral plane" (or spectral layer). Through the semi-transparent visualization provided by 3DGS , the demolished neoclassical and mythical sites are projected onto the contemporary urban fabric not as solid objects but as memories that emerge and fade away. Thus, the walker does not merely see a historical representation but experiences the sense of loss and sensuality that permeates Cavafy's poetry.

6. HERAKLION - NIKOS KAZANTZAKIS

Heraklion, located on the island of Crete, carries a profound historical legacy shaped by its Minoan origins, Byzantine presence, Arab cultural influences, Venetian rule, and Turkish conquest. As an island and port city, its strategic location and rich history have made it a gateway and a dominant force in the Aegean Sea. It is a fortress city scattered with historical remnants—a multifaceted, mythical, and conflicting city, a place that evokes complex emotions in modern visitors while inspiring native writers. These authors strive to capture Heraklion's unique character in their narratives. Often described as a "melting pot of cultures," Heraklion embodies numerous contradictions that prominent local writers attempt to represent, in significant novels and short story collections within Greek literature. Their works survey the city's physiognomy, interpreting the interplay between the stable elements of its urban space and the dynamic forces driving its transformation. They portray the "nuclear

Heraklion" within its walls as a distinctive, conflictual urban amalgam that reflects the heterogeneity of its historical periods, (Moira, 2018).

The Old City of Heraklion, built inward within the protective enclosure of the extensive Venetian wall, is an enclosed city that looks inward with an introspective mood, despite being a port. It turns its back on the sea—the northern border and a potential threat due to adverse weather conditions such as strong winds and humidity, as well as the historical memory of hostile pirate raids and defeats by Arabs, Venetians, and Ottomans. To illustrate its spatial character, Nikos Kazantzakis (1969) selects urban epicenters and main road axes, presenting them as significant fields of stage action, negotiation, confrontation, and communication. He describes the Great Castle as a closed space (Kazantzakis, 1969), controlled by the high walls that surround it and the four guarded gates located at the cardinal points of the horizon, symbols of order and exclusion (Moira, 2018). The stone mantle of the Venetian wall interrupts the flow of the streets, obstructs vision, and prevents contemplation of the distant horizon. Residents go outside the walls to breathe, to see, and to be seen. They gather in Lions Square, an institutional and social epicentre with timeless symbolism, or in Freedom Square (Three Arches), which, as a natural balcony and plateau, alleviates the feeling of suffocation by offering a view of the sea:

"*Captain Michalis took the longest route to go home; he felt he couldn't fit into four walls tonight; he was swelling inside; his heart was overflowing. He couldn't fit in his body, nor in his house; suddenly the Great Castle narrowed, it couldn't fit him. He took the road; houses, alleys, people, were suffocating him. He walked with strides, gritting his teeth, as if he were being chased. He entered Platia Strata, deserted; a few oil lanterns cast faint reddish glows down the cobblestones. He passed the bazaar, a Turkish restaurant was still open, a cafe, two or three taverns; someone called out to him, the voice of Captain Polyxigis seemed to him , he gurgled his steps, he escaped. He arrived outside the Pasha's Gate, at the marble Venetian fountain with the lions. He raised his eyes, saw the Great Plane Tree, the cursed one, he hesitated, no one was passing by, he made the sign of the cross*".

(Kazantzakis, 1964: 34).

In the case of Heraklion, the digital narrative centres on 'embodied movement' and the concept of boundaries. The AR system maps the hero's "escape routes, transforming the Venetian Walls from inert monuments into active fields of experiential transition. By following the footsteps of Captain Michalis (Kazantzakis, 1964) toward the sea, users experience, through augmented navigation, the tension between confinement (the Castle) and liberation (the sea), turning the reading of the text into a dynamic act of traversing urban space.

7. AUGMENTED REALITY AND URBAN EXPERIENCE

Augmented Reality, a cutting-edge digital technology, has the potential to radically transform the human perceptual, embodied, and sensory experience by integrating real and digital environments (Azuma, 2015; Jung, Tom Dieck, 2018). This integration enables a focus on both invisible microcosms and macrocosms, facilitating a range of sensory-motor and cognitive activities within space. Through digital applications, modern technology allows for a multi-sensory exploration of the city and fosters a connection with its historical past (Fiorini et al. 2022). Geolocation systems designate specific viewing anchor points (Cloulelis et al. 1987), where diverse narratives—authored by different authors or multiple texts by the same author—form a polyphonic framework of contrasts. This framework is enriched with factual

material, information, images, and historical elements, while intentionally leaving the interpretation open to the reader or receiver.

The city is a social and cultural space in constant interaction with diverse expressions of life (Massey et al. 1999; Massey, 2005). Since the complexity and potential of such interactions are particularly evident in works of fiction, there has been a growing interdisciplinary interest in literary mapping and the emergence of new correlations between narrative and real locations in recent years (Alter, 2005; Piatti et al. 2009; Cooper et al. 2016). The characteristic urban elements of novels support the spatiotemporal dimensions of their narratives (Hones, 2014; Cooper et al. 2016, Moira, Makris 2018). Through these elements, the social structures that shaped them, the various stories of their transformation over time, and ultimately the identities of the people whose lives are inextricably linked to the spatial environments in which they were born are revealed. A major problem is the lack of a reliable method for the cartographic representation of qualitative data, such as the characteristics of literary texts—including meanings, emotional states, and psychological conditions. Augmented Reality is a technology designed to bridge the real world with its virtual aspects. By overlaying digital information onto the physical environment, it creates an enhanced that is expanded, enriched, and improved—a novel entity with its own unique characteristics and dynamics (Azuma, 2015).

Seamon (2014) views engagement with a place as a complex, multivalent, and dynamic process. His framework is based on the assumption that this attachment or connection results from the interaction between the experience of a place and the creation of meaning associated with that experience (Seamon, 2014). The body itself is the central element in engaging with the surrounding urban space (Low, Altman, 1992). The body's position within space is fundamental both to understanding AR and to the medium's ability to offer new dimensions to the relationship between the body and the environment. The significance of the embedding features provided by AR, particularly those based on novels, is crucial for comprehending user participation and engagement within the palimpsest of the urban landscape.

Augmented Reality is proposed as a powerful tool to capture and visualize the inherent complexity of the spatiotemporal dimensions of novels. An AR system comprises interconnected layers, including the geographical, temporal, and topographical aspects of the narrative, the various scales of the unfolding plot, and the nuances of the characters' emotions (Makris and Moira, 2021). Instead of a static digital image, users encounter actions, scenes, and environments shaped by social, collective, cultural, and historical forces. The AR environment aims to create an immersive experience rather than provide a concise translation of the narrative from one medium to another. The proposed AR framework, based on literary texts, offers significant immersive potential because users are encouraged to explore the city by following the spatiotemporal fields and chronotopes of the novel (Bakhtin, 1981), resulting in a powerful and engaging experiential journey.

8. AUGMENTED REALITY, LITERATURE AND URBAN SPACES

The transformation of the urban experience through the integration of literary narratives, AR frameworks, and advanced three-dimensional digitization techniques, such as 3D GS, represents a significant epistemological shift for the 21st-century traveller. This convergence liberates the representation of the city from the constraints of a fixed material event, enabling access to the multifaceted layers of urban chronotopes and enhancing the visitor's sense of engagement within the spatiotemporal palimpsest of the urban environment. AR framework, guided by text analysis, reveals diverse versions of urban landscapes, offering a richer field of

interpretation and perception (Makris and Moira, 2021). This approach shifts engagement from passive consumption of standardized tourist products to personalized, critical, and experiential discovery.

I. Construction of Multilevel Urban Timelines through Narrative

Literary narratives serve as a crucial interface that deciphers the culture, history, memory, and socio-political structures of a city, offering the essential intangible content for digital augmentation.

Disconnection from Contemporaneity and the Revelation of the City's Palimpsest. The novels disentangle the representation of the city from the illusion of contemporary reality, revealing distinct urban chronotopes. The city is understood as a palimpsest—a multi-layered text inscribed with historical events, collective actions, and personal testimonies. Through literary mediation, multiple perspectives are offered to the reader, allowing them to perceive the city not as a singular reality but as a fluid continuum in which the past is actively recalled and reconstructed.

Anchor Points and Chronotopic Fields. Literary texts identify significant, distinct locations on the urban map—referred to as "concentrator points" or 'anchor sites'—where multiple representations of urban space converge, revealing the city's intrinsic character and accumulating its historical, social, and mnemonic significance. An AR framework based on these narratives enables users to trace the novel's spatiotemporal fields and chronotopes within the physical urban environment.

Visualizing Complexity. The AR system serves as a powerful tool for capturing, expressing, and visualizing the inherent complexity of the novel's spatiotemporal dimensions. It integrates layers of geography, time, plot scales, and the emotional nuances of characters. This immersive environment aims to deepen the narrative experience, moving beyond a mere summary or direct translation from one medium to another.

II. 3D Gaussian Splatting: A New Visual Ontology for Urban Memory

The integration of the 3D Gaussian Splatting (3DGS) method in the proposed context is not merely a technical enhancement but introduces a novel aesthetic approach to the digital representation of the past, effectively engaging with the fluidity of literary narrative.

From Geometric Precision to Atmospheric Sensibility. Traditional digitization methods, such as photogrammetry, emphasize strict geometric reconstruction, producing "hard" models that claim objective truth. In contrast, 3DGS operates more impressionistically: it renders three-dimensional space through "clouds" of brightness and colour (Gaussians) rather than solid surfaces. This approach offers a new visual aesthetic that captures the "intangible" essence of the city. Instead of representing buildings as fossilized objects, 3DGS can depict decay, fog, light, and atmosphere—elements that compose the experiential memory of a place.

Technology as a Memory Mechanism. This technical peculiarity makes 3DGS ideal for visualizing literary chronotopes. Its ability to produce images that sometimes appear "spectral" or dreamlike enables researchers to reconstruct buildings that no longer exist—not as cold architectural designs, but as mnemonic traces. Thus, technology ceases to be merely a measuring tool and becomes an instrument of recall, blurring the boundaries between the real and the imaginary, and allowing users to experience the emotional depth of the city.

Dynamic Urbanity and the Flow of Time. Furthermore, recent advancements in the method, such as Dynamic Fields (Fischer, et al.2024), enable the incorporation of the dimensions of time and movement. Unlike static digital models, this system can represent changes in weather, lighting, and human activity. This capability is crucial for the visitor's experience, as the city is not depicted as a lifeless museum but as a living organism that evolves—precisely as portrayed in literary narratives.

III. Improved Urban Integration and Experiential Engagement

The AR framework significantly enhances visitors' engagement with urban environments by prioritizing their physical presence and movement, effectively transforming them into co-creators of the experience.

The Body as a Central Interface. The position and placement of the user's body within space are recognized as fundamental to understanding the AR medium and enhancing user participation and engagement in the urban palimpsest. AR applications, particularly location-based ones, influence the presence and behaviour of the physical body within the socio-cultural context of the place.

Re-engagement Strategy. A key strategic enhancement is re-engagement, which incorporates the user's movement through both familiar and unfamiliar environments. This process facilitates the discovery and manipulation of the inexhaustible layers of matter and meaning within urban locations. By navigating the city along narrative paths, the user shifts from passive visual enjoyment to actively discovering actions, scenes, and environments shaped by social, collective, cultural, and historical forces.

Active and Immersive Participation. The novel-based AR framework transforms the user from a passive observer into an active participant, enhancing both mental and physical engagement with the complex nature of the city. The user becomes an "augmented reality nomad" who does not merely consume images but is physically and mentally involved in decoding the multi-layered urban landscape. This experience, driven by the juxtaposition of literary narrative (emotion, myth, history) and digital technology, transcends the dichotomy between lived experience and virtual reality. Users design sensory experiences mapped to the plot, identify landmarks, and explore urban monuments, while simultaneously inhabiting the past by reliving moments and scenes through digital representations. This process enables the re-appropriation of urban space: through the direct visual juxtaposition of historical traces with the contemporary environment, the traveller simultaneously experiences the "there" of myth and the "here" of reality. Thus, repressed or lost "cities" hidden beneath the material shell of the present are brought to the surface, transforming the walk into an act of revelation.

Immersive Spatial, Emotional, and Cognitive Understanding. This augmented integration, guided by the narrative framework and visually supported by advanced 3DGS visualization, fosters a profound spatial, emotional, and cognitive comprehension of the location. By connecting with the cultural memory embedded in the urban space, residents and visitors can gain a deeper appreciation of the origins and significance of the collective and cultural heritage. This connection leads to a pluralistic, holistic experience of the city's chrono-local depth and the continuity of its socio-political and cultural history.

9. DISCUSSION

This research highlights that the convergence of literary narrative, AR and three-dimensional imaging 3DGS is not merely a technological innovation but establishes a new epistemology for urban experience and digital cultural heritage. Through the analysis of the results, three main axes of contribution emerge.

Three-Dimensional Visual Ontology in the Humanities: The introduction of 3DGS bridges the gap between metric accuracy and the aesthetics of memory. Unlike classical photogrammetry, which requires strict geometric continuity, 3DGS functions as a "visual ontology" capable of modeling absence, temporal overlap, and atmospheric ambiguity. This method enables the visualization of urban heritage as a semi-material, probabilistic condition,

avoiding the illusion of a single historical truth and allowing users to experience the 'aura' of the past.

From Tourism to Embodied Interpretation: Findings strongly support the narrative approach to AR interfaces. When digital content is guided by literary chronotopes rather than tourist stereotypes, urban cognition shifts from passive consumption to active, embodied interpretation. Literary 'anchor points'—such as thresholds, ruins, or hidden neighborhoods—are transformed into semantic beacons. The user ceases to be a mere spectator and assumes the role of a walker-reader, co-mapping the city through movement and experienced detail.

Towards a New Epistemology of the Urban Visitor: This study proposes a new contract between the city and its interpretation. The city becomes legible through narrative and comprehensible through digital augmentation. The proposed framework does not produce a static "digital twin" of tourist information but rather a dynamic "twin of urban memory" that evolves in the field. This hybrid construction allows for the coexistence of multiple spatial and temporal grammars without asserting unique truth claims, thereby promoting a model of cultural heritage based on multiplicity and the dialectical relationship between the present and the past.

10. CONCLUSIONS – EPILOGUE

We demonstrate that cities are not merely physical containers of landmarks but layered mnemonic archives whose legibility depends on narrative mediation and digital re-materialization. The careful orchestration of literature, augmented reality, and advanced 3DGS methods radically transforms the 21st-century traveler's experience. The proposed system does not replace the physical environment with the virtual; rather, it establishes a "palimpsest chronotope" in which history, myth, and everyday practice are productively synthesized.

In this way, the city emerges not as a static exhibit but as a dynamic, open archive that invites continuous discovery and personal meaning-making, thereby redefining our relationship with cultural memory and urban space.

According to this methodological framework, the visitor to the historical cities mentioned as examples exists in the urban space in the present tense, moves along paths indicated by the literary narrative, derives sensory experiences based on the plot's mapping, receives messages, and communicates with other attendees. The visitor locates landmarks and navigates urban monuments through multiple literary references. Simultaneously, they can inhabit the past by reliving moments and recalling images and scenes from history. Through augmented reality, visitors have the ability to visualize buildings that no longer exist, explore the form and use of spaces during significant periods with the aid of various archival sources, and apply multiple cultural layers to perceive the continuity of historical time and changes in socio-political events. This approach enables a multifaceted, holistic experience of the city.

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SMILES AMONG THE RUINS AND CROWDS? RETHINKING TOURIST WELL-BEING AND HAPPINESS FOR SUSTAINABLE URBAN TOURISM IN ATHENS

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Abstract
Tourism is a powerful driver of urban and regional development, yet its sustainability increasingly depends on the balance between economic benefits, cultural heritage preservation, and the well-being of visitors and residents. In this context, happiness has emerged as a key dimension of sustainable tourism, reflecting the extent to which destinations provide not only memorable experiences but also contribute to quality of life. This study explores the relationship between happiness and tourism in the urban environment of Athens, focusing on international visitors participating in guided tours of the Acropolis. Drawing on primary research conducted over the past two years, the study investigates how overtourism—characterized by crowding, congestion, and extended waiting times—affects tourists' emotional responses, satisfaction, and overall perception of the destination.

Findings reveal that, while the Acropolis continues to inspire admiration due to its cultural and historical significance, excessive visitor numbers during peak months negatively impact tourists' sense of happiness, reducing both personal fulfillment and the perceived quality of the experience. Nevertheless, the research highlights the role of guiding and storytelling in mitigating these challenges, with many respondents noting that interpretive engagement enhanced their connection to the site despite adverse conditions.

These insights contribute to the broader debate on sustainable urban and regional tourism development. Specifically, they emphasize the need for destination management strategies that regulate visitor flows, protect cultural assets, and ensure positive visitor experiences. Such approaches align with the United Nations Sustainable Development Goals (SDGs), particularly those related to sustainable cities and communities, responsible consumption and production, and the protection of cultural heritage. By integrating tourist happiness into urban planning and heritage management, destinations like Athens can enhance resilience, safeguard authenticity, and promote sustainable development that benefits both visitors and local communities.

Keywords: happiness, overtourism, urban tourism, sustainability, Athens, Acropolis

GEOTOURISM AS A TOOL FOR SUSTAINABLE TOURISM DEVELOPMENT: THE CASE OF LAVREOTIKI'S GEOPARK

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Abstract
Tourism development is one of the most important sources of economic and social progress for Greece, but in some cases it creates environmental degradation, mainly in popular tourist destinations. In this context, alternative forms of tourism emerge as the most appropriate strategies to promote a balanced and sustainable tourism model. In particular, Geotourism focuses on highlighting the geological heritage, the natural landscape, the cultural identity, while combining recreation, education and the sustainable management of the natural resources of each region.

This paper examines the area of Lavreotiki where "UNESCO World Geopark of Lavreotiki" is located. Lavreotiki is an area with rich geological and cultural heritage, as well as a long mining history and combines rare mining monuments, geological formations, archaeological sites and traditional rural settlements, offering a unique tourist product. Primary data has been collected through quantitative research to examine the perspective of residents and visitors. Useful recommendations and implications derived from the data analysis for local authorities and professionals. Through the development of Georoutes, the highlighting of mining and cultural heritage, the Geopark can contribute to the strengthening of the local economy, the environmental education of residents and visitors and lay the foundations for sustainable tourism development.

Key words: Alternative tourism, Geotourism, Sustainable Tourism Development, Geoparks

SESSION

"Environmental Sustainability-Waste Management-Circular Economy"

Chaired by **Prof Brzezińska-Rawa Anna** and **Prof Theodoropoulou Eleni**

THE BOTTLE-NECK OF SUSTAINABLE GOVERNANCE: LEGAL AMBIGUITIES IN POLAND'S MUNICIPAL WASTE MANAGEMENTAND THE EPR-BASED DEPOSIT SYSTEM

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Abstract
The need for transparency, efficiency, and legitimacy in environmental governance, particularly in municipal waste management, is underscored by Sustainable Development Goal 16 (targets 16.6 and 16.7). Extended Producer Responsibility (EPR), as an instrument aligned with this Goal and the Circular Economy paradigm, continues to generate challenges across all levels of contemporary legal system. Particular difficulties have been observed in the allocation of competences between central and local authorities, as well as between public institutions and private producers. These governance and regulatory gaps are evident in Poland, an EU Member State currently developing a national deposit-refund system for beverage containers.

The Polish legal and institutional framework governing municipal waste management has been analysed to identify structural weaknesses affecting EPR implementation. Special attention has been given to the legal ambiguity surrounding the distribution of duties between municipalities and producers, and the implications this has for the effectiveness of the deposit system. As a result, regulatory fragmentation, implementation delays, and insufficient coordination have been observed, undermining the achievement of sustainability targets required by EU law, particularly the Waste Framework Directive and the Single-Use Plastics Directive.

A legal doctrinal approach has been combined with analysis of national policy acts. Through this method, tensions have been identified between environmental protection as a constitutional obligation and the practical functioning of a decentralised governance system. It is concluded that the effective realisation of the EPR requires a redefinition of institutional roles and the introduction of clearer legal obligations concerning producer responsibility and municipal capacity.

Key words: Extended Producer Responsibility (EPR), municipal waste management, deposit-refund system, environmental governance, legal fragmentation

BALANCING SUSTAINABILITY AND PERFORMANCE: COMPARING RECYCLED, BIO-BASED AND LOW-CARBON MATERIALS USING AHP

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Abstract
Choosing sustainable materials involves balancing environmental impact, cost, performance, and supply risks. This study presents a practical framework to compare three alternatives—recycled, bio-based, and low-carbon virgin materials—using the Analytic Hierarchy Process (AHP). Each material is characterized with clear definitions, technical properties, and measurable indicators tied to key criteria such as carbon footprint, availability, cost, performance, and circularity.

Quantitative data are normalized and converted into pairwise comparisons, while qualitative aspects are captured through expert judgment. A worked example on lifecycle emissions illustrates how raw data can be transformed into actionable AHP weights. The framework also provides guidance for data collection, stakeholder engagement, and sensitivity analysis.

By combining measurable metrics with expert insights, this approach helps practitioners make transparent, evidence-based decisions to select materials that balance sustainability objectives with practical operational requirements.

Keywords: Sustainability, recycled, bio-based, and low-carbon virgin materials, Analytic Hierarchy Process (AHP)

CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT – EXAMPLES OF THE POLISH EXPERIENCE

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Abstract
This paper explores the intersection of circular economy (CE) practices and sustainable development (SD) in Poland, highlighting national strategies and local initiatives that support long-term environmental and economic resilience. The analysis focuses on key Polish policies aligned with the European Green Deal and the Circular Economy Action Plan, with particular emphasis on waste management and urban sustainability.

Methodologically, the study adopts a mixed-methods approach, combining policy document analysis, national statistical data from the Supreme Audit Office, and a case study from the city of Łódź. The Łódź example illustrates innovative municipal approaches to circularity, such as reuse parks, zero-waste programs, and circular construction models.

Although Poland faces systemic challenges - including uneven regional capacity, low recycling rates, and a declining material circularity rate (7.5% in 2023 vs. the EU average of 11.8%) - emerging practices reveal the potential for scalable, locally adapted solutions. Cities are increasingly leveraging EU funding, public-private partnerships, and grassroots innovation to support measurable progress in CE implementation.

Intended for an international audience of researchers, policymakers, and practitioners, this paper provides practical insights into how a post-transition European economy is applying circular principles under real-world constraints.

The final findings indicate that recycling and the preparation of materials for reuse have declined, and material circularity has worsened in recent years. Nevertheless, new circular initiatives are gaining public attention and gradually generating both environmental and socio-economic benefits. The paper concludes with recommendations for scaling these practices and aligning them with Poland's sustainable development goals, including the UN Agenda 2030.

Keywords: Circular economy, sustainable development, Poland, waste management, urban sustainability, EU Green Deal, post-transition economies

CIRCULAR BIOECONOMY TO SUPPORT THE GREEN TRANSITION IN INSULAR AREAS

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Abstract
Insular regions face challenges such as energy deficit, a declining agricultural sector, deteriorating water and soil quality, a rise in the risk of natural disasters brought on by climate change, coastal pollution, ineffective biowaste management, deteriorating ecosystems, a loss of biodiversity, etc. Circular and resource-efficient economic models, which consider the entire material cycle to promote reuse as well as waste reduction and efficient resource utilization, are increasingly replacing linear economic models based on production-consumption-disposal systems. Bioeconomy covers a wide range of sectors and systems which are based on biological resources (animals, plants, microorganisms, and biomass, including organic waste), their functions and principles. The transition to circular bioeconomy will be further reinforced through the development and uptake of innovative technologies as well as the training of scientists and researchers through the collaborative ecosystem at national and international level. This work aims to present a holistic approach which combines the recovery and valorization of biological resources, promotes sustainability and protects the natural environment. The approach is organized into four pillars as follows: (a) sustainable production and management of biomass, (b) sustainable water resources and soil management using nature-based solutions, (c) recycling of materials and production of new products, (d) reduction of the environmental footprint in the tourism industry.

The overall objective of the study is the adoption of the EU Bioeconomy Strategy making sure it reflects the specific conditions of the island regions. This can lead to new jobs, contribution to achieve carbon neutrality, shift to the circular economy model, harnessing of healthy natural ecosystem as well as modernisation and strengthening industry.

Key words: circular economy, bioeconomy, resource recovery, insular regions, environmental footprint

EXAMINING CIRCULAR ECONOMY BARRIERS, DRIVERS AND SPECIFICATIONS IN THE CONSTRUCTION SECTOR: KEY STAKEHOLDERS' SURVEY

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Abstract
The construction sector significantly impacts energy consumption, raw materials usage, and waste production, making the adoption of Circular Economy (CE) essential for sustainability and carbon neutrality. To this end, it is important to develop a strategy that engages key stakeholders in identifying the necessary actions to integrate CE into climate mitigation efforts.

To achieve this objective, a survey was designed, organised, and conducted to examine key stakeholders' perceptions of the circular economy in the construction sector, focusing on the identification of specifications/ requirements, barriers, and drivers that could enhance the implementation of CE practices. The target audience of the survey was stakeholders from the research, academic, industrial, policy, and construction sectors.

The survey was initiated with a literature analysis, the findings of which, combined with additional feedback from key stakeholders in the field of CE and sustainable development, led to the development of the survey questionnaire. The questionnaire was created on the Google Forms platform. The QR code and link to the survey were distributed to key stakeholders via email, as well as during workshops and conferences on related to the survey topics.

The collection of interviews was conducted between June 2024 and April 2025, resulting in a sample of 114 questionnaires from nearly 30 European countries. A dataset was created that incorporated all selected responses. Statistical analysis of the dataset was performed using the SPSS 20 statistical package and Microsoft Excel 2021.

The results of the statistical analysis showed that perceptions of certain CE specifications/requirements - particularly safety, contribution to climate mitigation, and environmental impact - are prioritised over aesthetic and implementation-related factors. Notably, barriers such as cost-related aspects, lack of government support and regulatory framework are perceived as the most significant obstacles, while drivers like established markets for circular materials and innovation funding are considered key enablers.

Keywords: Circular economy, construction sector, barriers, drivers, specifications, stakeholders, perceptions

Acknowledgments

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This output reflects only the authors' view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

In addition, part of this research is conducted within the framework of the ongoing PhD of Theoni I. Oikonomou, to be awarded by the Department of Economics and Sustainable Development of Harokopio University.

EXAMINING THE "RETHINK" AND "REFUSE" CIRCULAR ECONOMY PRACTICES IN THE CONSTRUCTION SECTOR: RESULTS FROM A SURVEY FOCUSED ON YOUTH ACROSS SEVEN EUROPEAN COUNTRIES

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Abstract
The CO2NSTRUCT project aims to develop strategies for quantifying citizen behaviour and stakeholder opinions regarding circular economy (CE) practices in the construction sector, to enhance climate change mitigation models. In this regard, a survey on young citizens' attitudes towards high-level CE practices like "Rethink" and "Refuse" was planned and carried out.

The survey explored young citizens' attitudes toward the adoption of CE practices in construction, such as sharing residences, living in smaller or bio-based buildings, and engaging in shared study spaces or workspaces. The factors that may affect this decision were also evaluated, including economic, environmental, and social reasons, as well as living/ studying/ working conditions (depending on the case).

The survey was conducted between May and August 2025 across seven European countries (Denmark, Germany, Greece, Italy, Portugal, Spain, the UK), including 285 participants under 36 years old. The survey unveiled interesting attitudes, with a general openness to adopting certain CE practices such as living in smaller or bio-based constructed homes, and sharing study and workspaces. Economic reasons emerge as the primary

motivator influencing willingness in the case of sharing a residence or living in a smaller one, while environmental considerations are particularly influential in decisions related to bio-based materials. In the case of sharing studying or working spaces, the provided conditions are perceived as the leading factor.

Attitudes vary on a country level, influenced by factors like income, age, and residence characteristics, but show no gender differences. The findings highlight the importance of tailored strategies to promote CE adoption, emphasizing awareness of environmental benefits and addressing economic barriers to foster a more sustainable and circular construction sector.

Keywords: Circular economy, construction sector, rethink, refuse, sharing, motivators, survey

Acknowledgments

This research has been supported by the European Union's Horizon Europe research and innovation program, under grant agreement No. 101056862, CO2NSTRUCT project.

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SESSION

"Consumers and Sustainability"

Chaired by **Prof Sardianou Eleni** and **Kostakis Ioannis**

PERSUASIVE TECHNOLOGIES AND SUSTAINABLE CONSUMER BEHAVIOR: A BIBLIOMETRIC MAPPING OF RESEARCH TRENDS (2015–2025)

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Abstract
This study explores the evolution of academic research linking persuasive technologies with sustainable consumer behavior over the period 2015–2025. A bibliometric analysis is conducted using data retrieved from the Scopus database, with VOSviewer employed to visualize keyword co-occurrence and thematic clusters. The analysis maps prevailing research directions, influential publications and emerging interdisciplinary connections, reflecting the growing interest in how digital interventions may influence sustainable consumption patterns. The findings provide a structured overview of the intellectual landscape in this field, offering valuable insights into the trajectory of research and contributing to the understanding of how persuasive technologies can be positioned as tools to foster environmental and social responsibility.

Keywords: Persuasive technologies, consumer behavior, sustainability, sustainable consumption, bibliometric analysis, VOSviewer.

LAST-MILE DELIVERY WITH DRONES IN AN URBAN ENVIRONMENT. EMPIRICAL STUDY ON CONSUMER PERCEPTIONS.

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Abstract
This study explores the prospects and challenges of using drones as an alternative means of transport for last-mile delivery within modern logistics networks. It investigates the technological, environmental, and economic aspects of drone delivery, focusing on how these systems can enhance efficiency and sustainability in the supply chain. The research combines a theoretical analysis of global and Greek case studies with an empirical survey conducted among 261 participants from the general public. The findings reveal a generally positive perception of drone deliveries, emphasizing speed, reduced environmental impact, and improved accessibility as key benefits, while highlighting concerns related to safety, regulation, and privacy. The results suggest that drones can play a crucial role in reshaping last-mile logistics, provided that policy frameworks and technological infrastructures evolve accordingly. Finally, the study proposes practical recommendations for integrating drone technology into sustainable logistics models and urban delivery systems.

Keywords: Logistics, last-mile deliveries, drones, city Logistics

ASURING THE EFFECTS ON WELL-BEING, SELF EFFICIENCY AND EMPLOYABILITY OF VULNERABLE POPULATION GROUP AFTER IMPLEMENTING A PLATFORM FOR MENTORING

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Abstract
Background. Mentoring is a modern method for a job expert to be communicated with person that needs a personalized direction for seeking or addressing for a job. E-mentoring is the evolution of mentoring applying through electronic communication technologies. E-mentoring advantages were many including flexibility and broader reach. **Aim of the study** is to present information on how the mentees have considered the changes in their employability and their emotional status after the usage of an e-mentoring platform **Methods**: A list of 105 people belonging to vulnerable population groups such as long-term unemployed, single parents, persons with ADHD / ASD disorders, immigrants, etc were asked to define the degree of agreement with a list of 34 statements concerning: the evaluation of platform usage, psychological and emotional changes, development of skills, job search and voluntary participants. Twenty-three of the statements were in a 6-poing Likert scale of disagree / agree and eleven statements of no / maybe / yes. **Results.** All statements showed a mean level of agreement to partly agree with the statements. Sex of participants showed to affect only a specific statement related to the affection of professional growth. Educational levels are shown to affect professional growth, improvement of skills, emotional distress, improvement of self-efficacy and improvement of well-being. **Conclusion.** The usage of an e-mentoring platform on vulnerable populations groups showed a lot of benefits not only on their occupation status, growth or skills improvements but there is also a clear effect on self-esteem, optimism and well-being.

Key words: well being, self-efficiency, employability, vulnerable population groups

Introduction

Mentoring is a process characterized by pairwise relationships where an experienced professional provides not only knowledge about its working area but also psychosocial

support and role modelling to the mentees. Mentoring thereby is shaping professional identity and long- term career trajectories (Mullen & Klimaitis, 2021). Mentoring accelerates skill acquisition by enabling the transfer of expert's knowledge and situated problem solving through observation and feedback; this leads to accelerated learning and skill development and faster workplace integration. (Baran & Zarzycki, 2021; Parker et al., 2008).

The relational support between mentor and mentees inherent in the process can enhance confidence and self- efficacy of mentees. Mentees were validated through the process and incremental challenges that build mastery and resilience. The relathionship between mentor-mentee gives variety of perspectives through mentor's networks provides broader outlooks and adaptability, while this interaction cultivates personal growth and soft skills such as communication, emotional intelligence, and reflective practice. Finally, the accountability embedded in mentoring relationships—regular meetings, goal setting, and progress review—sustains motivation and goal attainment more effectively than one- off guidance sessions (Eby et al., 2008)

A similar term the career guidance often called as career counselling typically involves shorter- term, structured interventions—assessments, information provision, and decision- making support—aimed at matching interests, skills and opportunities rather than cultivating an enduring developmental alliance Empirical syntheses in health professions and higher education underline that mentoring contributes uniquely to *professional identity formation* and relational learning processes that are not fully replicated by formal guidance services. (Leavitt et al., 2022). Mentoring and career guidance are therefore **complementary**: mentoring provides relational depth and long-term professional socialization, while career guidance offers structured assessment and decision support; integrating both yields the strongest outcomes for career development and employability.(Toh et al., 2022)

Communities or individuals whose social, economic, environmental, or health-related situations make them more vulnerable to damage are known as vulnerable population groups (VPGs). According to the World Health Organization, vulnerability is a state that is influenced by physical, social, economic, and environmental elements that make a person more susceptible to risks, such as persistent poverty, a lack of institutional support, hazardous living conditions, or social isolation. Vulnerability is multifaceted, with evolving physical, psychological, and social dimensions, and frequently arising from interlocking structural disadvantages like poverty, marginalization, disability, and immigration status, according to recent scientific studies. (Mechanic & Tanner, 2007; Wisner et al., 2002)

Recent literature underscores that VPGs include long- term unemployed individuals, people with disabilities, immigrants and refugees, single parents, ethnic minorities, and those with chronic health or developmental conditions (e.g., ADHD, ASD). These groups experience increased probability of social deprivation, reduced institutional support, limited access to resources, and systemic discrimination, all of which significantly shape their vulnerability trajectories (De Chesnay & Anderson, 2019; Marmot, 2020)

Beyond technical progression, the psychosocial support inherent in mentoring enhances personal growth and soft skills, providing the necessary accountability and motivation for sustained performance. Furthermore, studies indicate that protégés benefit significantly from exposure to broader perspectives, which correlates with increased confidence and self-efficacy regarding their professional capabilities (Allen et al., 2004).

Aim of the study is an exploration to the mentees' views and perceptions regarding their skills, competences and employability after participating in an e-mentoring program offered by the Hellenic Mediterranean University at Crete region during 2021-2022 to individuals belonging to vulnerable groups (e.g. long-term unemployed, single parents, immigrants,

individuals with ADHD / ASD disorders and other disabilities) who were beneficiaries of material support and received social benefits via the municipality social services under the FAED program in Crete region.

Methodology

Participants

The study sample consisted of 110 participants belonging to VPGs who were beneficiaries of material support and social benefits via municipal social services under the FAED program. The cohort included long-term unemployed individuals, single-parent families, and persons with disabilities at the higher extent.

E-mentoring platform

The name of the platform was Mentoring and was developed under the collaboration of Region of Crete and the Hellenic Mediterranean University (HMU). The framework was the «Social Partnership of the Region of Crete – Decentralized procurement of food and basic material assistance, administrative costs and provision of accompanying measures 2018-2019». The platform's purpose was career guidance (mentoring) and the support of personal and professional growth. The platform is accessible through the website https://mentoring.sw.hmu.gr.

The "exit" Questionnaire

To evaluate the platform and the mentees' progress, an exit questionnaire comprising 33 questions was developed. The instrument was divided into two types of response formats: Part A: 22 questions utilizing a Likert scale (Not at all, Very little, Little, Enough, Much, Very much). Part B: 11 questions utilizing a categorical scale (No / Maybe / Yes).

The questions were grouped into five analytical categories: Job Search and Employment Assistance (JSEA): Assessed whether the platform helped users discover new job search methods, improve qualifications, or find employment (e.g., "Did you find a job or a better job with the help of the platform?"). Skills Development and Professional Growth (SDPG): Evaluated training and skill acquisition (e.g., "Do you believe that by using the platform... you gained training/education to develop your skills?"). Psychological and Emotional Benefits (PEB): Measured coping mechanisms, confidence, and self-esteem (e.g., "Did the program help you better cope with the fear of failure?") Voluntary Participation (VP): Gauged willingness to participate in future programs, both remote and in-person. Evaluation of Structures and Services Provided (ESSP): Focused on the quality of guidance received. Table 1 roughly describes the number of items of each part (A or B) included in each category

Table 1. Categories of exit questionnaire, acronyms and number of items included

Acronym	Category	Items
JSEA	Job Search and Employment Assistance	A (2) B (3)
SDPG	Skills Development and Professional Growth	A (8) B (4)
PEB	Psychological and Emotional Benefits	A (9) B (2)
VP	Voluntary Participation	B (2)
ESSP	Evaluation of Structures and Services Provided	A (8)

Table 2. Lists the questionnaire items included in each of the categories and the values of internal consistency measures (Cronbach's coefficients a). All coefficients showed acceptable values of >0.700. Higher values were shown in psychological and emotional benefits in section A (α=0.922) and in skill development and professional development in section B (α=0.822).

Table 2. Questionnaire items and measures of internal consistency

Category	Questionnaire item	Cronbach' α
Job Search and Employment Assistance	A5, A19	0.790
	B1, B3, B11	0.771
Skills Development and Professional Growth	A2, A3, A4, A17	0.895
	B4, B5, B6, B8	0.822
Psychological and Emotional Benefits	A1, A6, A7, A8, A9, A10, A11, A16, A18	0.922
	B2, B7	0.721
Voluntary Participation	B9, B10	0.710
Evaluation of Structures and Services Provided	A12, A13, A14, A15, A20, A21, A22, A23	0.834

A complete list of the questionnaire items / statements can be found at the end of the manuscript in Appendix A (Table 1A)

Intervention

The process of mentoring initiates when the mentee receives an automated confirmation email directing them to the platform, where they can access the profile of their assigned mentor. Prior to the first interaction, the mentee is encouraged to review the mentor's curriculum vitae or video introduction to prepare for the engagement. Simultaneously, the mentor acknowledges the assignment by transmitting their availability for the initial web-based meeting via the platform's internal chat system. The framework stipulates that all interactions are conducted on a pairwise basis. The program is provided free of charge, the intervention is finite, capped at a maximum of five sessions. The duration of each meeting determined at the discretion of the mentor.

Each of the participant (mentee) who follow mentoring lectures was asked to participate in the "exit" questionnaire. Data collection was performed on a voluntary basis. Data collection was on based on anonymity in a online platform created using Google forms.

Results

A total of 110 participants from the VPG group responded to the exit questionnaire. Demographic characteristics of the participants of the exit questionnaire were: Over two thirds (2/3, 67.6%) of the 110 participants were females. Single is most of the sample 51.4%, while 44.8% were married and 33.8% were divorced /widowed. A 45.7% have at least one children

and level of education was 6.7% for primary, 49.7% for secondary (Gymnasium or Lyceum) and 43.8% over Lyceum.

Part A and Part B responses of each item and per category were shown in Figure 1. In Part A (6-point Likert questions) agreement was considered as the sum of agree (Enough, Much, Very much). The highest %agreement for each of the questionnaire categories were: 90,4% for JSEA (job search and employment assistance), 86,7 for PEB (Psychological and Emotional Benefits), 92,4% for Skills Development and Professional Growth, 88,6% for Evaluation of Structures and Services

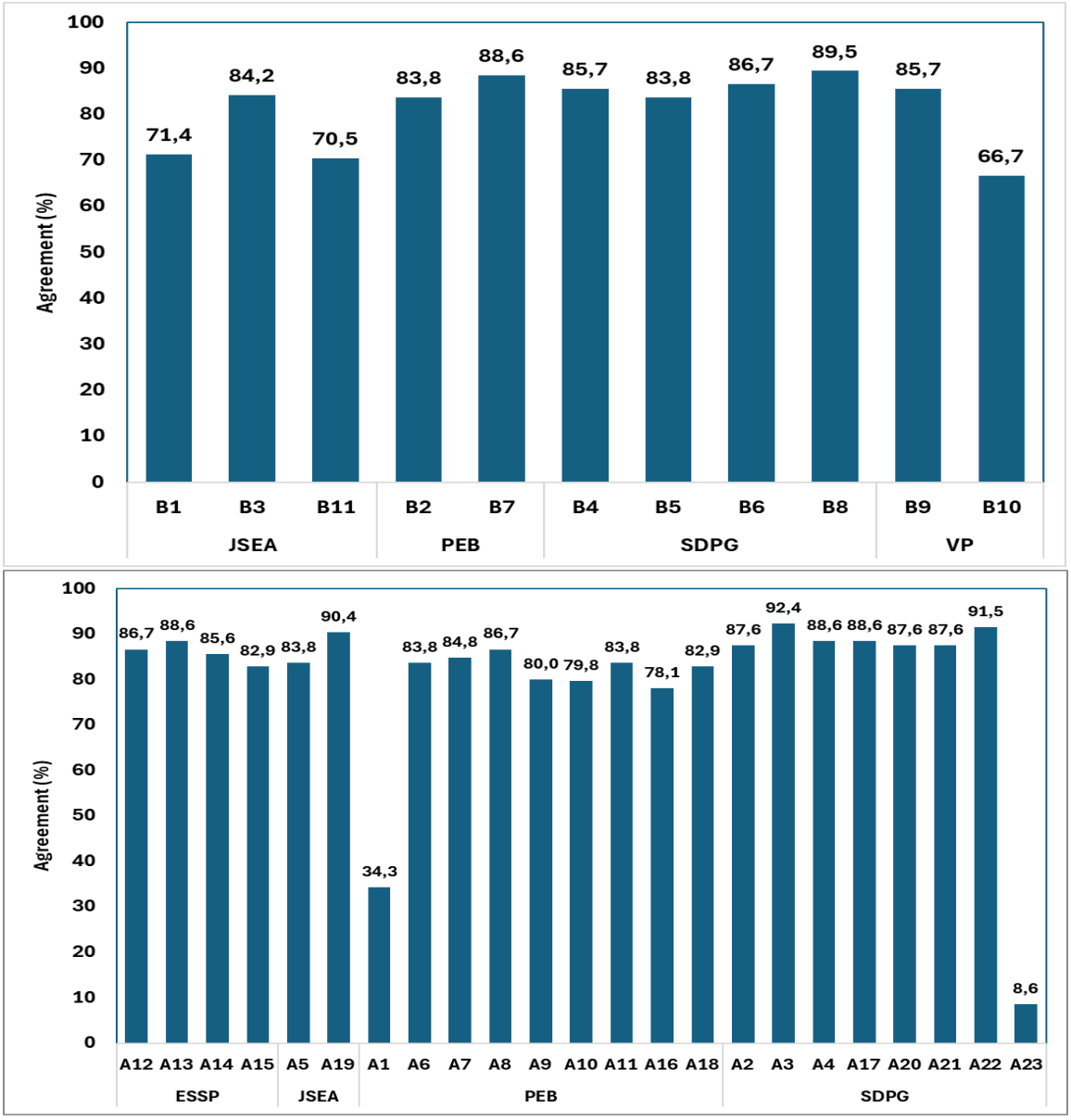

Figure 1 Responses of each item and per category of participants in the exit questionnaire (Part A – upper, Part B – lower) JSEA: Job Search and Employment Assistance, SDPG: Skills Development and Professional Growth, PEB: Psychological and Emotional Benefits, BP: Voluntary Participation, ESSP: Evaluation of Structures and Services Provided

The effect of gender on the scales of exit questionnaire were presented in Table 2 Gender of mentees do not affect the JSEA (job search and employment assistance) category ($p>0.100$),

the PEB (Psychological and Emotional Benefits) (p>0.05), the VP (Voluntary Participation) (p>0.100), the ESSP (Evaluation of Structures and Services Provided) (p>0.100). There is only one significant difference between women and men on the agreement in item A17 (Do you believe that the use of new technologies was beneficial for your professional development?) where women shown higher acceptance 93.0% than men 79.4% (p=0.041)

Table 2. Effect of gender on JSEA, SDPG, PEB, VP and ESSP scale of the exit questionnaire

		Man		Woman		
		n	**%**	**n**	**%**	**p**
JSEA	**A5**	28	82.4	60	84.5	0.779
	A19	29	85.3	65	92.9	0.220
	B1	21	61.8	54	76.1	0.129
	B3	28	82.4	57	85.1	0.723
	B11	22	64.7	52	73.2	0.37
SDPG	**A2**	28	82.4	64	90.1	0.257
	A3	29	85.3	68	95.8	0.053
	A4	29	85.3	64	90.1	0.465
	A17	27	79.4	66	93.0	**0.041**
	B4	27	79.4	63	88.7	0.202
	B5	28	82.4	60	84.5	0.790
	B6	29	85.3	62	87.3	0.775
	B8	30	88.2	64	90.1	0.765
PEB	**A1**	13	38.2	23	32.4	0.555
	A6	26	76.5	62	87.3	0.158
	A7	26	76.5	63	88.7	0.102
	A8	27	79.4	64	90.1	0.130
	A9	24	70.6	60	84.5	0.095
	A10	24	70.6	59	84.3	0.103
	A11	27	79.4	61	85.9	0.397
	A16	26	76.5	56	78.9	0.397
	A18	26	76.5	61	85.9	0.23
VP	**B1**	21	61.8	54	76.1	0.129
	B9	29	85.3	62	87.3	0.775
	B10	28	82.4	62	87.3	0.496
	B11	21	61.8	49	69.0	0.461
ESSP	**A12**	28	82.4	63	88.7	0.368
	A13	28	82.4	65	91.5	0.166
	A14	27	81.8	62	87.3	0.457
	A15	27	79.4	60	84.5	0.517
	A20	28	82.4	64	90.1	0.257
	A21	28	82.4	64	90.1	0.257
	A22	29	85.3	67	94.4	0.120
	A23	2	5.9	7	9.9	0.496

JSEA: Job Search and Employment Assistance, SDPG: Skills Development and Professional Growth, PEB: Psychological and Emotional Benefits, BP: Voluntary Participation, ESSP: Evaluation of Structures and Services Provided

Educational level showed significant difference in %percentages in B3 item (Did the platform, after matching you with a mentor/employer, help you look for a job or a better job?) (p=0.029) in JSEA category). Two items A3 (How satisfied are you with the guidance/training provided by your Mentor/employer?) and item B5 (Did you organize a better CV with the help of your Mentor?) showed significant differences with p<0,001 and p=0.015 in SDPG category. Educational level do not affect VP (p>0.05) and only one item A15 (How much do you believe the training/guidance program helped you to have a better professional career?) (p=0.006).

Finally, the most significant differences were found in PEB category. Item A1 (Are you feeling disappointed at this time?), item A9 (Do you believe that after the program you will handle personal and work-related problems better?), item A10 (Did the program help you maintain self-confidence when you are stressed?) and item A18 (To what extent do you believe that the counseling process from your Mentor/employer contributed to your good psychological state?) showed p<0.05.

Additionally, in JSEA, B5 (p=0.052) and A7 (p=0.096) showed tendencies to significant effects, while in SDPG, A8 (p=0.067) and A11 (p=0.058) showed the same tendency for significant. Most of the tendencies were found in PEB category were A5 (p=0.058), A16 (p=0.057), A8 (p=0.067), and A11 (p=0.058) were included.

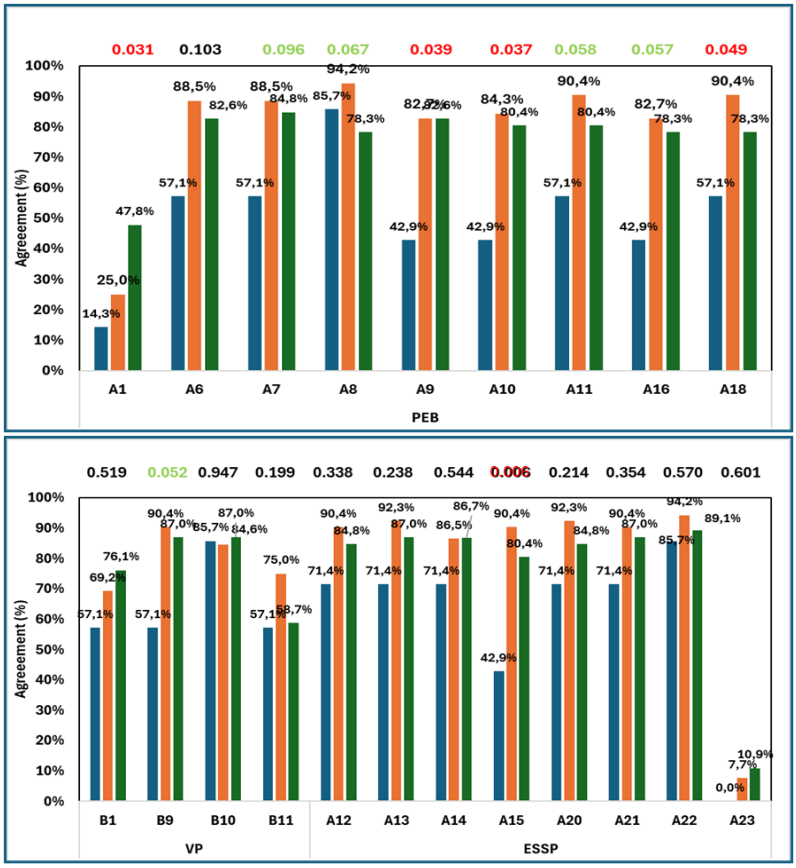

Figure 2. Effects of educational level in each item of the exit questionnaire (JSEA, SDPG, PEB, VP, ESSP). JSEA: Job Search and Employment Assistance, SDPG: Skills Development and Professional Growth, PEB: Psychological and Emotional Benefits, BP: Voluntary Participation, ESSP: Evaluation of Structures and Services Provided
Red values refers to significant values ($p < 0.05$), while green values refers to p-values between $0.05 < p < 0.100$.

Discussion

The results of this study suggest that e-mentoring is a potent intervention for mitigating the effects of social exclusion among vulnerable populations in Crete. Analysis revealed a "positive attitude" toward various aspect of e-mentoring procedure. Those aspects were related not only on the experience gained from the interface, but it also supports various psychological aspects. In more details, there were impacts on well-being, self-efficacy and employability skills. Only one of the questionnaire items was affected from gender related with the professional development. Educational level showed better acceptance mainly in Lyceum graduate and more specific in items related on psychological and emotional aspects.

The effects on VPG groups from mentoring or e-mentoring have been supported in previous published work by the authors. They support that over half of participants in an e-mentoring initiative reported improved emotional security and optimism about employment prospects, highlighting the dual benefit of mental well-being and career empowerment (Spyridaki, 2022; Spyridaki et al., 2025). Other studies focused on self and functional efficacy, support that mentees release from prison were empowered to navigate their personal needs like housing, healthcare (Elisha, 2025). In other groups, like the long term unemployment groups, e-mentoring could disrupt the emotional cycle of failure, E-mentoring can builds the

mentee's global self-worth and transform the mentee's mindset from passive resignation to active "career self-management" (Carvalho et al., 2025)

Regarding self-efficacy and functional efficiency, mentoring platforms act as "social scaffolding" that transforms latent potential into actionable agency. For single parents and those facing systemic barriers, the "efficiency" of these programs lies in their ability to streamline complex social and bureaucratic navigation. Elisha (2025) describes the mentor's role as a "one-stop shop" that empowers mentees to navigate healthcare, housing, and employment systems with greater speed and less friction than they could achieve in isolation. This directly correlates with increased self-efficacy; as mentees successfully navigate these hurdles with guidance, their belief in their own capability to affect change grows. Furthermore, Spyridaki et al. (2025) found that this boosted self-efficacy is a strong predictor of employability, as it encourages "active" coping strategies—such as persistent job seeking and upskilling—rather than the "passive" avoidance often seen in long-term unemployment. By converting the "masked vulnerability" of these groups into recognized resilience, mentoring programs effectively bridge the gap between psychological readiness and concrete economic participation (Meldrum & Lyons, 2026).

A notable limitation identified in the conclusion is the "lack of data on the final outcome" regarding actual job placement. While the study measures *perceptions* of employability and skill acquisition, it does not track the long-term employment status of the VPG persons who looked for a job. Future longitudinal studies are required to map the transition from "improved employability" to "sustained employment."

As a conclusion, the implementation of the mentoring platform by the Hellenic Mediterranean University has demonstrated that digital interventions can successfully reach and positively impact vulnerable population groups. The study concludes that the overall consideration of VPG persons yielded a positive outcome showing levels >70% of the participants. Platform intervention showed an improving emotional status and well-being, an enhanced self-efficacy and upgrading technical skills.

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Appendix A

Table 1A. Items of exit questionnaire per category (Part A and Part B)

ID	Question Item / Statement
A1	Are you feeling disappointed at this time?
A2	To what extent do you believe that the career counseling process of the program helped you discover/improve your skills?
A3	How satisfied are you with the guidance/training provided by your Mentor/employer?
A4	How much did the career guidance program help you plan your professional development?
A5	Do you believe that the career guidance from your Mentor/employer will help you find a job or a better job in the field you were trained in?
A6	Did the career guidance help you achieve a better emotional state?
A7	Did the career guidance help you think more positively about things in the work environment?
A8	Do you believe that the career counseling from the program led you to greater appreciation of yourself and your abilities?

A9	Do you believe that after the program you will handle personal and work-related problems better?
A10	Did the program help you maintain self-confidence when you are stressed?
A11	Do you believe that your participation in the training and guidance program (through the platform) strengthened your self-esteem?
A12	Did the platform help you acquire knowledge and information in the employment sector you were trained in?
A13	How satisfied are you with the professional training you received?
A14	How satisfied are you with the content of the online meetings with your Mentor?
A15	How much do you believe the training/guidance program helped you to have a better professional career?
A16	Do you believe that the program through the platform helped you better address issues of social exclusion?
A17	Do you believe that the use of new technologies was beneficial for your professional development?
A18	To what extent do you believe that the counseling process from your Mentor/employer contributed to your good psychological state?
A19	How much do you believe that using the new CV will help you find a job or a better job more easily?
A20	How satisfied do you feel with the material provided by your Mentor/employer?
A21	How satisfied do you feel with the operation and organization of the platform?
A22	How important were the knowledge/information you acquired from the Mentor/employer of the program for the employment sector you attended?
A23	Did you encounter difficulties using the platform?

ID	Question Item / Statement
B1	Do you believe that the program using the platform helped you discover new ways to search for a job or a better job?
B2	Did the program help you better cope with the fear of failure?
B3	Did the platform, after matching you with a mentor/employer, help you look for a job or a better job?
B4	Do you believe the platform helped you become more familiar with new technologies?
B5	Did you organize a better CV with the help of your Mentor?
B6	Do you believe that by using the platform and its programs you gained training/education to develop your skills?
B7	Do you believe that the training/education from the Mentor and the platform's programs made you feel more confident about yourself and your abilities?
B8	Do you believe that your participation in the programs through the platform helped you better develop your skills?
B9	Would you participate again in a similar program using a platform? (remote)
B10	Would you participate in a similar career guidance program if it were in person? (physical presence with the Mentor)
B11	Did you find a job or a better job with the help of the platform?

PRE – ORGANISED SPECIAL SESSION

"Virtual cities" and social sustainability in EU framework- Cultural, sociological and communication perspectives"

Organised and Chaired by **Dr Bokolas Vassilis, Prof Vassilakou Tonia, Prof Colantoni Andrea, Assoc Prof Ferrigni Nicola, Prof Kaperonis Stavros, Assoc Prof Nosova Bogdana** and **Ntrouva Efi**

USER EXPERIENCE AND DIGITAL SKILLS IN VIRTUAL GAMIFIED ENVIRONMENTS: BETWEEN SCIENTIFIC RESEARCH AND EUROPEAN POLICY GUIDELINES

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Abstract
Digital evolution and the consequent digital transformation that is taking place in all dimensions of economic, social and cultural life is strongly linked to the need for education and training of the population in modern digital skills. At the same time, current research shows that digital games [a pioneering industry with a global economic impact, which is the first to develop/integrate digital innovations, e.g. AI] are being used in all areas of human activity (particularly in the fields of medicine, vocational training, etc.).

User experience (UX) in gamified environments constitutes a critical factor for the effectiveness of the learning process and the development of digital skills. According to research findings, the quality of user experience directly influences the level of engagement, intrinsic motivation, and user satisfaction. Design elements such as interface intuitiveness, immediate feedback, system adaptability (adaptive learning paths), and the balance between challenge and competence (flow theory) contribute decisively to the learning experience. Furthermore, positive user experience is associated with enhanced knowledge retention and transfer of skills to real-world contexts.

In parallel, digital games and gamification strategies are first-class tools for the self-directed training of people in the new skills required. In this context, the EU welcomes and at the same time invests in digital games by establishing the appropriate legal framework but, above all, by funding innovative projects.

Key words: digital skills, gamification, user experience, training

PRECARIOUS EMPLOYMENT IN THE GIG ECONOMY: UNVEILING THE EFFECTS OF WORK CONDITIONS ON THE HEALTH AND QUALITY OF LIFE OF MIGRANT FOOD DELIVERY WORKERS

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Abstract
Migrant food delivery workers are essential participants in the worldwide gig economy. Migrant workers form the essential workforce for businesses yet they face recurring changes in their employment conditions. Working in this field requires great effort because it involves dangerous physical conditions. The paper followed PRISMA methodology to perform a systematic literature review. Research shows that people who work at minimum wage experience multiple negative health effects and unstable work schedules and economic instability and dangerous workplace environments. The need to meet customer needs causes employees to rush their work which produces increased workplace tension. Customer demands for fast delivery cause employers to push workers into prolonged work hours by making them work overtime and night shifts with insufficient time for rest. Workers face dangerous working conditions when severe weather strikes and their daily commute becomes dangerous because of accidents which negatively affect their life quality.

Key words:migrant workers; food delivery; couriers; precarious employment; low-status work, health; quality of life; gig economy; working conditions

VIRTUAL VULNERABILITIES AND REAL OBLIGATIONS: RETHINKING COMPENSATION PRACTICES IN DIGITALLY MEDIATED RESEARCH

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Abstract
The growing use of online platforms and digital tools in research has redefined the relationship between investigators and participants. While digitally mediated participation reduces physical risks associated with in-person engagement, it generates new forms of virtual vulnerability, including privacy breaches, algorithmic exploitation, digital exclusion, and inequitable access. These risks complicate how participants' rights and welfare are protected, and how compensation practices are ethically justified.

This study investigates stakeholder perspectives on compensating online research participants in Uganda, focusing on Research Ethics Committees, regulatory bodies, institutional managers, and funders. Guided by Social Exchange Theory and Rawls' Theory of Justice, the research explores how reciprocity and fairness are understood when participation occurs in digital environments.

Adopting a qualitative case study design, the study employs semi-structured interviews, focus group discussions, and key informant interviews, analyzed thematically with NVivo. Preliminary findings suggest that stakeholders perceive digital participation as lowering traditional inconveniences (e.g., travel) while raising new ethical obligations around privacy, inclusivity, and protection of vulnerable populations.

The paper contributes both conceptually and practically by proposing context-sensitive guidelines for compensating participants in digital research within low- and middle-income settings. These insights inform global debates on research ethics, responsible conduct, and integrity in an increasingly digitalized research landscape.

Key words: Research ethics; Participant compensation; Online participation; Virtual vulnerabilities; Reciprocity; Research integrity

VIRTUAL ENVIRONMENTS AND THE ELDERLY: RESEARCH, GOOD PRACTICES, AND TRAINING IN DIGITAL SKILLS IN THE EUROPEAN CONTEXT

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Abstract
The European Union considers digital environments and their development as key factors directly connected to social cohesion and citizens' well-being. The rapid expansion of virtual environments presents both opportunities and challenges; the latter mainly concern accessibility, education, security, and the alignment of all age groups with digital developments. Addressing these issues requires coordinated action by member states, institutions, and organizations focused on education and innovation. In response to this dynamic, the EU has developed a series of initiatives that promote the development of digital skills and the active participation of citizens in the digital transformation.

In this context, the digital education of the elderly and the enhancement of their presence in virtual environments are gaining increasing importance, as they are linked to social participation and the improvement of quality of life. This approach is also aligned with the United Nations Sustainable Development Goals, particularly Goals 4 (quality education), 10 (reduced inequalities), and 3 (good health and well-being), which promote equal access to knowledge, lifelong learning, and the well-being of all age groups in the digital era.

The objective of the present study unfolds in two directions. On the first level, it aims to map and analyze both European organizations and initiatives, as well as distinguished best practices that promote digital inclusion, virtual learning environments, and the development of digital skills among the elderly. On the second level, the study draws data from EU-funded program databases in order to identify, systematize, and present innovative projects that have been implemented in the field of digital skills development for older adults—particularly in relation to their social inclusion and overall care. The combination of these two levels of research is expected to provide a comprehensive picture of the European landscape, highlighting examples of policies, institutions, and practices that support digital transformation, inclusion, and the participation of the elderly in the emerging digital reality.

Key words: virtual environments, elderly, digital skills, social inclusion

DIGITAL RELIGIOUS RHETORIC AND MEDIA LITERACY IN EUROPEAN CONTEXT: RESEARCH, GUIDELINES AND POLICY IMPLEMENTATION

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Abstract
In the contemporary digital era, religious rhetoric emerges as a multidimensional and continuously evolving field of discourse, developing and transforming within online media, social networks, and cross-platform forms of social engagement. Digital platforms, with their capacity to combine multimodal content and direct interaction, significantly influence the ways in which citizens perceive, process, and reproduce religious narratives. At the same time, the increasing phenomena of misinformation, ideological polarization, and the diffusion of unverified religious or cultural content render digital literacy and media education central priorities within the European Union (EU) policy agenda, particularly regarding the protection of democracy, social cohesion, and intercultural dialogue.

The aim of the present study is twofold. First, it investigates the role of digital religious rhetoric in shaping attitudes, perceptions, and social behaviors through an extensive review and analysis of the international literature. It highlights the function of digital media as multipliers of religious discourse, enhancing citizens' access to and participation in it, while simultaneously amplifying the risk of disseminating false or extreme narratives. Secondly, the study provides an initial examination of the relevant EU policy frameworks that seek to foster digital critical thinking skills, promote the recognition of reliable sources, and strengthen citizens' resilience against misinformation in matters of religion. In parallel, data drawn from EU-funded programme databases are analysed in order to identify innovative initiatives implemented in this field and to systematize their findings.

The EU appears to invest in the enhancement of digital literacy and responsible communication, aiming to shape a safe, inclusive, and culturally sensitive digital public sphere. The present study—aligned with European policy orientations—seeks to contribute to the academic discourse on managing religious rhetoric in the digital environment by mapping the field and proposing the development of interdisciplinary approaches and international collaborations with a strong social orientation.

Keywords: digital religious rhetoric, European policies, digital literacy, communication, misinformation, social cohesion

DEVELOPING GREEN ENTERPRISE THROUGH INTEGRATED PCI–PGI-DCCI GOVERNANCE AND DDCI EVIDENCE IN BAC NINH, VIETNAM

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Abstract
Green enterprise development is increasingly central to provincial governance in Viet Nam, where local authorities must pursue competitiveness while aligning with national sustainability goals. Provinces are assessed through the Provincial Competitiveness Index (PCI) and the Provincial Green Index (PGI).

In practice, these agendas are often implemented separately, creating coordination gaps in policy design and delivery. The present paper examines how green enterprise development can be advanced when PCI and PGI are integrated and informed by officially published DDCI evidence on enterprise perceptions. Bac Ninh is selected as the case study.

The analysis focuses on what the 2025 DDCI program reports about the business environment—transparency, time costs, informal costs— and about expectations related to green transition. The initial objective is to present a coherent design for developing green enterprises at the provincial level based on existing, publicly available findings.

A parallel objective is to specify a practical policy bundle that is compatible with routine PCI/PGI monitoring and sub-national implementation capacity. Methods consist of secondary analysis of published DDCI materials, a restatement of survey scope, and a structured mapping of reported insights to policy levers commonly used in PCI/PGI practice (digitalized procedures, ESG disclosure, human-capital programs, green finance, green public procurement, and public recognition schemes).

Findings are synthesized by firm scale (SMEs, medium firms, large/FDI) and by location (urban and non-urban). Results indicate that public spaces of policy—administrative procedures, advisory services, finance, and recognition—are widely "used" by enterprises for economic and organizational reasons, while green transition instruments are perceived as important across the board.

During periods of heightened administrative constraints or external shocks, these instruments are used primarily for basic compliance and business continuity; under more normal conditions, they are used for capability upgrading and market positioning. Overall, differentiated access and readiness suggest targeted, tiered support rather than a single, uniform scheme.

Key words: Green enterprise development; PCI; PGI; DDCI; sub-national governance

INTRODUCTION

Vietnam's governance measurement system offers a structured way to observe how firms experience policy. The Provincial Competitiveness Index (PCI) was designed to capture economic governance through enterprise perceptions and has become a long-running reform signal across provinces (Malesky, 2009). Its enduring value lies in the diagnostic dimensions it stabilizes over time—transparency, time costs, informal costs, and competitive fairness—which help local governments identify where administrative reform most directly affects business conditions (VCCI, 2021). The Provincial Green Index (PGI) extends this measurement logic into environmental governance by assessing not only compliance and risk reduction but also leadership and the enabling supports that make green practices more adoptable for firms (VCCI, 2024). Together, PCI and PGI allow researchers to examine whether a province is building both the economic-governance backbone and the green-governance ecosystem required for enterprise transition.

However, provincial averages can obscure where frictions are produced. Firms interact with departments, districts, and one-stop service units that interpret requirements, process dossiers, and provide—or fail to provide—usable guidance. The Department and District Competitiveness Index (DDCI) was developed to make that intra-provincial variation visible and to support targeted reform by pinpointing which agencies and localities drive firm experiences (VCCI, 2021). Vietnam-focused scholarship similarly frames DDCI as the layer that explains why business perceptions differ within the same province and why departmental/district performance increasingly differentiates local competitiveness (Nguyen et al., 2024).

This diagnostic architecture becomes especially relevant in northern Vietnam, where environmental governance is tested under dispersed industrialization. In the Red River Delta, the expansion of craft villages and industrial clusters has delivered jobs and income while intensifying pollution and compliance pressures. The governance problem is not purely technical; it is also institutional, shaped by uneven capacity, trade-offs in enforcement, and the challenge of managing many small, dispersed emitters (Dang, 2020). In such a setting, indices are not just "rankings"; they become a way to trace whether green ambitions and administrative performance converge into conditions that firms can actually navigate.

Bac Ninh is a useful research area because it combines strong growth-facing incentives with visible environmental constraints, making the governance of green enterprise both urgent and empirically observable. The province's integration into large production networks means environmental externalities are structurally tied to growth trajectories, so policy must balance investment competitiveness with tightening environmental performance in ways that firms can operationalize.

Bac Ninh also provides an instructive contrast because its provincial green-governance signal is strong. In the 2024 PGI results, Bac Ninh is placed in the top group with 27.78 points and rank 4, indicating credible provincial-level signals of environmental governance and green enablement (VCCI, 2024). For research design, this matters: it shifts the focus away from "lack of intent" and toward the practical question of how intent translates into firm-facing conditions across heterogeneous production spaces.

That translation challenge is visible in localized hotspots associated with craft-village systems and small-scale recycling/production. An IUCN dialogue-based report on craft village pollution in Bac Ninh highlights governance constraints—limited participation, weak accountability, and uneven compliance routines—that shape why environmental problems persist even when formal frameworks exist (IUCN, 2011). Applied research on environmental security in Bac Ninh's craft villages similarly documents substantial pressures linked to

production and recycling activities and argues for local economic development policy that embeds environmental management more directly (Nguyen, 2018). These studies support treating transition capacity as uneven across firm types and locations, rather than assuming a single provincial pathway.

At the same time, Bac Ninh illustrates modernization potential through industrial-park governance. UNIDO's Environmental and Social Management Plan for Vietnam's Global Eco-Industrial Parks Programme describes VSIP Bac Ninh's environmental management system and wastewater treatment capacity, alongside resource monitoring efforts and remaining challenges related to consumption and emissions (UNIDO, 2024/2025). This juxtaposition—managed industrial parks versus dispersed craft-village/SME ecosystems—creates a high-contrast environment well suited for examining how green enterprise conditions vary inside one province.

The literature suggests that green enterprise development accelerates when environmental ambition is aligned with institutional capacity and consistent service delivery. PCI and PGI capture different parts of that alignment: PCI reflects whether day-to-day governance reduces friction for business activity, while PGI reflects whether environmental governance provides credible signals, standards, and enabling supports for greener practices (VCCI, 2021; VCCI, 2024). DDCI adds the missing explanatory layer by showing whether those provincial-level signals translate into consistent experiences across departments and districts, where firms actually conduct procedures and absorb compliance costs (Nguyen et al., 2024).

This integrated framing also clarifies why PCI and PGI may diverge in the short run. A province can improve green-governance signals through stronger leadership and policy tools while firms continue to face administrative burden or uneven handling across agencies, slowing behavioral change. The policy–practice gap is a coordination and implementation problem: coherence can be weakened when responsibilities are fragmented, and firm experience can vary with frontline discretion and capacity constraints (Rodrigo et al., 2009; Lipsky, 1980). In Bac Ninh, where both high-level green signals and localized governance bottlenecks are visible, the PCI–PGI–DDCI triad therefore offers a coherent way to explain not only "what improved," but also "where adoption is likely to stall," and which institutional nodes matter most for moving from formal greening to enterprise-level practice.

LITERATURE REVIEW

Green enterprise development and competitiveness: an institutional mechanism

Green enterprise development is best understood as an investment decision made under uncertainty. Firms adopt cleaner technologies, environmental management systems, and resource-efficiency routines when they can reasonably expect returns—lower input costs, reduced exposure to regulatory and reputational risks, and sustained access to more demanding markets. These expectations are not formed in markets alone. They are shaped by the institutional setting—how rules are specified, communicated, and enforced—which alters both perceived risk and the real cost of upgrading (North, 1990). When administrative processes are slow or unpredictable, transaction costs rise and long-horizon commitments are deferred, which is typical for green upgrading (Williamson, 1985).

This lens clarifies why the regulation–competitiveness debate is not a simple trade-off. The Porter Hypothesis argues that stringent but well-designed environmental rules can spur innovation and efficiency improvements that offset compliance costs and may strengthen competitiveness (Porter & van der Linde, 1995). Later syntheses treat this as a conditional

mechanism: outcomes depend on regulatory design, enforcement credibility, and the presence of complementary instruments that allow firms to respond through re-optimization rather than mere compliance (Ambec et al., 2013). Empirical research aligns with this conditional reading. Regulatory pressure is often associated with higher innovation effort, commonly measured via increased R&D expenditure, even when productivity gains do not appear immediately or uniformly across sectors (Jaffe & Palmer, 1997). Evidence consistent with productivity improvements also tends to appear in settings where adaptation is feasible and effects materialize with time lags (Lanoie et al., 2008). The implication for sub-national analysis is precise: competitiveness effects hinge less on the existence of environmental standards and more on whether firms face an institutional environment that makes upgrading responses practicable.

Provincial indices (PCI–PGI–DDCI) and implementation stress tests in Northern Vietnam

Vietnam's governance measurement system offers a structured way to observe how firms experience policy. The Provincial Competitiveness Index (PCI) was designed to capture economic governance through enterprise perceptions and has become a long-running reform signal across provinces (Malesky, 2009). Its enduring value lies in the diagnostic dimensions it stabilizes over time—transparency, time costs, informal costs, and competitive fairness—which help local governments identify where administrative reform most directly affects business conditions (VCCI, 2021). The Provincial Green Index (PGI) extends this measurement logic into environmental governance by assessing not only compliance and risk reduction but also leadership and the enabling supports that make green practices more adoptable for firms (VCCI, 2024). Together, PCI and PGI allow researchers to examine whether a province is building both the economic-governance backbone and the green-governance ecosystem required for enterprise transition.

However, provincial averages can obscure where frictions are produced. Firms interact with departments, districts, and one-stop service units that interpret requirements, process dossiers, and provide—or fail to provide—usable guidance. The Department and District Competitiveness Index (DDCI) was developed to make that intra-provincial variation visible and to support targeted reform by pinpointing which agencies and localities drive firm experiences (VCCI, 2021). Vietnam-focused scholarship similarly frames DDCI as the layer that explains why business perceptions differ within the same province and why departmental/district performance increasingly differentiates local competitiveness (Nguyen et al., 2024).

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RESEARCH AREA: BAC NINH AS A HIGH-CONTRAST SETTING FOR GREEN ENTERPRISE GOVERNANCE

Bac Ninh is a useful research area because it combines strong growth-facing incentives with visible environmental constraints, making the governance of green enterprise both urgent and

empirically observable. The province's integration into large production networks means environmental externalities are structurally tied to growth trajectories, so policy must balance investment competitiveness with tightening environmental performance in ways that firms can operationalize.

Bac Ninh also provides an instructive contrast because its provincial green-governance signal is strong. In the 2024 PGI results, Bac Ninh is placed in the top group with 27.78 points and rank 4, indicating credible provincial-level signals of environmental governance and green enablement (VCCI, 2024). For research design, this matters: it shifts the focus away from "lack of intent" and toward the practical question of how intent translates into firm-facing conditions across heterogeneous production spaces.

That translation challenge is visible in localized hotspots associated with craft-village systems and small-scale recycling/production. An IUCN dialogue-based report on craft village pollution in Bac Ninh highlights governance constraints—limited participation, weak accountability, and uneven compliance routines—that shape why environmental problems persist even when formal frameworks exist (IUCN, 2011). Applied research on environmental security in Bac Ninh's craft villages similarly documents substantial pressures linked to production and recycling activities and argues for local economic development policy that embeds environmental management more directly (Nguyen, 2018). These studies support treating transition capacity as uneven across firm types and locations, rather than assuming a single provincial pathway.

At the same time, Bac Ninh illustrates modernization potential through industrial-park governance. UNIDO's Environmental and Social Management Plan for Vietnam's Global Eco-Industrial Parks Programme describes VSIP Bac Ninh's environmental management system and wastewater treatment capacity, alongside resource monitoring efforts and remaining challenges related to consumption and emissions (UNIDO, 2024/2025). This juxtaposition—managed industrial parks versus dispersed craft-village/SME ecosystems—creates a high-contrast environment well suited for examining how green enterprise conditions vary inside one province.

What PCI, PGI, and DDCI jointly explain Bac Ninh

In sum, the literature suggests that green enterprise development accelerates when environmental ambition is aligned with institutional capacity and consistent service delivery. PCI and PGI capture different parts of that alignment: PCI reflects whether day-to-day governance reduces friction for business activity, while PGI reflects whether environmental governance provides credible signals, standards, and enabling supports for greener practices (VCCI, 2021; VCCI, 2024). DDCI adds the missing explanatory layer by showing whether those provincial-level signals translate into consistent experiences across departments and districts, where firms actually conduct procedures and absorb compliance costs (Nguyen et al., 2024).

This integrated framing also clarifies why PCI and PGI may diverge in the short run. A province can improve green-governance signals through stronger leadership and policy tools while firms continue to face administrative burden or uneven handling across agencies, slowing behavioral change. The policy–practice gap is a coordination and implementation problem: coherence can be weakened when responsibilities are fragmented, and firm experience can vary with frontline discretion and capacity constraints (Rodrigo et al., 2009; Lipsky, 1980). In Bac Ninh, where both high-level green signals and localized governance bottlenecks are visible, the PCI–PGI–DDCI triad therefore offers a coherent way to explain

not only "what improved," but also "where adoption is likely to stall," and which institutional nodes matter most for moving from formal greening to enterprise-level practice.

METHODOLOGY

Research Desgin. The study employs a single-province case design (Bac Ninh) and a secondary-data strategy, leveraging existing index datasets rather than fielding an original survey. This design matches the paper's explanatory objective: to interpret governance conditions as revealed by established measurement frameworks and to translate those signals into policy-relevant mechanisms. Empirically, the analysis triangulates PCI, PGI, and DDCI 2025, allowing province-level movements to be interpreted alongside implementation-layer evidence from the administrative units that firms engage with in routine transactions. The inclusion of DDCI 2025 addresses a key measurement gap: PCI and PGI summarize provincial performance, but they are less informative about where bottlenecks arise within the delivery chain. To preserve comparability, the analysis is conducted within a consistent window of 2016–2025, which is maintained throughout synthesis and heterogeneity analysis.

Data sources, constructs, and operationalization. The paper operationalizes "green enterprise development conditions" as a multi-level governance construct built from three complementary index families. PCI proxies core economic-governance frictions (e.g., transparency, time costs, informal costs, and fairness) that shape firms' operating environment. PGI captures environmental-governance enablement relevant to green transition through its component structure. Because PCI and PGI are primarily province-aggregated indicators, the analysis brings in DDCI 2025 to recover variation at the implementation margin, i.e., performance of provincial departments and localities as experienced by enterprises, using DDCI's structured component framework.

For policy interpretation, the study applies the project's bridging logic by mapping DDCI evidence into six commonly used reform levers in PCI/PGI-oriented practice (including digitalized procedures, ESG disclosure, human-capital programs, and green finance). This mapping serves as the operational link between unit-level implementation signals and a standardized reform vocabulary, enabling coherent synthesis and recommendation design.

Analytical procedure. The empirical strategy proceeds in stages. First, the analysis applies the consistent 2016–2025 scope to ensure that cross-index comparisons are not driven by mismatched periods. Second, it characterizes PCI and PGI as parallel province-level trajectories—economic governance versus environmental governance—then uses DDCI 2025 to diagnose how observed province-level patterns relate to implementation performance across administrative units. This sequencing follows the reporting logic in the DDCI materials, which juxtapose PCI component variation over recent years with the DDCI component system for 2025.

Third, the analysis explicitly tests for heterogeneity rather than relying on a representative-firm interpretation. Results are examined by firm group (SMEs, medium firms, and FDI enterprises) and by location (urban versus non-urban districts). This segmentation is substantively motivated by the two-layer institutional structure captured in DDCI (departments and localities) and by the expectation that exposure to administrative frictions and green-policy support differs across firm types and geographic settings.

Validity, limitations, and ethics

Validity. The primary validity strategy is triangulation across indices and levels of observation. PCI and PGI provide structured province-level benchmarks, while DDCI 2025 supplies implementation-layer granularity where firms directly experience public administration. Combining these sources strengthens interpretability by enabling consistency checks between aggregate movements and frontline delivery patterns.

Limitations. The design is non-causal: as a secondary analysis, it does not identify treatment effects or causal mechanisms. Findings reflect index-based evidence and enterprise experience rather than direct measurement of emissions or investment outcomes. Comparability is also bounded by differences in index design and measurement scope across PCI, PGI, and DDCI.

Ethics. The analysis relies on aggregated, report-based evidence as presented in the index and DDCI materials and does not disclose individual firm identifiers.

Statistical data and results

Macro-economic context

Table 1 reports the headline macro indicators cited in the DDCI 2025 summary report for Bac Ninh's 2024 recovery. The report records quarterly acceleration in GRDP growth in Q2/2024 (8.06% year-on-year), which is reported to bring first-half growth to 2.32% (year-on-year). For the full year 2024 (current prices), GRDP is estimated at 232.8 trillion VND, corresponding to 6.03% growth relative to 2023. The same section reports per-capita income of 73 million VND per person per year, increasing 14.8% relative to 2023. In addition, the report provides baseline index levels for 2023 to situate the subsequent governance evidence: PCI 2023 is reported at 65.96 points (down 3.12 points versus 2022) and PGI 2023 at 22.53 points, ranked 21/30 within the Top-30 group. The introductory framing also notes "green growth" and "digital transformation" as leading trends shaping policy priorities, providing background for linking governance metrics to sustainability-related reforms.

Category	Indicator	Year/Period	Value	Note
Macro-economy	GRDP growth (YoY)	Q2/2024	8.06%	Quarterly acceleration in Q2/2024
Macro-economy	GRDP growth (YoY)	H1/2024	2.32%	First-half growth (YoY)
Macro-economy	GRDP (current prices)	2024	232.8 trillion VND	Estimated full-year GRDP
Macro-economy	GRDP growth (YoY)	2024 vs 2023	6.03%	Full-year growth rate
Macro-economy	Per-capita income	2024	73 million VND/person/year	+14.8% vs 2023
Governance baseline	PCI score	2023	65.96 points	Down 3.12 points vs 2022
Governance baseline	PGI score	2023	22.53 points	Rank 21/30 within Top-30 group
Policy framing	Provincial priorities/trends	2023–2025 framing	"Green growth" & "digital transformation"	Used as background trends in the report's introduction

Table 1. Bac Ninh macro indicators and index baselines (2023–2024).
Source (compiled by author): DDCI 2025 Report and DDCI 2025 Synthesis Report

PGI outcomes: overall score, rank shift, and component profile

Figure 1 presents Bac Ninh's 2024 PGI position within the Top-30 provincial ranking. The report states a 2024 PGI total score of 27.78 points for Bac Ninh, with an increase of 5.25 points and an improvement of 17 ranks compared with 2023, placing Bac Ninh at rank 4/30 in 2024.

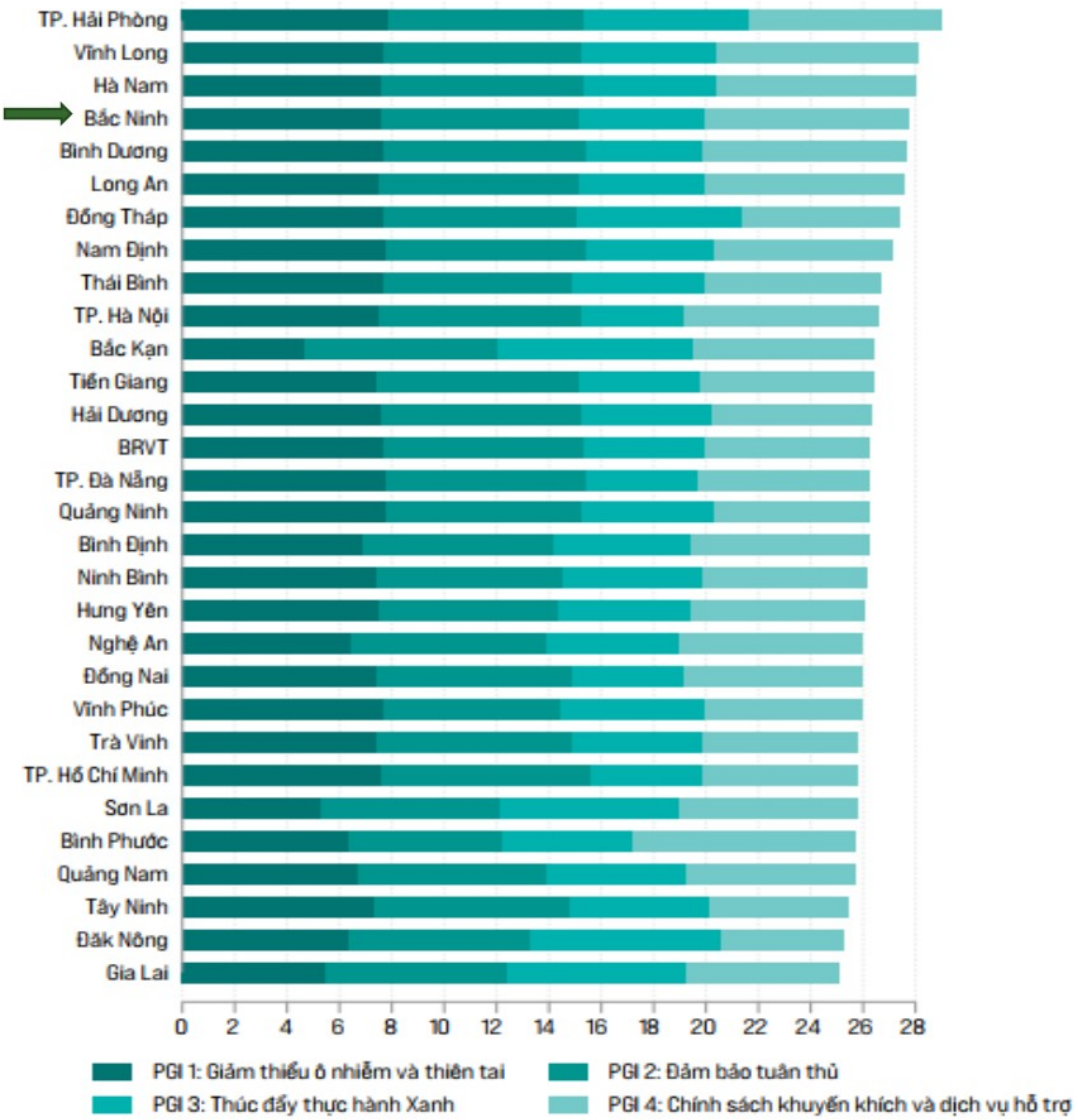

Figure 1. PGI 2024 score and rank for Bac Ninh (Top-30 group)

Table 2 decomposes the PGI total into its four component indices (CSTP1–CSTP4) for 2022–2024 and reports the province's rank in each year. The table reports that, in 2024, CSTP1 (pollution and disaster mitigation) = 7.64, CSTP2 (compliance) = 7.47, CSTP3 (green practices) = 4.88, and CSTP4 (incentives and support services) = 7.78. For reference, the same table provides the corresponding component levels for 2022 (6.85; 5.23; 3.59; 1.58) and 2023 (7.29; 5.99; 3.64; 5.61), as well as the associated rank sequence (3 in 2022; 21 in 2023; 4 in 2024). Within the 2024 component profile, CSTP3 is reported as the lowest component score relative to the other three components.

PGI component	2022	2023	2024
CSTP 1: Pollution reduction and disaster risk mitigation	6.85	7.29	7.64
CSTP 2: Environmental compliance	5.23	5.99	7.47
CSTP 3: Green practices promotion	3.59	3.64	4.88
CSTP 4: Incentive policies and support services	1.58	5.61	7.78
Rank	3	21	4

Table 2. PGI component scores for Bac Ninh (2022–2024) and rank

PCI-linked constraints reported as time-series component movements

Figures 2–5 reproduce PCI component time-series for Bac Ninh over 2019–2024 as presented in the DDCI 2025 report.

Figure 2 plots the "informal costs" component (chi phí không chính thức) and reports the sequence 7.24 (2019), 7.69 (2020), 7.27 (2021), 6.83 (2022), 6.79 (2023), and 6.58 (2024).

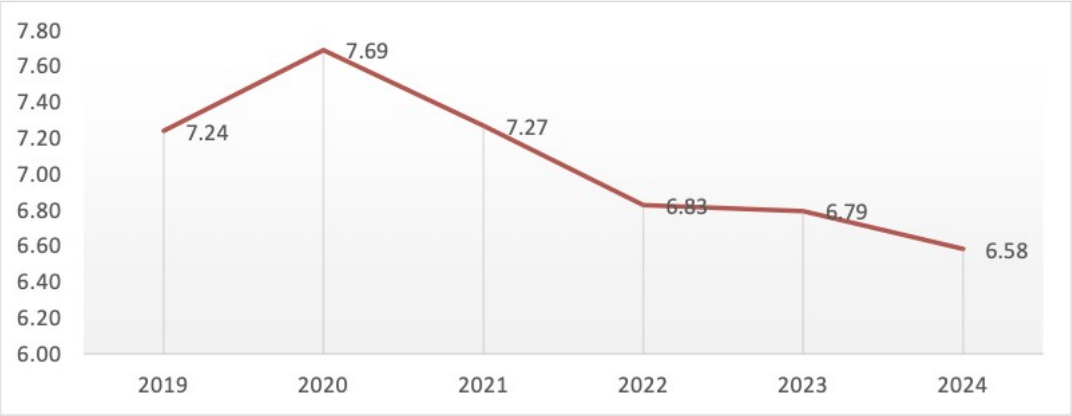

Figure 2. PCI informal costs, 2019–2024 (Bac Ninh)

Figure 3 plots the "time costs" component (chi phí thời gian) and reports the sequence 7.23 (2019), 8.42 (2020), 8.47 (2021), 8.54 (2022), 7.74 (2023), and 7.14 (2024).

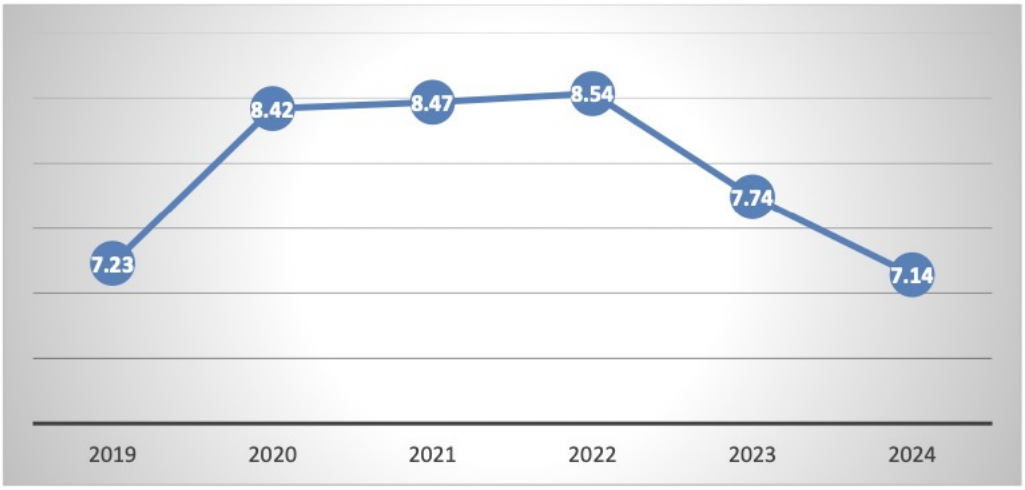

Figure 3. PCI time costs, 2019–2024 (Bac Ninh)

Figure 4 plots "equal competition" (cạnh tranh bình đẳng) and reports the sequence 7.51 (2019), 6.46 (2020), 6.29 (2021), 6.93 (2022), 5.91 (2023), and 5.36 (2024).

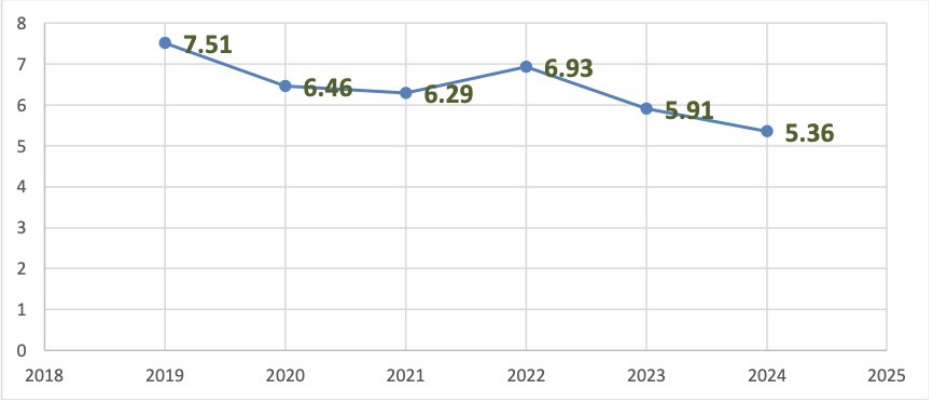

Figure 4. PCI equal competition, 2019–2024 (Bac Ninh)

Figure 5 plots "business support policy" (chính sách hỗ trợ doanh nghiệp) and reports 6.62 (2019), 6.75 (2020), 7.27 (2021), 6.48 (2022), 5.47 (2023), and 7.41 (2024), with accompanying text indicating that 7.41 represents the highest value recorded for the province since the component has been measured in the PCI series.

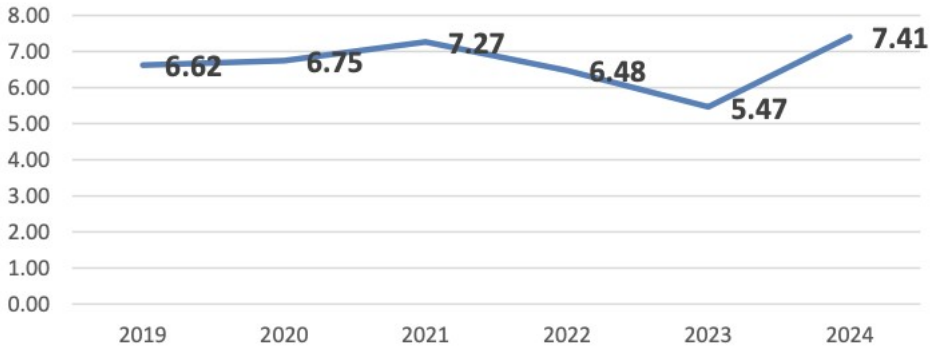

Figure 5. PCI business support policy, 2019–2024 (Bac Ninh)

Together, these figures document the direction and magnitude of recent changes in administrative and business-environment components reported within the PCI framework.

DDCI 2025: implementation-layer structure and selected distributional evidence

The DDCI 2025 report defines the DDCI instrument as an eight-dimension framework capturing transparency, dynamism/proactiveness, informal costs, time costs, equal competition, business support policy, legal institutions, and the effectiveness of business-environment improvement. Figure 6 is constructed directly from this definition statement to document the measurement architecture used to interpret implementation performance at the department and locality level.

Purpose ("zoom-in" use)	A diagnostic instrument designed to "zoom in" to departments and localities, clarifying responsibilities and implementation capacity, to support improvements in the provincial business environment (aligned with PCI/PGI improvement).
Dimensions (8)	
(1) Transparency	(5) Equal competition
(2) Dynamism / Proactiveness	(6) Business support policy
(3) Informal costs	(7) Legal institutions
(4) Time costs	(8) Effectiveness of business-environment improvement

Figure 6. DDCI 2025 eight-dimension framework (compiled by author from DDCI 2025 definition statement).

Beyond the framework, the report provides distributional evidence for environment-related administrative and inspection items. Figure 10 summarizes enterprise assessments of the importance of a set of compliance-related environmental governance items (reported as "Hoạt động đảm bảo tuân thủ các tiêu chuẩn môi trường tối thiểu (PGI)"). The accompanying text reports that the combined share of responses in the "very important / important / normal" categories exceeds 70% for most items and identifies the largest "very important" share as 11.43% for the item "The local government has solutions to prevent pollution."

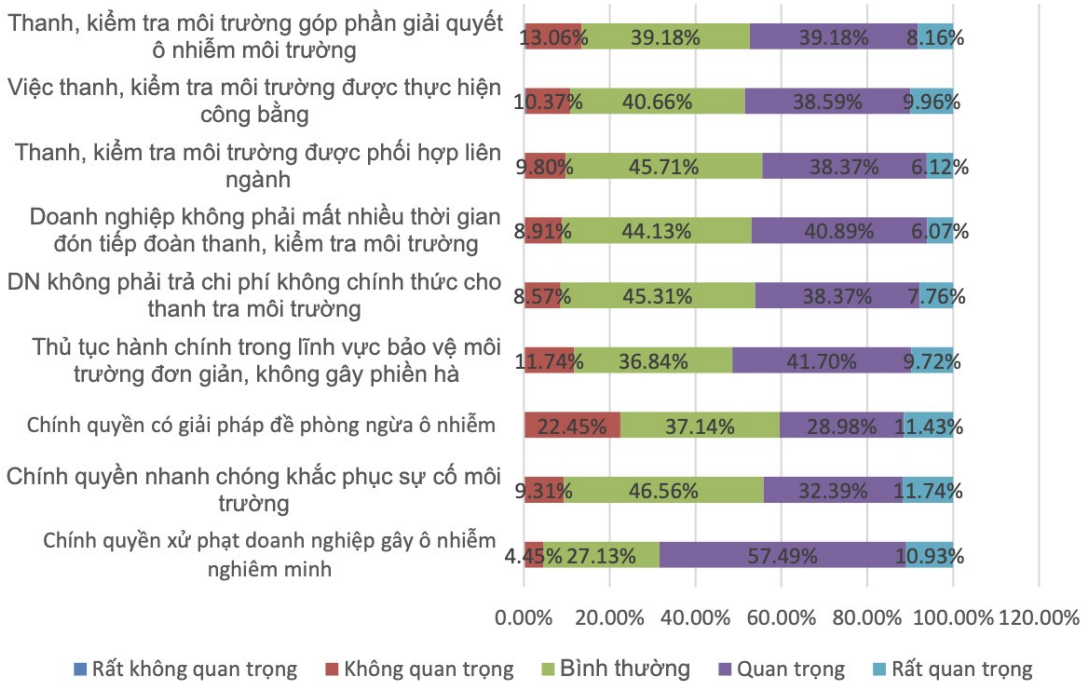

Figure 10. Aggregate distribution: importance of environmental compliance-related items (PGI).

To document locality heterogeneity using a compact presentation, Table 3 reports the urban-area subgroup distribution (Table 3.14 in the DDCI report) for key administrative-process and inspection-related items. For the item "Environmental administrative procedures

are simple and not troublesome," the urban subgroup shares are 13.58% "very important," 48.15% "important," 28.40% "normal," 9.88% "not important," and 0.00% "very unimportant."

Item	Very important	Important	Neutral	Not important	Not at all important
The government penalizes firms that cause serious pollution	14.81%	59.26%	19.75%	6.17%	0.00%
The government promptly remedies environmental incidents	16.25%	33.75%	40.00%	10.00%	0.00%
The government has measures/solutions to prevent pollution	10.00%	43.75%	23.75%	22.50%	0.00%
Environmental administrative procedures are simple and not burdensome	13.58%	48.15%	28.40%	9.88%	0.00%
Firms do not have to pay unofficial costs for environmental inspections	10.00%	43.75%	36.25%	10.00%	0.00%
Firms do not spend much time receiving environmental inspection teams	7.41%	49.38%	37.04%	6.17%	0.00%
Environmental inspections are coordinated across agencies/sectors	7.69%	50.00%	33.33%	8.97%	0.00%

Table 3. Urban-area subgroup distribution for environment administration/inspection items.

For the item "Firms do not have to pay informal costs for environmental inspections," shares are 10.00%, 43.75%, 36.25%, 10.00%, and 0.00%, respectively. For the item "Firms do not spend much time receiving environmental inspection teams," shares are 7.41%, 49.38%, 37.04%, 6.17%, and 0.00%. These same distributions are visualized in the report via Figure 7 and Figure 8 (Figures 3.25 and 3.26 in the report), which plot response shares for two of the urban-area items.

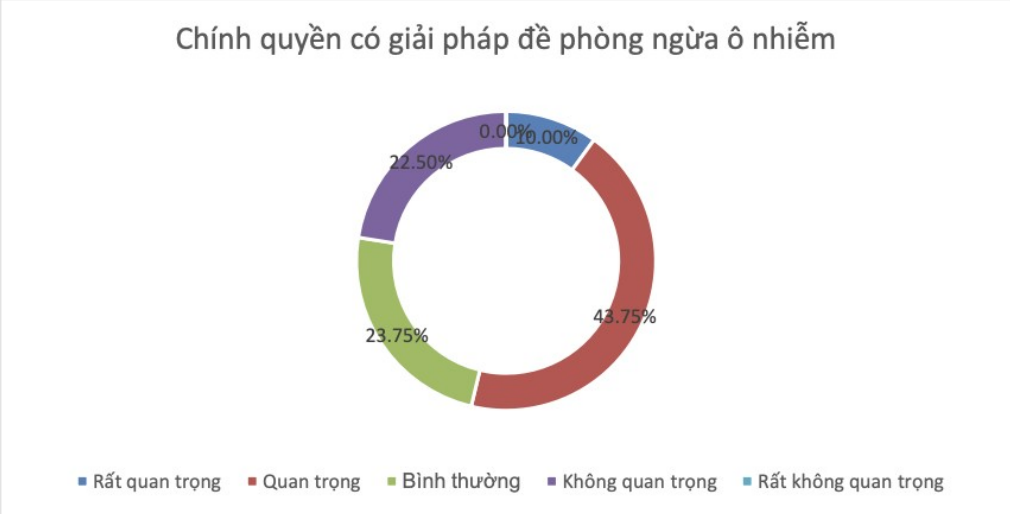

Figure 7. Urban subgroup: "Environmental procedures are simple, not troublesome.

Figure 8. Urban subgroup: "No excessive time receiving environmental inspection teams.

To illustrate firm-size heterogeneity, Table 4 reports selected entries from the micro-firm subgroup table (enterprises with fewer than 10 employees) on the "pollution and disaster mitigation" set of PGI-related items. For example, the table reports 31.25% "very important," 46.88% "important," and 15.63% "normal" for "Environmental quality is good"; and the same distribution for "Firms are not affected by pollution and climate change." The table also reports 35.48% "very important," 45.16% "important," and 19.35% "normal" for "Waste treatment services in industrial clusters/parks are good." The accompanying text reports an average combined share of 91.91% for the micro-firm subgroup in the "very important / important / normal" categories across the listed items.

Item	Very important	Important	Neutral	Not important	Not at all important
Good environmental quality	31.25%	46.88%	15.63%	6.25%	0.00%
Businesses are not affected by pollution and climate change	31.25%	46.88%	15.63%	6.25%	0.00%
Pollution caused by local businesses is not common	26.67%	43.33%	20.00%	10.00%	0.00%
Good quality of clean water supply services	34.38%	37.50%	25.00%	3.13%	0.00%
Good quality of waste treatment services in industrial parks/clusters	35.48%	45.16%	19.35%	0.00%	0.00%
Businesses do not face difficulties due to natural disasters and climate change	18.75%	53.13%	15.63%	12.50%	0.00%
Businesses can easily access information on weather and hydrometeorology	16.13%	51.61%	22.58%	9.68%	0.00%
Infrastructure quality is sufficient for climate-change and pollution prevention	25.00%	43.75%	21.88%	9.38%	0.00%
Most communes/wards have daily solid-waste collection activities	25.00%	40.63%	18.75%	12.50%	3.13%

Table 4. Enterprises with fewer than 10 employees: assessment of the impact of pollution reduction and disaster risk mitigation (PGI) on sustainable development

Finally, Figure 9 reports the micro-firm subgroup distribution for a green-transition support item: "Firms receive policy incentives when investing green." For enterprises with fewer than 10 employees, the report states shares of 22.58% "very important," 64.52% "important," 12.90% "normal," and 0.00% in both "not important" categories.

Figure 9. Micro firms (<10 employees): "Policy incentives when investing green".

DISCUSSION

Interpreting short-run divergence between PGI improvement and uneven PCI performance

The empirical record indicates a short-run divergence in governance signals: Bac Ninh's PGI improves sharply in 2024 (Figure 1; Table 2), while PCI-linked administrative frictions exhibit uneven movements and, for several core components, deterioration in the same period (Figures 2–5). This divergence is not necessarily contradictory. PGI and PCI capture related but non-identical dimensions of governance performance, and they can move asynchronously when policy priorities shift faster than administrative process reform. In the report evidence, the PGI surge is consistent with a strengthening of green-governance capacity at the provincial level—especially in compliance and support-policy dimensions (Table 2)—whereas the PCI series continues to register burdens in time costs, informal costs, and perceived unequal competition (Figures 2–4).

From a political-economy perspective, the pattern is consistent with a "two-speed" reform process: policy framing, compliance infrastructure, and outward-facing support programs can be strengthened relatively quickly, while deep reductions in transaction costs and improvements in perceived fairness require changes in discretionary implementation and inter-agency coordination, which are typically slower-moving. The DDCI report's own emphasis on using DDCI to "zoom in" on departments and localities reinforces the interpretation that province-level improvements may coexist with implementation-layer frictions that are not visible in aggregate PGI outcomes (Figure 6).

From green governance to green practices: why the weakest PGI pillar matters

The PGI component profile provides a disciplined way to locate where the green transition remains constrained. Table 2 shows that the 2024 improvement is broad-based, but green practices (CSTP3) remains the lowest component relative to compliance and incentives/support services. This configuration is analytically informative because it separates two margins: (i) the province's capacity to enforce and incentivize environmentally relevant behavior (captured more strongly by compliance and support-policy components) and (ii) the

extent to which firms internalize green upgrading as an operational and investment strategy (captured by "green practices").

The report's narrative interpretation is consistent with this structural reading: green practices tend to lag when firms face capability constraints—particularly for SMEs and firms outside core urban areas—because adoption requires complementary inputs such as financing, technology, and skilled labor, as well as predictable administrative procedures. Thus, the reported weakness in CSTP3 should be understood less as a lack of policy intent and more as evidence that private-side adoption is still limited relative to the pace of governance-side acceleration.

What DDCI adds empirically: identifying the implementation margin

The DDCI contribution is methodological and substantive. Methodologically, it introduces an implementation-layer measurement architecture that is conceptually aligned with the mechanism through which governance reforms affect firms. Substantively, it provides granular, experience-based evidence that can explain why province-level indices may not fully capture execution bottlenecks. The eight-dimension framework (Figure 6)—spanning transparency, proactiveness, informal costs, time costs, equal competition, business support policy, legal institutions, and the effectiveness of improving the business environment—maps directly onto the channels through which administrative quality shapes both general competitiveness and the feasibility of green upgrading.

In that sense, DDCI functions as a diagnostic bridge between the PCI time series and the PGI component profile. Where PCI signals persistent frictions in time costs and informal costs (Figures 2–3), DDCI provides a structured means to localize these frictions across agencies and territories rather than treating them as a uniform provincial characteristic. This is particularly relevant in a green-transition context because policy compliance and green investments are sensitive to administrative predictability, inspection burdens, and the credibility of support instruments.

Heterogeneity is systematic: firm type and location as governance "exposure"

A core implication of the report evidence is that heterogeneity should not be treated as noise. The DDCI environment-related distributions provide a concrete illustration. In the urban-area subgroup, the response distributions for administrative simplicity and inspection-related burdens (Figures 7–8; Table 3) indicate that these items are salient and evaluated in a way consistent with procedural exposure in denser regulatory environments. For micro firms, distributions highlight strong stated importance attached to incentives for green investment (Figure 9) and to several environment-quality and service-related items (Table 4).

This segmentation is consistent with the broader report framing that SMEs and non-urban firms face tighter constraints in capital, technology, and skills, while larger and FDI firms are more likely to have the organizational capability to comply with and benefit from green-governance systems. Economically, this suggests that the effective incidence of green-transition policies depends on the interaction between firm capacity and administrative delivery. When administrative frictions remain elevated (time costs, informal costs, and perceived unequal competition), these frictions are likely to be more distortionary for smaller firms and peripheral locations, potentially slowing diffusion of green practices even as province-level governance scores improve.

Uneven PCI performance and green transition: why transaction costs and fairness matter

The PCI component series points to a tension that is particularly important during transition periods. Figures 2–4 document that informal costs, time costs, and equal competition reach low points by 2024 relative to the 2019–2024 window, while Figure 5 shows that business support policy improves sharply in 2024. A plausible interpretation—consistent with the report's synthesis—is that programmatic support can expand even as firms continue to experience administrative burdens and perceived unequal treatment.

In a green-transition setting, this tension is consequential. Green upgrading often increases compliance requirements, documentation demands, and interaction frequency with administrative bodies (e.g., permits, inspections, reporting). If time costs and informal costs remain high and fairness perceptions deteriorate, the marginal burden of transition becomes unevenly distributed, undermining broad-based adoption of green practices (as reflected in the persistently low CSTP3 score). In other words, policy acceleration without commensurate reduction in transaction costs risks producing a governance profile in which compliance improves and support exists on paper, yet firm-level practice diffusion remains partial.

Synthesis: an integrated governance interpretation consistent with the report evidence

The results support an integrated interpretation: Bac Ninh's 2024 governance profile reflects (i) accelerated green-governance performance in PGI, (ii) persistent or worsening administrative frictions in key PCI components, and (iii) implementation-layer heterogeneity documented through DDCI's structured framework and subgroup distributions. The policy-relevant inference is not that any one index is "right," but that each captures a distinct layer of the same institutional system. The joint reading implies that strengthening green governance at the province level is necessary but not sufficient; diffusion of green practices requires that implementation performance—especially in transaction costs, transparency, and equal treatment—be sufficiently improved for smaller firms and non-urban districts to participate effectively.

CONCLUSIONS

The aim of this study was to assess the conditions for green enterprise development in Bac Ninh by integrating three complementary sources of governance evidence: PCI as a signal of economic governance, PGI as a signal of green governance, and DDCI 2025 as evidence on frontline implementation performance. A parallel goal was to show why province-level index movements alone are insufficient for interpreting firms' transition conditions, and how an implementation-layer "zoom-in" can clarify where policy delivery becomes binding in practice.

The results highlight a clear improvement in Bac Ninh's green-governance signal in 2024. PGI rises to 27.78 points and places Bac Ninh 4/30 in the top group (Figure 1; Table 2). At the same time, the component profile indicates that "green practices" remains the weakest pillar relative to the other PGI dimensions. This pattern suggests that stronger green-governance performance does not automatically translate into the diffusion of firm-level green practices at scale, particularly in an industrial province where upgrading requires both compliance capacity and operational capability.

The PCI evidence reported in the DDCI document describes a mixed economic-governance configuration over 2019–2024 (Figures 2–5). By 2024, several transaction-cost and fairness-related components—including informal costs, time costs, and equal competition—remain weaker, while business support policy shows a notable increase. Read

together, these results describe a policy environment in which support-policy signals strengthen, but firms may still face friction in the administrative interfaces that shape predictability and perceived fairness.

The DDCI 2025 evidence provides the key bridge between these provincial signals and firm experience. The report explicitly defines DDCI as an eight-dimension framework—covering transparency, dynamism, informal costs, time costs, equal competition, business support policy, legal institutions, and the effectiveness of business-environment improvement—and frames it as a tool to "zoom in" on performance across departments and localities (Figure 6). The subgroup results for urban-area enterprises (Figures 7–8; Table 3) and micro firms (Figure 9) further illustrate that the salience of procedures, inspection burdens, and incentives differs across firm groups and place contexts, which is consistent with an implementation-centered view of green transition.

Overall, this study shows that an integrated PCI–PGI–DDCI reading provides a more complete description of green enterprise conditions in Bac Ninh than any single index can offer. It allows policy to be interpreted not only through aggregate improvements, but also through the day-to-day implementation channels that shape firms' effective transition costs. The evidence supports a synchronized and tiered reform logic: reducing administrative friction and improving transparency in environment-related procedures, while strengthening capability-building instruments that move firms from compliance toward adoption, and differentiating delivery by firm group and locality to match the uneven transition capacity revealed by DDCI.

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THE INCLUSION OF INDIVIDUALS WITH NEURODEVELOPMENTAL DISORDERS IN THE CONTEXT OF SUSTAINABLE URBAN DEVELOPMENT: EDUCATION, INFRASTRUCTURE, AND SOCIAL COHESION

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Abstract
Contemporary discourse on sustainable urban development must not overlook the imperative of genuine social inclusion for individuals with neurodevelopmental disorders, such as autism and dyslexia. While special education has made significant strides within the educational sphere, substantial gaps remain in the creation of urban environments that support the functional independence and full social participation of these individuals, particularly in adulthood.

This presentation explores through a literature review how cities can become more welcoming and accessible for autistic individuals—who often face challenges related to sensory processing, social navigation, and access to services—as well as for dyslexic citizens, who encounter obstacles in reading public information, completing official forms, or orienting themselves through written signage. Drawing on international best practices, it is proposed a comprehensive urban policy framework that includes accessible public information, frontline staff training, neurodiversity-friendly urban design (e.g., quiet zones, dyslexia-friendly fonts, use of symbols), and enhanced cross-sector collaboration. The argument is made that social sustainability goes beyond ecological or economic considerations.

It is fundamentally defined by the extent to which cities ensure equal participation, autonomy, and dignity for all citizens, regardless of neurotypicality. Special education, when integrated with the principles of universal design, can act as a catalyst for a more inclusive and equitable urban future.

Keywords: neurodevelopmental disorders, autism, dyslexia, sustainable urban development, social inclusion, accessibility, urban policy, neurodiversity

GREEN AND SMART CITY APPROACHES: INSIGHTS FROM SUB-SAHARAN AFRICA

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Abstract
In view of achieving sustainability and sustainable development in urban areas, approach of smart and green cities continues to emerge strongly. The simultaneous nature of both smartness and green elements allows for the synergies in limiting the carbon footprint.

In this study the aim is to review the progress, with lessons from sub-Saharan Africa. Based a systematic analysis of case studies, we expose the strengths and weaknesses to highlight on the way forward. This is still work in progress. So far, we notice a gradual adoption of digital technologies and infrastructure as well as the enhancement of green infrastructure and citizen well-being to manage rapid urbanization. Yet, however, a variety of gaps still characterise and outweigh the ongoing steps. These are categorised into ecological, socio-cultural, and economic gaps. Ecologically, the unreliable electricity grid coupled with the limited affordability comminute to push for the use of wood fuel in cities; socio-culturally, cities remain gender and culturally insensitive; and the economic activities remain largely untouched as there are scarce green jobs in addition to the increasing unemployment.

Our findings tentatively point to the need for a Green and Smart City package that is centred around a circular economy strategy that is not only socio-culturally sensitive. But also incorporates agroecological technique of production biogas that is convertible to electricity as green entrepreneurship venture for city citizens.

Key words: Urban Clean Energy, Urban Green Smartt, Green Jobs, Green Urbanism

ROLE OF INTRAPRENEURSHIP IN THE ENTREPRENEURIAL ORIENTATION OF UNIVERSITIES

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Abstract
This study investigates how academic intrapreneurship shapes the entrepreneurial orientation (EO) of higher education institutions (HEIs) in Albania. Using a mixed-methods design that triangulates HEInnovate self-assessments with semi-structured interviews across six universities (public and private), we connect micro-level agency to meso-level routines and institutional change. We show that EO in universities is dimension-specific: opportunity seeking, innovativeness, risk management, and proactiveness evolve unevenly, contingent on governance arrangements, incentive systems, and organizational culture. Intrapreneurial actors navigate multiple institutional logics and perform identity work to reconcile academic norms with entrepreneurial aims. Private HEIs generally score higher on leadership and governance, entrepreneurial teaching and learning, and support for entrepreneurs, reflecting agile decision-making and stronger curricular integration; public HEIs display relative strengths in internationalization and knowledge exchange through EU-funded collaborations. Across all cases, measuring impact is the weakest dimension, indicating a systemic absence of tools to track and scale outcomes. Intrapreneurship operates as a bottom-up change mechanism—problem framing, coalition building, pilot legitimation, and routinization—through which internal services, programs, and partnerships become installed capabilities that gradually reconfigure structures. This study contributes by linking the micro-to-meso levels that turn intrapreneurial initiatives into organizational capabilities (advancing intrapreneurship research) and reframe EO in HE as a configurational, dimension-specific profile with identifiable boundary conditions and reconfiguration pathways (advancing EO scholarship).

Keywords: academic intrapreneurship, entrepreneurial orientation

ERASMUS+ GREENO2 AND GAME4CHANGE PROJECTS: SOCIAL SUSTAINABILITY, COMMUNICATION, AND A SOCIOLOGICAL PERSPECTIVE

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Abstract
In recent years, European policymakers and legislators have increasingly focused on environmental sustainability and sustainable development. This growing attention stems from the sharp rise in pollution levels, the overexploitation of natural resources, and, more broadly, the degradation of natural ecosystems. Against this backdrop, European research seeks to define new lines of action aimed at promoting the sustainable use of resources and fostering the ecological transition across all productive sectors.

In this context, communication and sociology provide essential theoretical frameworks for interpreting these issues, as they enable a deeper understanding of how individuals, institutions, and societies perceive, communicate, and act upon environmental challenges. They also help to connect technological and ecological innovation with social awareness, behavioural change, and participatory engagement.

Within this framework, Erasmus+ projects such as: GREENO2 – "Green Roofs in higher education institutions as sustainable cEnters for research, participation, ENvironmental consciousness and O2 generation" and GAME4CHANGE – "Digital Serious Games for Climate Change Education" aim to encourage and test innovative green solutions, particularly

through the application of nature-based solutions and the active involvement of citizens and the scientific community.
Educational and participatory tools, such as the serious games developed in the Game4Change project, have proven essential in raising awareness of environmental issues and in advancing the concept of social sustainability, understood as the shared commitment of citizens and communities to contribute to the objectives set by European environmental strategies. At the same time, the adoption of green infrastructures – such as green roofs – plays a strategic role in ensuring ecological transition in urban areas, helping to mitigate climate change and reduce land consumption. Furthermore, the possibility of implementing these structures in obsolete and aging buildings facilitates urban regeneration and increases social acceptance of sustainable innovation.

The aim of this paper is to present the preliminary results of the Erasmus+ GREENO2 and GAME4CHANGE projects, highlighting the crucial role of communication, sociology, gamification, and the educational process as key drivers for achieving environmental sustainability goals at the European level.

Key words: Social sustainability, Communication, Sociology, Green Transition, Environment Erasmus+.

DIGITAL SERIOUS GAMES FOR CLIMATE CHANGE EDUCATION: RESEARCH DATA AND FINDINGS

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In the current context of accelerating digital transformation, universities are attempting to modernize their teaching methods and educational approaches, especially in scientific fields such as the humanities and environmental studies.

Digital games, especially "serious games," have significant potential as educational tools, connecting higher education with real-world issues such as climate change and environmental protection. Studies have shown that digital games can enhance student motivation, engagement, and learning outcomes by using interactive and engaging methods to teach critical topics. However, despite their proven benefits, many academics lack the guidance and tools needed to integrate digital games into their teaching.

This study presents the research results of the transnational European project GAME4CHANGE. As part of the program, a mixed research approach was developed using questionnaires and focus groups in the six countries participating in the program (Portugal, Greece, Italy, Ukraine, Poland, and the Netherlands). The aim was to highlight the views and attitudes of students, teachers, and researchers on the role of serious games in higher education and their potential for teaching about key environmental issues (climate change). The data were analyzed using thematic analysis, focusing on pedagogical approaches, good practices in the use of games, and the development of university cooperation strategies.

Key words: digital games, serious games, environment, higher education

SESSION

"Education and Sustainable Development"

Chaired by **Prof Kaldi Stavroula** and
Dr Dologlou Maria

PHYSICAL EDUCATION AND SUSTAINABLE DEVELOPMENT: EDUCATING ACTIVE CITIZENS FOR SOCIAL TRANSFORMATION

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Abstract
This study examines the role of Physical Education in advancing Education for Sustainable Development and its potential to empower students as future active citizens. The contribution builds on international frameworks such as the 2030 Agenda and UNESCO's Education for Sustainable Development roadmap, highlighting the transformative power of Physical Education in fostering sustainability-related competencies. The scope of this work is twofold: first, to demonstrate how Physical Education can serve as a vehicle for cultivating values such as empathy, cooperation, and responsibility; and second, to illustrate how these competencies can support broader social and political change.

The methodology combines a narrative synthesis of recent empirical and theoretical studies with practical examples drawn from primary school contexts. Special attention is given to experiential and cooperative learning approaches, outdoor education initiatives, and whole-school projects that integrate sustainability principles into Physical Education. Furthermore, the study reflects on the professional development of Physical Education teachers and the importance of equipping them with pedagogical strategies to embed Education for Sustainable Development in their teaching practices.

Findings indicate that Physical Education, when intentionally designed with sustainability objectives, can significantly enhance students' environmental awareness, social responsibility, and commitment to collective action. These outcomes align with core Sustainable Development Goals, particularly those related to health, quality education, equality, and climate action.

This study provides educators, researchers, and policymakers with insights into how Physical Education can contribute not only to educational reform but also to societal transformation. By reframing Physical Education as a medium for sustainability and citizenship, schools can become active agents of change in building more inclusive, resilient, and sustainable communities.

Key words: Physical Education, Sustainable Development Goals, Education for Sustainable Development, Active Citizenship, Transformative Learning, School Communities, Teacher Training

THE ROLE OF SCHOOL LEADERSHIP IN FOSTERING INCLUSIVITY WITHIN THE FRAMEWORK OF SUSTAINABLE DEVELOPMENT

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Abstract
Inclusivity constitutes a fundamental pillar of contemporary educational practice and is closely linked to the principles of sustainable development. Promoting equal opportunities, recognizing diversity and empowering all members of a school community contribute significantly to the creation of resilient and fair societies. In the school context, inclusivity acquires particular importance, as the school functions as a space for socialization, value formation and the preparation of students for their active role in future society. The school principal plays a central role in this process, since his or her leadership stance and decisions largely determine whether and how a climate of acceptance, cooperation and solidarity will be cultivated.

The purpose of this study is to highlight leadership strategies that can strengthen inclusivity and to examine the challenges that principals face in implementing them. By formulating a shared vision, encouraging dialogue and promoting participatory practices, the principal mobilizes human resources, empowers teachers and reinforces the cohesion of the school community. The development of emotional intelligence, effective conflict management, systematic professional development and close collaboration with parents and local stakeholders are critical prerequisites for the success of this effort. Furthermore, the identification of good practices, continuous evaluation and adaptation to new social conditions contribute to the sustainability of such initiatives.

The connection between inclusivity and sustainable development is crucial, as strengthening equality and justice leads to the responsible use of resources, promotes cooperation among diverse social groups and creates solid foundations for long-term progress. In conclusion, the principal's contribution to the acceptance of inclusivity is essential and constitutes a necessary condition for advancing sustainable development through a school environment that fosters values of equality, respect, social justice and active participation.

Key words: Inclusivity, school leadership, sustainable development, educational equity

1. INTRODUCTION

The concept of inclusion in education has assumed a leading role in the 21st century, as societies are called upon to respond to increasingly complex challenges associated with globalization, migratory flows, social inequality and the climate crisis. Within this context, education cannot be confined to the transmission of knowledge. It must function as a lever for social change and empowerment and as a vehicle for promoting values that uphold democracy, justice, and sustainable development (OECD, 2021; European Commission, 2020). Inclusive education—which emphasizes equality of opportunity, respect for diversity and the

empowerment of all students regardless of background—lies at the heart of this endeavor (Eurydice, 2020; UNESCO, 2020).

The United Nations' 2030 Agenda for Sustainable Development incorporates inclusion as a fundamental dimension of Goal 4 on quality education, seeking "to eliminate disparities in education and ensure equal access to all levels of learning for vulnerable people" (United Nations, 2025). This implies that education systems must create structures and practices that do not exclude but actively integrate students into a learning process with social and pedagogical meaning. Inclusion, therefore, is not merely a pedagogical option but an ethical and political commitment directly linked to sustainable development (Ainscow, 2020).

In this regard, the role of the school principal is of critical importance. The principal is not only an administrative manager but also a leader who is called upon to inspire, mobilize and guide staff toward creating a school environment that fosters acceptance, collaboration and solidarity (Harris & Jones, 2020). Leadership strategies associated with emotional intelligence, conflict management, participation and vision-building play a decisive role in shaping a school culture that promotes inclusion.

International literature highlights that inclusive leadership is positively associated with teachers' job satisfaction, enhanced collaboration and improved learning outcomes (OECD, 2021). At the same time, promoting participatory practices—such as developing a shared vision and empowering teacher teams—contributes to strengthening the resilience of the school community in the face of social and pedagogical challenges (Netolicky, 2020). Participatory leadership, combined with cultivating a climate of trust and mutual respect, lays the groundwork for embracing diversity as a source of learning and development.

Despite clear progress in recent decades, implementing inclusion policies continues to encounter obstacles. Some of these relate to limited infrastructure, inequalities between schools in different socio-economic areas and resistance stemming from social prejudices. The COVID-19 pandemic brought new challenges to the fore, such as the digital divide and the need to adapt inclusive practices to remote learning environments (Zhao, 2020). These conditions make the need for leadership that can respond to constantly changing environments and ensure access to quality education for all even more pressing.

Linking inclusion to sustainable development lends additional strategic weight to the work of school principals. By investing in practices that reduce inequalities, promote collaboration among diverse social groups and reinforce responsibility toward the common good, schools function as laboratories of democracy and social cohesion (Schuelka & Engsig, 2022). In this way, inclusive leadership benefits not only students and teachers but society at large, laying the foundations for fairer and more resilient communities.

This article seeks to explore how school principals can adopt leadership strategies that strengthen inclusion, focusing on both the opportunities and challenges that emerge. Through a review of contemporary literature and examples of good practice, it aims to show how leadership can be organically connected with sustainable development. The research proceeds from the premise that inclusion cannot be considered a supplementary dimension of education but constitutes an integral element of its quality.

Against this backdrop, the research questions guiding the analysis are:

1. Which leadership strategies of school principals enhance inclusion?
2. What challenges do principals encounter in their efforts to cultivate an inclusive climate?
3. In what ways does inclusive leadership contribute to sustainable development at local and international levels?

The significance of these questions is particularly great, as education is called upon to respond to a dynamic and often uncertain environment. Leadership grounded in inclusion seeks not only the achievement of learning objectives but also the formation of citizens capable of collaboration, critical thinking and commitment to the principles of equality and justice. Inclusion and sustainable development are inextricably linked and the principal significantly influences this relationship. By developing strategies that promote collaboration, recognition of diversity and the active participation of all members of the school community, leadership can make a substantive contribution to shaping an educational and social future grounded in equality, respect and resilience.

2. INCLUSION AND SUSTAINABLE DEVELOPMENT

Education in the 21st century is characterized by growing recognition of inclusion as a fundamental principle of quality and equity in education systems. The notion of inclusion goes beyond the simple integration of students with special needs and extends to creating an environment in which every student—regardless of socio-economic background, gender, language, nationality or abilities—can participate equitably in the learning process (UNESCO, 2020). Inclusion is recognized as a key factor that strengthens social justice (OECD, 2021) and is an integral component of the 2030 Agenda for Sustainable Development (United Nations, 2025) and for european education policy frameworks (European Commission, 2020).

Contemporary literature emphasizes that inclusion must be understood both as a value-laden principle and as practice. At the level of values, it presupposes recognizing diversity as an asset rather than an obstacle. At the practical level, it concerns designing pedagogical methods, school policies and community partnerships that facilitate the active participation of all students (Schuelka & Engsig, 2022). Within this framework, the concept of Universal Design for Learning (UDL) proposes strategies that ensure teaching practices respond to multiple needs and learning styles. Thus, inclusion is directly linked to pedagogical innovation and to the adaptation of school systems to changing social conditions (OECD, 2021).

Inclusive education is considered a prerequisite for achieving social justice. In an era of widening social inequalities, schools are called upon to act as mechanisms for reducing exclusion and strengthening equity (Eurydice, 2020). According to Ainscow (2020), inclusion is the "reformist principle" that transforms education from an instrument reproducing inequalities into a vehicle for social change. Strengthening inclusion is also associated with building societies that are more resilient to crises. As the COVID-19 pandemic demonstrated, educational institutions that had invested in inclusive practices were able to respond more effectively to remote learning, ensuring continuity of learning even for vulnerable groups (Zhao, 2020).

The connection between inclusion and sustainable development is multi-layered. On the one hand, inclusive education reduces social inequalities that hinder social cohesion and economic progress. On the other hand, it empowers students to become active citizens with a sense of responsibility toward the environment and society. UNESCO (2020) argues that education that is not inclusive cannot be considered sustainable because it reproduces exclusions that undermine long-term development.

In parallel, inclusion is linked to responsible resource management and the cultivation of a culture of collaboration. When students from diverse cultural and social backgrounds learn to work together, the foundations are laid for societies that promote dialogue, peace and

democratic participation. This aligns with SDG 16, which concerns the promotion of peaceful and inclusive societies (United Nations, 2025).

According to Harris and Jones (2020), school leadership is crucial for promoting inclusion. The principal shapes the vision, influences culture and mobilizes the human resources of the school community. The authors note that in times of crisis, such as the pandemic, inclusion-based leadership is pivotal for the psychological and pedagogical resilience of schools. Transformational leadership is recognized as particularly effective in this context: the principal serves as a role model, inspires and empowers teachers, encouraging them to develop innovative practices. In parallel, distributed leadership facilitates the participation of all community members in decision-making, strengthening the sense of belonging (OECD, 2021).

Despite progress, implementing inclusive policies faces challenges. Emphasis on performance and standardized assessment often conflicts with the principles of inclusion, leading to practices that exclude the most vulnerable students. Furthermore, lack of resources and unequal distribution across schools in different areas complicate the implementation of inclusive strategies (UNESCO, 2020). In addition, social prejudices and stereotypical perceptions regarding disability, language or cultural diversity function as barriers that often extend beyond the school setting. Here, the importance of leadership is once again underscored, as the principal must create a climate of trust and cultivate values of acceptance and respect.

Consequently, inclusion is a necessary precondition for sustainable development and school leadership is a basic prerequisite for its realization. Inclusive education is not confined to the classroom; it extends to the social and political levels, influencing social cohesion, economic development and environmental responsibility. To the extent that schools succeed in embedding the principles of inclusion, they contribute to creating societies that are fairer, more resilient and better equipped to meet future challenges.

3. THE PRINCIPAL'S ROLE IN CREATING AN INCLUSIVE CLIMATE

The school unit is a microcosm of society, where diverse identities, values and experiences intersect. In this context, the principal's role goes beyond administrative management to include culture-building, staff guidance and creating an environment that nurtures inclusion. Leadership decisively shapes how teachers, students and families experience school life. Based on current literature, leadership strategies that promote inclusion relate to developing a shared vision, strengthening participation, cultivating emotional intelligence, effectively managing conflict and fostering collaboration with the wider community (OECD, 2021; Harris & Jones, 2020).

A principal is not merely a resource manager, but primarily a pedagogical leader who shapes the learning climate. International research shows that leadership aligned with the values of inclusion can empower teachers, increase their sense of commitment and improve learning outcomes (Netolicky, 2020). A leader who places equity and respect for diversity at the center sets—by example—the behavioral framework for the entire school community. The pedagogical dimension of leadership is evident in the shaping of school policies (Buskila & Chen-Levi, 2021). A principal who prioritizes access for all students to quality learning reinforces education as a public good rather than a privilege. This implies redefining success not only in terms of performance but also in terms of inclusion, participation and social cohesion.

Crafting a shared vision for inclusion is foundational. Such a vision cannot be imposed top-down; it must be co-constructed with teachers, students and families. OECD (2021) reports that schools where the vision for inclusion emerges from collective processes demonstrate greater resilience and commitment to implementing equity principles. The vision functions as a compass for everyday decisions. Through strategic planning, the principal sets goals related to reducing exclusion, improving access to resources and creating a climate of mutual respect. Moreover, indicators for monitoring progress are incorporated so that movement toward inclusion is measurable and transparent.

Inclusion cannot be achieved without teacher participation. The principal must cultivate a culture of collaboration in which every staff member feels they have a voice and a role. Distributed leadership is particularly significant here, since it proposes delegating responsibilities to teacher teams, enabling them to contribute actively to shaping policies and practices (Harris & Jones, 2020).

Teacher empowerment is also linked to professional development (Buskila & Chen-Levi, 2021). Principals encourage continuous training by offering opportunities for collaborative learning, sharing good practices and engaging in innovative pedagogical approaches. In this way, professional growth is tied to a personal sense of purpose and contributes to commitment to inclusion (Li et al., 2024).

It should be emphasized that inclusion presupposes the principal's ability to recognize and manage the emotions of community members. Emotional intelligence emerges as a crucial leadership tool, enabling principals to perceive students' needs, address parents' concerns and support teachers during times of pressure (Li et al., 2024; Goleman, 2020). Conflicts are inevitable in any school setting, particularly when expectations and cultural perspectives differ. Principals must manage conflicts in ways that foster dialogue and understanding. Mediation practices, dialogue groups and established dispute-resolution mechanisms strengthen a climate of trust and stability.

Inclusion cannot be confined within classroom walls. Collaboration with parents and the local community is a critical leadership dimension. Schuelka and Engsig (2022) underscore that school inclusion acquires meaning only when accompanied by the active participation of families and local agencies. Principals enhance transparency and communication with parents by organizing regular meetings, workshops and initiatives that promote understanding of inclusion's principles. In parallel, they cultivate partnerships with local organizations, social services, and NGOs, expanding the support network for students with diverse needs.

Cultivating a culture of trust is essential to consolidating inclusion. By example, the principal shapes the attitudes and behaviors of community members. Transparency, fairness, and consistency in decisions strengthen feelings of safety and acceptance. This culture is expressed in the school's daily functioning: treating diversity as a source of learning, recognizing and celebrating all students and reinforcing cooperative classroom practices. In this context, inclusion is not presented as an obligation but as an organic dimension of school life.

Crises—such as the COVID-19 pandemic—further highlighted leadership's importance in maintaining inclusion. Principals faced challenges such as the digital divide, supporting students with limited access to technology and providing psychological support to families affected by social and economic difficulties (Zhao, 2020). Inclusive leadership in such conditions entails rapid adaptation, flexibility and creating mechanisms to ensure learning continuity for all. Adopting hybrid teaching models, providing support for students with special needs, and strengthening communication with parents were practices that confirmed the principal's central role as an agent of inclusion.

In sum, the principal plays a multidimensional role in creating an inclusive climate. Through a shared vision, teacher empowerment, emotional intelligence, collaboration with parents and the community and crisis management, the principal determines the success or failure of inclusion efforts. Leadership imbued with the values of equity, justice and acceptance benefits not only the school community but also contributes to shaping societies that are more resilient, fairer and better able to meet the challenges of sustainable development.

4. PRACTICES AND STRATEGIES FOR ADVANCING INCLUSION

Moving from recognizing the importance of inclusion in theory to its actual implementation in schools is among the most critical issues in educational policy and practice. School principals, as leaders who define the climate and strategy of learning organizations, are called upon to adopt specific practices and strategies that ensure inclusion does not remain an abstract ideal but becomes a daily reality (Bao et al., 2024). These practices relate to pedagogical approaches, continuous professional development for teachers, collaboration with parents and the community, creation of support systems for students with diverse needs and the adoption of internationally validated good practices (UNESCO, 2020).

At the core of every inclusion strategy lies pedagogy. Teachers are called upon to design instruction that responds to students' different needs, abilities and learning styles. Differentiated instruction is also essential. Through methods such as cooperative learning, the use of multimedia and interdisciplinary approaches, teachers can address the particular needs of students with disabilities, students learning the language of instruction as an additional language or those facing socio-economic difficulties (Schuelka & Engsig, 2022). Moreover, integrating technology can strengthen inclusion. Tools such as adaptive learning platforms, assistive technologies and online libraries offer opportunities for personalization and facilitate access to knowledge for students with diverse abilities (OECD, 2021; Zhao, 2020).

Naturally, inclusion cannot be achieved without adequately prepared teachers. Professional development is vital for cultivating the skills, attitudes and knowledge that underpin inclusive pedagogy. Training programs should focus on differentiated instruction, intercultural education, classroom management and the use of innovative learning tools. Equally important is collaborative learning among teachers themselves. Principals can encourage professional learning communities in which teachers exchange experiences, discuss challenges and co-design solutions. Such communities strengthen the sense of collective responsibility and foster a culture of continuous improvement (Bao et al., 2024; Netolicky, 2020). In addition, mentoring and coaching support novice teachers and help disseminate good practices. Principals who cultivate these structures empower their staff and ensure that inclusion is not the responsibility of individuals but a collective commitment.

Inclusion is most successful when the school community partners with parents and the local society. Parents are valuable allies who bring knowledge, experience and cultural values that enrich the learning environment. Principals can strengthen parental engagement through frequent and meaningful communication, workshops, participation in school councils and the creation of support networks (UNESCO, 2020). Collaboration with local agencies—such as social services, NGOs and cultural associations—also bolsters inclusive practices. Partnerships with organizations specializing in disability or migration, for example, can provide additional support and targeted interventions for students who need them.

Inclusion cannot be limited to general principles; specific support systems are required to meet students' distinct needs. These include creating teams of specialist educators,

psychologists and social workers who collaborate with teachers to develop individualized learning plans. Providing psychosocial support is also crucial. The pandemic showed that students need reinforcement not only cognitively but also emotionally. Schools that offer listening spaces, counseling and mental-health support contribute to students' holistic development (Harris & Jones, 2020).

Inclusive practices extend beyond teaching to the school's everyday operation. Establishing student councils, encouraging student participation in decision-making and cultivating a culture of respect for human rights transform the school into a laboratory of democracy. Students engaged in such structures develop leadership, collaboration and responsibility, while learning to value diversity. In this way, inclusion becomes not only an educational strategy but a social experience that shapes the citizens of the future (Schuelka & Engsig, 2022).

International examples can offer valuable lessons. In Finland, for instance, education places strong emphasis on inclusion, with support teams in every school and a culture of collaboration among teachers, parents and communities. In Canada, policies aimed at strengthening Indigenous and immigrant students show how education can contribute to intercultural understanding. In Singapore, emphasis on teacher professional development and technology integration enhances all students' access to learning (OECD, 2021). Adapting such good practices to each social and cultural context is essential. Principals who recognize the specificities of their communities can draw inspiration from international experience and tailor it to their school's needs.

Advancing inclusion requires continuous evaluation of practices. Principals should implement mechanisms for collecting data—such as questionnaires, interviews, and performance analyses—to determine whether inclusion strategies are effective. Evaluation should not be punitive but serve as a tool for reflection and improvement. Systematic feedback from students, teachers and parents allows timely adaptation of strategies and strengthens their effectiveness (UNESCO, 2020).

In practice, inclusion requires a web of strategies combining pedagogical innovation, professional development, community collaboration, targeted support and a culture of democracy. As leaders of this process, principals are called upon to coordinate and inspire, ensuring that every student has equal opportunities to participate and thrive. Through systematic implementation and adaptation of these practices, the school community can become a place where diversity is a strength and education contributes meaningfully to sustainable development.

5. CHALLENGES IN IMPLEMENTING INCLUSIVE POLICIES

Promoting inclusion is a strategic objective of education policy and a foundational element of sustainable development. However, translating the principles of inclusive education into practical actions within schools faces a range of challenges. These are linked to institutional, social, cultural, economic and pedagogical factors that create barriers to policies aimed at equity, justice and the empowerment of all students.

One of the most significant challenges concerns the unequal distribution of resources. In many education systems, schools in disadvantaged areas have limited access to infrastructure, digital technologies and specialized staff (OECD, 2021; Eurydice, 2020). The COVID-19 pandemic highlighted this issue acutely, as students from low-income families had greater difficulty accessing remote learning due to lack of computers, internet access or suitable study spaces at home (UNESCO, 2020). Even when policies promote equity, differences in resource

allocation often reproduce inequalities. Thus, schools with the greatest needs are in a worse position to implement inclusive practices, intensifying the risk of social exclusion.

Implementing inclusion policies also often encounters resistance within the school community. Teachers—especially those who have worked for many years in traditional settings—may perceive changes as a threat to their professional identity or as an additional workload. Parents may also express concerns about the quality of their children's education when schools enroll students with diverse needs or cultural backgrounds. Such resistance often stems from limited information and understanding of inclusion and requires strategic action by principals to cultivate a culture of trust (Goleman, 2020).

Societal attitudes and prejudices constitute deeper obstacles to inclusion. In many societies, persons with disabilities or students of migrant origin continue to face suspicion or stigma. These attitudes often carry over into schools, hindering the creation of a climate of acceptance (Schuelka & Engsig, 2022). Overcoming prejudice requires not only education and training but systematic efforts to change culture. Introducing courses on intercultural understanding, showcasing success stories of students from diverse backgrounds, and ongoing collaboration with parents and the community can gradually dismantle stereotypes.

A particularly complex issue is the tension between inclusion and prevailing assessment systems. In many contexts, assessment focuses on standardized examinations and performance indicators, creating pressures toward uniformity and excluding students with different abilities or ways of learning (UNESCO, 2020). Principals face the challenge of balancing system demands with the need to adapt teaching to all learners. This calls for innovative forms of assessment that recognize diversity as an advantage rather than a problem.

Finally, the pandemic period revealed new dimensions of inclusion challenges. The digital divide, psychological strain on students and teachers and the need to adapt quickly to remote learning created additional difficulties (Netolicky, 2020). The most vulnerable groups bore a disproportionate burden, as lack of access to digital tools and limited support at home exacerbated educational inequalities. Crises are not limited to the pandemic; climate change, economic crises and migratory flows also create challenges affecting school functioning. Principals must develop resilience strategies to ensure continuity of learning under uncertainty. Despite widespread recognition of professional development's importance for inclusion, many systems still do not provide sufficient training opportunities. Programs are often fragmented, overly theoretical and poorly connected to daily practice, leaving teachers feeling unprepared for the challenges of differentiated instruction (OECD, 2021). The absence of mentoring and support for novice teachers compounds the problem. Principals who do not invest in a culture of continuous learning struggle to cultivate collective commitment to inclusion.

At the policy level, a lack of coherence and strategic planning is often evident. Inclusion policies are implemented piecemeal rather than embedded in a broader reform framework, leading to practices with limited long-term impact (UNESCO, 2020). Moreover, insufficient teacher participation in policy design heightens alienation and reduces the effectiveness of interventions.

In sum, implementing inclusive policies encounters multiple challenges related to resources, social attitudes, assessment regimes, crises and policy contradictions. As leaders of the school community, principals must address these barriers with strategy, sensitivity and vision. Recognizing challenges does not imply abandoning the goal but acknowledging the need for continual adaptation and innovation. Inclusion is not only an educational objective but a social commitment. Overcoming challenges requires collaboration at all levels—from education policy and school leadership to families and local communities—so that education can fulfill its role as a foundation of equity, social justice and sustainable development.

6. LINKING INCLUSION TO SUSTAINABILITY

Sustainability has been established as a global priority, particularly since the adoption of the UN's 2030 Agenda. Education—recognized as a fundamental driver of social change—is central to achieving the Sustainable Development Goals (SDGs). However, education's contribution to sustainability cannot materialize without the full integration of inclusion's principles. Inclusion is not simply a pedagogical choice or a social policy; it is a prerequisite for creating societies that are resilient, just, and capable of addressing the complex challenges of the 21st century.

Sustainable development cannot be achieved in societies characterized by inequalities and exclusions (United Nations, 2025). Inclusive education lowers social barriers, strengthens social cohesion and creates conditions for resilience in the face of crises. The COVID-19 pandemic showed clearly that the most marginalized groups suffered disproportionate consequences—educational, social and economic (Netolicky, 2020). Schools that had invested in inclusion, with support systems and networks of collaboration with parents and the community, responded more effectively to maintaining learning (Harris & Jones, 2020; Netolicky, 2020). The resilience generated by inclusion concerns not only emergency responses but also societies' long-term adaptability (OECD, 2021). Students who grow up in environments where diversity is considered a resource learn to collaborate, resolve conflicts and face challenges collectively—skills essential to sustainable societies.

It should be noted that sustainability is not only environmental; it is also a matter of social justice. SDG 10 focuses on reducing inequalities, recognizing that without social equity there can be no sustainable progress. Inclusive education directly contributes to reducing inequalities by ensuring that all children, regardless of background, have access to quality learning (UNESCO, 2020). The social justice fostered through inclusion extends beyond school. When students experience equality and respect in their daily schooling, they form values that endure into adulthood, becoming citizens with a heightened sense of social responsibility, willing to sustain institutions that promote justice and democracy.

The economic dimension of sustainability is closely tied to education. Research shows that lack of access to quality education leads to lower productivity, limited career opportunities, and the reproduction of poverty cycles (OECD, 2021). Conversely, education systems that embed inclusion cultivate human capital capable of contributing to innovation, development and fairer distribution of resources. Inclusive education mobilizes the talents of the entire population, not only the privileged. Societies that do not invest in inclusion squander vast human potential; those that do benefit from diversity, creativity and wider participation.

The environmental dimension of sustainability is also linked to inclusion. Education for Sustainable Development (ESD) emphasizes the need to cultivate skills and values that lead to responsible environmental choices. Inclusive education fosters these skills by teaching collaboration, empathy and solidarity—values critical to protecting the planet (UNESCO, 2020). Experiencing diversity within the school community helps students understand the interconnectedness of people and the environment. Students who learn to respect diversity are more likely to adopt responsible attitudes toward nature and to promote sustainability practices in daily life.

The school principal is central to unifying inclusion and sustainability. Through vision and strategy, principals can shape schools that function as microcosms of a just and sustainable society. Principals who embed sustainability in decision-making—from resource management to cultivating a democratic culture—reinforce the idea of education as a public

good. Their practices include promoting green initiatives, fostering environmental awareness through student projects and encouraging partnerships with local actors that advance sustainability. At the same time, cultivating a climate of acceptance and respect within the school provides the pedagogical groundwork for social and environmental responsibility.

Sustainability is directly connected to democratic participation. Inclusive education offers students experiences of democracy through participation in collective bodies, opportunities to voice their opinions and encouragement of collaboration. The participatory culture cultivated in school carries over into society, creating citizens ready to engage responsibly in decision-making and to respect diversity (Schuelka & Engsig, 2022). This relationship is central to sustainability, as societies characterized by active, equitable civic participation are more resilient and better able to address future challenges.

International experience shows that countries investing in inclusive policies have strengthened their progress toward sustainability. In Finland, embedding inclusion in the national curriculum aligns with a broader strategy for social equality and sustainability. In Canada, promoting intercultural education and recognizing Indigenous rights advances social justice. In Singapore, strong emphasis on teacher professional development and technology use promotes inclusion while preparing students for a knowledge-based, sustainable economy (OECD, 2021). By contrast, countries that have not invested in inclusion face deep social inequalities that obstruct long-term development goals.

The link between inclusion and sustainability is indisputable and multi-faceted. Inclusive education is not simply a tool for pedagogical improvement. It is a foundation for societies aspiring to be just, resilient, and environmentally responsible. By promoting social resilience, justice, economic development, environmental responsibility and democratic participation, inclusion operates as a core pillar of sustainable development. The principal's role is decisive for embedding this linkage at the school level: through vision, strategy and daily practice, schools can become communities that reflect the values of equity and sustainability.

7. CASE STUDIES AND GOOD PRACTICES

Debates on inclusion and sustainability often take on a theoretical character. Their real force emerges through concrete case studies and good practices implemented in schools and systems worldwide. These practices confirm that inclusion can be a driver of social justice, pedagogical innovation, and environmental responsibility. They also show how leadership, collaboration and systematic support can translate principles into daily reality.

Finland is among the most recognized examples of successfully integrating inclusion into its education system. In Finnish schools, differentiation and individualized support are not add-ons but structural features of the curriculum. Support teams—including psychologists, special educators and social workers—ensure no student is left behind. This strategy has proven highly effective in reducing inequalities and creating a school climate grounded in trust and collaboration. Finland's experience also highlights the principal's decisive role as coordinator of multi-layered support and as a cultivator of a culture of acceptance (OECD, 2021).

Canada, as a multicultural society, has invested heavily in intercultural education and recognition of Indigenous rights. Schools emphasize learning environments that acknowledge and respect diversity of language, religion, and cultural practices. Programs such as "Indigenous Ways of Knowing" have been incorporated into curricula so that students learn about the history and culture of Indigenous communities. Parent participation in learning is

also emphasized, strengthening the link between school and community. This has contributed not only to reducing inequalities but also to promoting social cohesion in a country marked by pronounced cultural diversity (UNESCO, 2020).

Singapore offers a different but equally important example, emphasizing technology use and teacher professional development. Schools invest in digital learning platforms that enable personalized instruction while implementing systems of continuous teacher training. This strategy has a dual benefit: it promotes inclusion through personalization and prepares students for a knowledge- and technology-based economy. The principal's role is to ensure that technology is used not merely as a teaching tool but as a means of enhancing participation for all students (OECD, 2021).

In Greece, inclusion has been promoted through policies concerning the integration of students with disabilities, migrants, and refugees into mainstream schools. Despite challenges related to limited resources and institutional inconsistencies, important initiatives point the way toward more inclusive education. Integration classes and parallel support services assist students with special educational needs. Programs in intercultural education have improved access for students of migrant origin. The principal's role remains crucial to the effectiveness of these policies by shaping a climate of acceptance and encouraging community cooperation.

The COVID-19 pandemic posed an unprecedented challenge yet also offered lessons on inclusion's importance. Schools that had developed mechanisms of collaboration with families and invested in differentiated teaching were better positioned to respond to remote learning (Harris & Jones, 2020). The crisis also underscored the need to strengthen digital equity, as students without access to technology were disadvantaged. This led to new policies and strategies, such as providing devices to low-income students and developing open-access learning platforms.

International organizations such as UNESCO, OECD, and UNICEF are pivotal in disseminating good practices and offering frameworks to advance inclusion. UNESCO (2020) stresses inclusive education as an integral part of a new social contract for education. OECD provides data and assessment tools enabling comparative study and contextual adaptation of policies. UNICEF supports programs focusing on vulnerable groups (e.g., refugee children) and provides material support in low-resource contexts.

Across the above cases, several common elements characterize successful inclusion strategies:

1. **Systemic support:** institutional mechanisms that ensure long-term policy implementation.
2. **Visionary leadership:** the principal as a central agent cultivating a culture of acceptance and participation.
3. **Community collaboration:** active engagement of parents and local actors in the learning process.
4. **Continuous professional development:** strengthening teachers' skills as a prerequisite for success.
5. **Technology and innovation:** leveraging digital tools to reduce exclusion and differentiate instruction.

Case studies and good practices confirm that inclusion is not a utopia but an achievable goal when accompanied by strategy, collaboration, and continuous evaluation. Experiences from Finland, Canada and Singapore show that inclusion can strengthen sustainability and create fairer, more resilient societies. For countries still working to implement inclusive policies, these examples offer useful lessons and encourage the adaptation of international

experience to local conditions. Ultimately, inclusion is an integral part of the vision for education that contributes meaningfully to sustainable development.

8. DISCUSSION - CONCLUSIONS AND PROSPECTS

A systematic exploration of the role of inclusion in education and its relationship to sustainable development underscores both its complexity and strategic significance. This article analyzed the theoretical foundations, the principal's role, practices and strategies for implementation, the challenges encountered in practice, the link to sustainability and good practices from diverse social and cultural contexts. This final section synthesizes the findings to extract conclusions and highlight future directions.

First, leadership is decisive in creating an inclusive climate. The principal operates not merely as a manager but as a carrier of values, a motivator and a strategic guide. The capacity to inspire, empower staff, cultivate trust and promote community partnerships is critical to the success of any initiative (OECD, 2021; Harris & Jones, 2020).

Second, inclusion is inseparable from social justice and equity. Inclusive education does not only support students with special needs or minority groups; it constitutes a broader strategy aimed at reducing social inequalities and creating schools that function as communities of justice. This renders inclusion not simply a pedagogical choice but a policy priority with societal impact (UNESCO, 2020).

Third, sustainability and inclusion are intrinsically linked. There can be no sustainable society without education that promotes equity, nor can education be considered inclusive if it ignores sustainability's challenges—environmental crises, social inequalities and economic imbalances (Schuelka & Engsig, 2022).

Despite international progress, significant challenges continue to hinder inclusive policy implementation. Unequal resources, social prejudices, resistance to change and standardized assessment systems reproduce inequalities and impede progress (UNESCO, 2020). The COVID-19 pandemic revealed the digital divide and socio-economic disparities, highlighting the need for greater investment in digital equity and psychosocial support (Netolicky, 2020). Policy contradictions also arise: while inclusion is often endorsed rhetorically, interventions are sometimes fragmented and not embedded in a coherent strategy, limiting effectiveness and undermining teacher commitment.

Case studies from Finland, Canada, and Singapore demonstrate that inclusion becomes reality when anchored in key pillars: systemic support, teacher professional development, participatory leadership, community collaboration and innovation. These examples cannot be replicated mechanically, but they provide valuable lessons adaptable to diverse contexts (OECD, 2021). A major lesson is the necessity of culture-building. Policies alone are insufficient; shifts in attitudes, values and daily practices are required. Schools investing in trust and acceptance achieve better outcomes in implementing inclusive practices.

International organizations—UNESCO, OECD—play a decisive role by providing policy frameworks, data and good practices, thereby strengthening systems' capacity to tailor strategies to local needs. Transnational school networks also foster exchange and innovation. International cooperation is particularly important for sustainability, since issues such as climate change, migration and social inequality transcend national boundaries. Education, as a global public good, requires inclusive, globally coordinated responses.

Looking ahead, the debate on inclusion and sustainability should focus on several key directions:

1. **Holistic approaches:** Policies must not treat inclusion as an isolated action but consider every dimension of the education system—from curriculum and teacher development to resource management and assessment.
2. **Investment in professional development:** Teachers are the primary agents of inclusion. Continuing education, mentoring and collaborative learning communities should be standard practice.
3. **Technology as catalyst:** Leverage digital tools for differentiated instruction, develop open-access platforms and ensure digital equity to reduce exclusion.
4. **School–community linkage:** Strengthen cooperation with parents, local agencies and organizations to support inclusion and foster social cohesion.
5. **Embedding inclusion in ESD:** Integrate environmental and social dimensions so students develop responsibility and solidarity—foundations of a just and sustainable society.

The discussion leads to a central conclusion: inclusion and sustainability are interdependent and cannot be addressed separately. Inclusion is the pathway to sustainability and sustainability provides the horizon that gives inclusion meaning. As leader of the school community, the principal must act as the catalyst for this connection, while policies must ensure coherence, continuity and adequate resources. International organizations and collaboration networks offer tools and guidance, but success depends on the commitment of local school communities.

Ultimately, inclusion is not only an educational matter, but a societal choice—the foundation upon which fairer, more resilient societies can be built, capable of meeting future challenges. Investing in inclusive education is therefore the most reliable investment in sustainable development, as it cultivates citizens with the values, skills and capacities to build a better world.

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TEACHER WELL-BEING AS A PILLAR OF EDUCATIONAL SUSTAINABILITY

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Abstract
This paper explores the central role of education in promoting sustainable development, emphasizing the importance of safeguarding teachers' well-being as a decisive factor in this process. Quality education is widely acknowledged as a cornerstone for achieving the United Nations' Sustainable Development Goals (SDGs), offering solutions to interconnected environmental, social, and economic challenges. Yet, the extent to which education systems can contribute effectively to these goals depends greatly on the condition and empowerment of the teaching workforce.

Teachers are the backbone of every education system, shaping both the content and the quality of learning experiences. Their well-being—encompassing professional satisfaction, access to continuous training, mental health support, and fair remuneration—is indispensable for strengthening their capacity to inspire and innovate in the classroom. Educators who feel valued and supported are more capable of implementing creative pedagogical practices, fostering meaningful student engagement, and preparing learners to address pressing global concerns such as climate change, poverty, and inequality.

The paper argues that enhancing teachers' well-being not only benefits the educators themselves but also generates wider societal advantages. A supportive school culture and positive working conditions create a multiplier effect that advances sustainability, equity, and social cohesion. Furthermore, it examines the role of governments, school leaders, and communities in designing and implementing policies that place teachers' well-being at the center, while remaining aligned with long-term sustainability strategies.

In conclusion, the study highlights that constructing a sustainable future requires a comprehensive approach that acknowledges teachers as critical agents of change. By coupling quality education with the protection and promotion of teachers' well-being, societies can establish a strong foundation for nurturing inclusive, equitable and sustainable communities, capable of responding effectively to the challenges of the twenty-first century.

Key words: Teachers' well-being, sustainable development, quality education, educational policy

1. INTRODUCTION

Education is a key prerequisite for sustainable development, as highlighted in the 2030 Agenda and the United Nations Sustainable Development Goals (SDGs). Goal 4 (Quality Education) is recognized as a catalyst for achieving all other goals, as it is linked to poverty eradication, gender equality, health, decent work, climate action and social peace (UNESCO, 2019). However, the success of education systems depends not only on the existence and content of policies but primarily on teachers themselves, who are the backbone of the

educational process. The quality of education is inextricably tied to the quality of teachers' working lives, their professional satisfaction and their psychosocial well-being (OECD, 2020).

Teachers' well-being is not merely a matter of working conditions or professional development; it is a multidimensional factor that influences their capacity to innovate, inspire, and respond to complex social challenges. Research shows that teachers who are supported, fairly compensated, have access to continuous professional learning and enjoy psychological safety are more effective in teaching and contribute to higher learning outcomes (Schleicher, 2018). Conversely, lack of support leads to professional burnout, higher attrition rates and ultimately a decline in the quality of education (ILO, UNESCO & UNICEF, 2021).

International discussions on education within the framework of sustainable development have often focused on the skills students should cultivate, such as critical thinking, environmental awareness and collaboration (UNESCO, 2020). Less attention, however, has been paid to the condition of those tasked with cultivating these skills—the teachers. As recognized by UNESCO's Global Education Monitoring Report (2020), sustainable education is impossible without the active participation and support of teaching staff. Teachers are considered agents of change who can shape citizens capable of responding to global crises such as climate change, the COVID-19 pandemic and socioeconomic inequalities (OECD, 2021).

The COVID-19 pandemic underscored the critical nature of the issue in the most dramatic way. Between 2020 and 2022, millions of teachers worldwide faced the sudden transition to remote learning, increased work pressures, and the need to support students amid uncertainty. This experience highlighted that teachers' resilience cannot be taken for granted and that safeguarding their well-being is a precondition for the resilience of educational systems themselves (ILO, UNESCO & UNICEF, 2021). At the same time, studies in countries such as Germany and Canada showed that supporting teachers' mental health and ensuring access to professional development significantly contributed to maintaining teaching quality (Collie, 2021; König et al., 2020).

At theoretical level, the discussion of teachers' well-being is connected to two key frameworks: the Job Demands–Resources (JD-R) model and Self-Determination Theory (SDT) (Bakker & Demerouti, 2018). Both posit that the balance between demands and resources is crucial for job satisfaction, professional growth and ultimately productivity and creativity (Ryan & Deci, 2020; Bakker & Demerouti, 2018). Emphasizing autonomy and competence—fundamental psychological needs of teachers—provides a fertile framework for understanding how their well-being relates to effective teaching and the promotion of sustainability (Ryan & Deci, 2020).

The well-being of teachers takes on particular significance in the context of sustainable development. An education that ignores teachers' needs cannot be truly sustainable, as it fails to create conditions for long-term quality and social cohesion. By contrast, when teachers feel respected, supported and involved, teaching becomes a space of creativity, innovation and social change (OECD, 2021). The OECD's Future of Education and Skills 2030 project emphasizes that empowering teachers is critical for developing educational systems capable of responding to uncertain and dynamic social environments (OECD, 2021).

Summarizing, the discussion on education and sustainability cannot ignore teachers' well-being. Teachers are not merely transmitters of knowledge; they are a prerequisite for social change. Safeguarding their well-being is not only a moral obligation but also a strategic necessity for building resilient and sustainable societies in the 21st century. The following article provides an in-depth analysis of the role of education in sustainable development, the

theoretical and practical dimensions of teachers' well-being, the policies that promote it and the societal impacts of an education that places teachers at its center.

2. EDUCATION AND SUSTAINABLE DEVELOPMENT

Recent debates on sustainable development have made it clear that education is not only a fundamental human right but also one of the most powerful mechanisms for social transformation. The United Nations' 2030 Agenda places Goal 4—quality education—at the center, recognizing that without ensuring equitable and inclusive access to education, the remaining SDGs become practically unattainable (UNESCO, 2019). Education shapes the values, knowledge and skills that enable citizens to understand and address the environmental, social and economic challenges of the 21st century.

According to UNESCO (2020), education for sustainable development aims to equip individuals to make informed decisions and take responsible actions for environmental protection, economic sustainability and social justice. In this context, education is not confined to the transmission of knowledge. It includes the development of values and attitudes related to responsibility, critical thinking, and collective action (UNESCO, 2020).

Research across various countries indicates that education systems investing in sustainability education positively influence the formation of citizens with environmental consciousness and social responsibility. For example, Finland's national curriculum incorporates sustainability-related goals and promotes interdisciplinary approaches, while in Singapore sustainable development is integrated into STEM education, encouraging students to seek innovative solutions to environmental problems (OECD, 2021).

The social dimension of education for sustainable development is equally important. Equitable access to education enhances social mobility, reduces inequalities and fosters conditions for social cohesion. As UNESCO (2020) notes, societies with strong and inclusive education systems are better equipped to respond to crises and to build peaceful and democratic communities.

Moreover, education is closely linked to economic development, as it prepares human capital with the knowledge and skills required by the labor market. According to the OECD (2020), investing in education increases productivity, fosters innovation and promotes social mobility. In economies undergoing constant change due to technological advances and the green transition, education plays a crucial role in preparing citizens to cope with new conditions (OECD, 2020).

Beyond vocational training, education for sustainability encourages the development of skills such as collaboration, innovation and complexity management—skills necessary for societies seeking balanced economic and social development. These skills are embedded in the "OECD Learning Compass 2030" which outlines the core competencies students need to shape a sustainable future (OECD, 2021).

The environmental dimension of education for sustainable development is decisive, as the climate crisis has emerged as the greatest threat to humanity (Rousell & Cutter-Mackenzie-Knowles, 2020). UNESCO (2021) stresses that climate education should become compulsory at all levels of education to shape citizens capable of acting against climate change. At the same time, embedding sustainable practices in school operations (e.g., energy efficiency, recycling, green infrastructure) provides students with hands-on examples of responsible behavior.

Studies show that students participating in environmental education programs develop higher levels of ecological awareness and are more inclined toward environmental action

(Rousell & Cutter-Mackenzie-Knowles, 2020). Education thus becomes a tool for prevention and adaptation to the climate crisis, contributing to the creation of environmentally responsible societies.

Education is also a powerful means of promoting social justice and equality. UNESCO (2020) emphasizes that inclusive education is critical for achieving all other SDGs, as it narrows gaps between social groups and strengthens social cohesion. In particular, girls' education has been shown to generate multiplier effects, improving indicators of health, income and civic participation (World Bank, 2018). In societies with pronounced inequalities, investment in education functions as a tool for overcoming exclusion and fostering democratic participation. Providing equal opportunities for learning empowers the most vulnerable groups, creating conditions for social and political inclusion.

Despite international recognition of the importance of education for sustainable development, challenges persist. Unequal resource distribution, underfunded public education systems, teacher shortages and social inequalities continue to hinder goal attainment (UNESCO, 2020). Furthermore, the COVID-19 pandemic exposed new forms of exclusion, as millions of students lacked access to digital learning tools, exacerbating existing disparities (OECD, 2021).

Nevertheless, the outlook is encouraging. Growing international commitment to the green transition, new technologies and strengthened international cooperation can create fresh opportunities for truly sustainable education systems. The key lies in empowering teachers, investing continuously in innovative pedagogies and devising policies that place education at the heart of strategies for sustainable development.

3. TEACHERS' WELL-BEING

In recent years, teachers' well-being has emerged as a central topic in international research and policy discourse. The attention it receives reflects a growing recognition that teachers are the most important determinant of educational quality and, by extension, of advancing sustainable development. Job satisfaction, psychological resilience, sense of purpose and opportunities for continuous professional growth constitute critical dimensions of well-being that shape teachers' capacity to meet the challenges of the 21st century (Collie, 2021).

Teachers' well-being is a multidimensional construct encompassing psychological, social, professional and material factors. The OECD (2020) defines professional well-being as the quality of teachers' working lives, reflected in job satisfaction, mental health, professional autonomy and sense of purpose. Research indicates that well-being is influenced by many factors, including working conditions (workload, preparation time), peer and school leadership support, pay and job security, opportunities for professional development and psychosocial support and recognition (OECD, 2020). This holistic understanding aligns closely with work psychology models emphasizing the relationship between demands and resources.

The JD-R model (Job Demands–Resources Model) has been widely applied in education to explain how demands and available resources shape teachers' well-being. Job demands include factors such as intensified teaching, classroom behavior management, assessment and administrative duties. When these demands exceed teachers' endurance without adequate resources, the likelihood of burnout increases. Conversely, resources—such as supportive leadership, decision-making autonomy and access to professional learning—enhance job satisfaction and professional commitment (Bakker & Demerouti, 2018).

Indicatively, research in schools in Canada and Australia showed that supportive climates and resources positively affect teachers' resilience and classroom innovation (Collie, 2021). The JD-R framework thus offers a practical tool for understanding how policy and school leadership can mitigate the negative effects of heightened demands and strengthen professional well-being.

Self-Determination Theory (Ryan & Deci, 2020) provides a complementary lens. It highlights three basic psychological needs: autonomy, competence and relatedness. When these needs are fulfilled, teachers develop intrinsic motivation, enhanced resilience and professional commitment. Recent studies show that teachers who experience high levels of classroom autonomy and feel that their contributions are recognized by the community report higher job satisfaction and fewer symptoms of anxiety (Ryan & Deci, 2020; Collie, 2021). Moreover, collaborative practices at the school level strengthen relatedness, promoting psychological well-being and professional engagement.

Conversely, the absence of fundamental resources and unmet psychological needs lead to serious consequences for teachers and the educational process overall. Studies confirm rising cases of burnout, particularly during the COVID-19 pandemic, when the pressure to rapidly adapt to digital teaching further burdened an already demanding role (König et al., 2020). By contrast, well-being bolsters occupational resilience, fosters creative pedagogical methods and nurtures positive learning environments. Evidence from Canada shows that schools implementing policies to support teachers' mental health achieved higher staff retention and better student learning outcomes (Collie, 2021).

These observations lead to the conclusion that teachers' well-being is not simply one issue among many; it is a precondition for the success of education for sustainable development. The JD-R and SDT frameworks demonstrate that when teachers' needs are met, conditions are created for high-quality teaching, creative learning and social transformation. When these needs are neglected, education risks becoming unsustainable, reproducing inequalities and social vulnerabilities. Future policy and research must therefore place teachers' well-being at the core of strategies for education. Only then can education systems achieve the SDGs and contribute to just, resilient and sustainable societies.

4. TEACHERS' WELL-BEING AS A DRIVER OF SUSTAINABLE EDUCATION

Education for sustainable development presupposes a workforce capable of meeting increasing challenges, innovating pedagogically and shaping citizens who demonstrate critical thinking, social responsibility and environmental consciousness. At the heart of this process are teachers. Their well-being, in all its dimensions, is not a workplace privilege or secondary condition but the cornerstone of sustainable education. The quality of educational practice, the long-term resilience of education systems and social cohesion depend directly on whether teachers are supported, recognized, and empowered (OECD, 2021).

The link between teachers' well-being and the quality of teaching is direct. Teachers who enjoy positive work experiences, a sense of autonomy and professional support are more inclined to incorporate innovative methods in the classroom. According to Collie (2021), teachers who experience psychological safety and feel supported by school leadership display higher levels of creativity and readiness to implement learning practices that strengthen critical thinking and collaboration.

On the contrary, a lack of well-being leads to conservative teaching practices. Teachers who feel exhausted or unrecognized tend to adopt traditional methods, limiting students' developmental potential. Sustainable education—which requires active student participation,

interdisciplinary connections and critical understanding of complex issues—is difficult to advance when teachers are in a state of psychological and professional fatigue (König et al., 2020).

Student outcomes are likewise decisively influenced by teachers' well-being. The OECD's Teachers' Professional Learning and Well-being report (OECD, 2020) finds that students taught by satisfied and psychologically healthy teachers achieve better results, show higher levels of engagement and are more willing to participate in sustainability-related activities. Conversely, low teacher well-being weakens teacher–student relationships, undermining trust and student motivation.

Studies in diverse contexts corroborate this link. In Australia, teachers with access to mental health supports and collaborative teaching structures reported lower stress levels and their students demonstrated improved academic performance. Similarly, in Canada, research showed that teachers' professional well-being is associated with a positive learning climate and reduced dropout rates (Collie, 2021).

Teachers' well-being also functions as a lever for enhancing equity in education. In schools where necessary resources and appropriate support are provided, teachers can offer individualized assistance to students from disadvantaged backgrounds. UNESCO's Global Education Monitoring Report (2020) underscores that educational equity cannot be achieved without simultaneously strengthening teachers, who are on the front line of efforts to combat social inequalities.

The experience of minority-area schools in the United States is illustrative. Teachers in such environments often face higher demands with limited resources, which strain their psychological state and drives higher staff turnover—thereby deepening disparities between affluent and poor areas. When policies are implemented to bolster teacher well-being (e.g., mentoring, coaching, and improved pay), teaching quality rises and students gain better opportunities (OECD, 2021).

Teachers are widely regarded as agents of change, capable of influencing entire societies. Their well-being is a prerequisite for fulfilling this role. As UNESCO (2021) emphasizes, teachers who have a voice in decision-making, see their work recognized and possess the tools for continuous learning are better able to cultivate in students attitudes of responsibility and critical civic engagement. The transition to a sustainability-centered society requires teachers' active participation as carriers of values. Through their well-being, they model for students that a just and equitable society begins with everyday school experience.

The relationship between teachers' well-being and sustainable education is evident in concrete examples. In Finland, the education system has consistently invested in teachers' professional development and well-being, resulting in high levels of satisfaction and long-term retention (Sahlberg, 2021). This has led to consistently strong student performance and the consolidation of a system widely regarded as a model of sustainable education. By contrast, in countries where teachers work in precarious conditions, with low pay and little support, signs of systemic breakdown appear. Nigeria is a case in point, where resource shortages and low teachers' well-being lead to poor education quality and high dropout rates (UNESCO, 2020). Such comparisons show that sustainable education cannot be conceived apart from teachers' well-being.

Regarding the resilience of teachers and education systems, the COVID-19 pandemic demonstrated that it depends on the resilience of teachers themselves (Collie, 2021). Where policies strengthened teachers' well-being—through digital tools, psychological support, and professional learning—the transition to remote teaching was smoother. Where teachers' well-

being was overlooked, the consequences were serious for both teachers and students (König et al., 2020).

Resilience is therefore not an abstract notion but a practical dimension of sustainable education grounded in teachers' well-being. Only when teachers feel safe, supported and empowered can they cultivate in students the resilience and adaptability skills essential for the 21st century. Teachers' well-being acts as a catalyst for every dimension of sustainable education, improving teaching quality, bolstering equity, fostering social cohesion and reinforcing the resilience of education systems. Policies aimed at achieving the SDGs must explicitly recognize that without happy, supported and empowered teachers, sustainable education remains an empty promise.

5. POLICIES AND STRATEGIES TO PROMOTE TEACHERS' WELL-BEING

Promoting teachers' well-being cannot be treated as an individual responsibility or confined to isolated school-level practices. It is a matter of broader education policy, strategic planning, and institutional support. Teachers are the cornerstone of education systems; thus, protecting and enhancing their well-being must be placed at the center of the sustainable development agenda.

Governments bear primary responsibility for designing and implementing policies that directly affect teachers' working lives. One key dimension is adequate education funding. Underfunding leads to excessive workload, staff shortages and deteriorating working conditions, which in turn undermine professional and psychological well-being (UNESCO, 2020). Policies ensuring stable investments in education—with priority given to salaries, recruitment and teacher training—are a prerequisite for sustainable and resilient education systems.

Setting fair and competitive salaries is equally crucial. In many countries, teachers' pay remains lower than that of professions requiring similar education levels, leading to low professional status and difficulties in attracting new entrants (OECD, 2020). Recent policies in countries such as Estonia and Portugal demonstrate that targeted salary increases, combined with improved working conditions, have enhanced the attractiveness of the profession and raised teachers' job satisfaction (OECD, 2021).

Ensuring access to continuous professional development is also essential. UNESCO (2021) and the OECD (2020) stress that professional learning should not be viewed as an obligation but as a right that empowers teachers. Policies incorporating mentoring for novice teachers, opportunities for international exchanges and access to innovative teaching methods are associated with higher levels of job satisfaction and psychological resilience.

Governments should also build institutional frameworks that recognize mental health as a priority. During the COVID-19 period, several systems introduced psychological support programs for teachers, but these often proved fragmented (König et al., 2020). A coherent policy should include counseling services, stress-management programs and structures to prevent burnout.

The everyday experience of teachers is largely shaped by school leadership. According to Collie (2021), principals who adopt participatory and supportive leadership models enhance teachers' well-being by promoting instructional autonomy, fostering collaborative teacher teams, recognizing and rewarding good practice and cultivating a culture of trust and mutual respect. Leadership that is controlling and evaluation-heavy reduces job satisfaction and increases stress (Ryan & Deci, 2020). By contrast, transformational leadership is linked to

higher levels of work engagement and psychological resilience, as it creates a sense of purpose and strengthens teachers' professional identities (Collie, 2021).

Developing school-level support mechanisms is also critical. The presence of school counselors, peer-mentoring programs and regular experience-sharing sessions reduces feelings of isolation and strengthens staff resilience. Experience from Canada and Australia shows that schools with robust internal support structures adapted better during remote learning (Collie, 2021).

Local communities play an important role in promoting teachers' well-being. Communities and parents can decisively contribute to creating a supportive environment. First, communities can actively participate in improving schools' material infrastructure. In many low-income areas, the lack of basic infrastructure burdens teachers and limits teaching possibilities. Collaboration with local authorities and organizations to upgrade school facilities eases pressure on teachers and creates a positive learning climate (UNESCO, 2021).

Enhancing social recognition of teachers' work is another key factor. Public awareness campaigns, local initiatives and parent partnerships can elevate the profession's status and foster a culture of respect (Schleicher, 2018). Social recognition is directly linked to psychological well-being, as it reduces feelings of devaluation and strengthens professional pride. Civil society organizations can also offer complementary support in areas such as mental health, professional development and equity promotion. In several countries, NGOs provide free counseling services to teachers or implement international good-practice exchange programs (ILO, UNESCO & UNICEF, 2021).

The importance of teachers' well-being has been recognized internationally. Organizations such as UNESCO, the OECD, and the ILO have issued guidelines proposing specific policies and practices. UNESCO (2021) underscores that investing in teachers should be a central pillar of any sustainability strategy, recommending action along four axes: (a) improving working conditions; (b) access to quality professional learning; (c) strengthening mental health; and (d) promoting social recognition.

The OECD (2020, 2021) focuses on cultivating a culture of continuous learning, developing collaboration mechanisms and building leadership capacity. TALIS 2018 data indicate that systems with higher teacher well-being invest systematically in ongoing professional development and promote participatory forms of school leadership (OECD, 2020). In 2021 the ILO, in collaboration with UNESCO and UNICEF, issued guidance on supporting teachers as schools resumed after the pandemic. The document emphasized the need for institutional policies to manage burnout and build resilience mechanisms (ILO, UNESCO & UNICEF, 2021).

Despite such international guidance, implementing policies for teacher well-being faces significant challenges. In many countries, fiscal constraints and political instability result in limited education investments. Even in developed contexts, policies often remain fragmented and are not embedded in a comprehensive sustainability framework. Additionally, societal perceptions of the teaching profession affect the willingness to implement such policies. Where teachers are of low status, achieving social recognition and policy support is harder. Finally, the lack of teacher participation in policymaking is a serious barrier. Without active involvement, policies risk remaining theoretical and ineffective.

To overcome these challenges, the following strategies are proposed:

1. **Institutionalize national strategies** for teachers' well-being linked to the SDGs.
2. **Increase education funding** with specific commitments for salaries, professional learning, and mental health.

3. **Establish participatory mechanisms** enabling teachers to contribute actively to decision-making.
4. **Develop international collaborations** to exchange good practices and adopt innovative support models.
5. **Embed teacher well-being in national sustainability strategies,** recognizing it as a central precondition for social progress rather than a peripheral issue.

Promoting teachers' well-being is fundamental to the success of education and sustainable development. Governments, school leaders and local communities have decisive roles in shaping policies that ensure fair working conditions, provide psychological support, continuous professional development and social recognition. Despite challenges, international guidelines and good practices point the way toward education that places teachers at the center of reform. Strengthening teachers' well-being is not only a matter of justice but also a strategic investment for societies seeking resilience, equity and sustainability.

2. BROADER SOCIAL IMPACTS

Teachers' well-being influences not only teaching quality or the functioning of education systems; it directly affects social cohesion, equality and global progress. Recognizing and promoting the well-being of teachers creates a web of positive effects that extend beyond the classroom and shape fairer, more resilient and more sustainable societies.

Social cohesion is strengthened when teachers enjoy stable and dignified working conditions. According to the OECD (2020), teachers' job satisfaction is associated with their ability to build positive relationships with students and families, reinforcing trust in schools. When teachers feel safe, respected and empowered, the school functions as a nucleus of social cohesion and unity.

By contrast, low well-being leads to higher turnover, reduced teaching quality and, often, social tensions. In highly unequal communities, teachers frequently serve as the only stable link between students and institutions. The loss of this role has consequences that affect the very fabric of society (UNESCO, 2020).

Enhancing teachers' well-being directly contributes to reducing social and educational inequalities. In disadvantaged schools, teachers often face greater challenges—limited resources, higher student needs and social pressures. Without support, students in these areas are further excluded from learning opportunities (ILO, UNESCO & UNICEF, 2021). Conversely, policies promoting well-being—such as additional support, higher allowances and access to specialized mental health services—have proven particularly effective. Examples from Canada and Australia show that improving teachers' working conditions in vulnerable communities leads to higher school participation and better student performance (Collie, 2021).

Teachers' well-being is directly linked to social justice. Fair pay, recognition and psychological support are not privileges but basic human rights. UNESCO (2021) stresses that investing in teachers is an investment in justice and democracy, empowering both educators and their students to become active citizens. Promoting teachers' well-being operates as a tool for combating social exclusion. When teachers are encouraged to implement equity-based pedagogies, they can create learning environments where all students feel accepted. This is especially important for minorities, students with disabilities or refugee children who might otherwise be marginalized (OECD, 2021).

Teachers' well-being also has significant economic implications. According to the OECD (2020), systems that ensure professional satisfaction and support for teachers

experience lower attrition, reducing the costs of recruiting and training new staff. Strengthening teachers' mental health also reduces sick leave and increases productivity. In the long term, investing in teachers' well-being contributes to stronger economies: students benefiting from high-quality teaching develop skills that make them more competitive in the labor market, leading to increased innovation and sustainable growth (World Bank, 2018).

Regarding teachers' mental health and social resilience, a strong connection is evident. During COVID-19, teachers with access to mental health programs were better able to meet the demands of remote teaching and support students experiencing heightened anxiety (König et al., 2020). The resilience of schools—and, by extension, communities—depends on teachers' psychological strength and adaptability. Embedding burnout-prevention policies helps create societies better prepared for crises. As emphasized by the ILO, UNESCO, and UNICEF (2021), protecting teachers' mental health is not only a matter of workplace policy but also a critical factor in social security.

Cultural perceptions of the profession likewise affect well-being. In societies where teachers' work is recognized and respected, psychological well-being is higher and trust in institutions stronger (Schleicher, 2018). Scandinavia provides a notable example, where the profession's high status is associated with social cohesion and institutional trust (Sahlberg, 2021). Conversely, where teachers are undervalued, lack of recognition leads to feelings of devaluation and diminished willingness to innovate. Recognition is therefore not merely symbolic but a practical mechanism for strengthening social cohesion.

Over time, investing in teachers' well-being helps build societies that are fairer, more equal and more adaptable. Empowered teachers instill in students values of cooperation, responsibility, solidarity and environmental agency (Rousell & Cutter-Mackenzie-Knowles, 2019). In this way, future generations acquire the tools to collectively face global crises such as climate change, pandemics or economic shocks (OECD, 2021). The interaction between teachers' well-being and sustainable development is cyclical: societies that invest in teachers enjoy higher levels of social cohesion and resilience, which in turn reinforce sustainable progress.

We contend that promoting teachers' well-being is not merely an education policy concern but a strategy of social significance. Empowering teachers creates societies with greater cohesion, fewer inequalities, stronger economic dynamism and enhanced crisis resilience. Social justice, recognition and support for teachers are prerequisites for shaping a future in which education is not only a means of learning but also a driver of social progress. Investing in teachers' well-being is therefore an investment in the sustainability of societies themselves.

3. DISCUSSION – CONCLUSION AND PROSPECTS

The analysis above clearly shows that teachers' well-being is not a secondary aspect of education systems; it lies at the core of educational quality and, by extension, sustainable development. Strengthening teachers as professionals—and as individuals with psychological and social needs—creates the conditions for a transition toward fairer, more equitable and more resilient societies. This section synthesizes the findings, highlights key conclusions and outlines prospects for future research and policy.

First, teachers' well-being is directly linked to the quality of teaching and student outcomes. Recent studies show that teachers who enjoy high job satisfaction and supportive work environments implement more creative and effective pedagogies that foster students' critical thinking, collaboration and social responsibility (Collie, 2021). Conversely, lack of

support leads to burnout, reduced commitment and ultimately lower levels of learning (König et al., 2020).

Second, teachers' well-being has a strong social dimension. Strengthening teachers in disadvantaged areas helps reduce inequalities and promotes social justice. When teachers have the means to provide quality education, even the most vulnerable groups gain access to learning opportunities and social inclusion (ILO, UNESCO & UNICEF, 2021). This demonstrates that policy for teacher well-being is not merely professional support but a strategic intervention with social impact.

Third, teachers' well-being relates to the resilience of education systems in times of crisis. The COVID-19 pandemic showed that systems investing in mechanisms supporting teachers' mental health and professional learning adapted better to new conditions, while others faced serious dysfunctions (OECD, 2021). This confirms that sustainable education cannot exist without sustainable professional lives for teachers.

Despite international recognition of the importance of teachers' well-being, many policies remain fragmented and short-term. In some countries, interventions focus solely on financial incentives—such as salary increases—while overlooking the need for psychological support, professional recognition, and a supportive culture (UNESCO, 2020). Although pay matters, research shows that job satisfaction is equally influenced by autonomy, collaboration, and sense of purpose (Ryan & Deci, 2020).

Policymaking also often neglects the participation of teachers themselves. Decisions are taken at government level without substantive consultation with those directly involved, resulting in policies that do not meet the profession's real needs (OECD, 2020). A more participatory approach with teachers playing an active role in shaping strategies is essential for sustainable reforms.

Accordingly, the research community should delve deeper into specific aspects of the relationship between teacher well-being and sustainable development. Longitudinal studies are needed to track professional well-being over time and its effects on learning outcomes and social cohesion. Differences across cultural contexts also require investigation, as well-being is not a neutral concept but shaped by social and cultural factors (Sahlberg, 2021).

Another research area concerns the interplay between digital transformation and well-being. Remote teaching and new technologies create new demands but also new opportunities for teachers. Understanding how these changes affect teachers' psychological and professional states is critical for designing appropriate policies (König et al., 2020). Finally, more studies should examine the links between teachers' well-being and sustainable development at the macro-policy level, such as climate education, gender equality, and the promotion of democratic participation.

For policy at international and national levels, the following directions emerge:

1. **Holistic approach:** Address all dimensions of teachers' well-being—economic, psychological, social, and professional.
2. **Integration into sustainability strategies:** National SDG strategies should include teachers' well-being as a key precondition for achieving Goal 4 (Quality Education).
3. **Participatory policymaking:** Teachers must have an active role in shaping policies and strategies.
4. **Investment in professional development and mental health:** Continuous professional learning and mental health services should be treated as rights, not luxuries.
5. **Enhancing social recognition:** Changing societal perceptions of the teaching profession is as important as institutional reforms.

In conclusion, teachers' well-being cannot be treated as a peripheral issue. It is central to educational quality, the reduction of inequalities, social cohesion and the resilience of societies. The 2030 Agenda for Sustainable Development cannot be achieved without the active support and empowerment of teachers. Investing in teachers creates a multiplier: it improves education, strengthens social justice and advances sustainability at all levels. In a world facing complex and interlinked challenges, teachers are the quintessential agents of change. Protecting and promoting their well-being is therefore not only a moral obligation but a strategic choice for a fairer, more resilient and sustainable future.

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EDUCATION POLICY FOR SUSTAINABLE TRANSITION: STRATEGIES AT LOCAL AND REGIONAL LEVEL

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Abstract
Education policy is widely recognized as a cornerstone of sustainable transition, since it sets the conditions under which education systems, infrastructures, and learning practices evolve. The purpose of this paper is to examine the contribution of education policy to sustainable urban and regional development, focusing on strategies that are implemented at local and regional levels of governance. The paper emphasizes the added value of aligning education policy with international sustainability agendas and demonstrates its potential to promote social inclusion, skills development, and community resilience. The study is grounded in a literature review, allowing for a synthesis of knowledge from international and European frameworks, highlighting policy orientations and identifying the challenges that arise in practice. Building on this, the paper aims to provide a comprehensive understanding of how education policy functions as a lever for sustainable transition. The literature review indicate that education policy supports sustainable transition in three main ways: by integrating sustainability-oriented curricula across different levels of education, by promoting the development of green and digital skills required for future economies, and by supporting inclusive measures that reduce social inequalities and address the digital divide. At the same time, the literature highlights persistent challenges, such as fragmented governance structures, unequal allocation of resources, and limited inter-sectoral cooperation, that continue to hinder the effective implementation of such policies. The overall contribution of the paper is to argue that the design and implementation of coherent, multi-level, and evidence-based education policy strategies are essential for achieving resilient and sustainable cities and regions in the 21st century.

Key words: education policy, sustainable development, sustainable transition, local & regional level, strategies, green and digital skills, sustainability-oriented curricula

1. PRELIMINARY REMARKS

The growing complexity of global challenges and mega-trends, such as climate change, rapid digital transformation, digital economy, demographic shifts, Covid-19 pandemic as well as deepening socioeconomic and education inequalities has placed increasing pressure on education systems to adapt and respond in meaningful ways (Papadakis & Drakaki, 2025). Within this framework education policy is widely recognized as a crucial tool for shaping sustainable future, as it defines how education systems, infrastructures and learning practices develop and evolve. Nowadays, education and subsequently education policy are no longer viewed as a process of knowledge transmission, but as a transformative force that can strengthen social cohesion and community resilience and equipping individuals with the competencies needed to deal with labour market transitions and ongoing social change (UNESCO, 2021; OECD, 2025a). As UNESCO (2021) has pointed out: *"Forging a new social contract for education is all the more urgent given emerging societal transformations underway and radical disruptions on the horizon. It must address the existing web of inequalities that perpetuate educational and social exclusions, while helping to shape environmentally sustainable, and socially just and inclusive shared futures."* (p.27).

Sustainable transition, conceived as the shift of societies toward more environmentally responsible, socially fair, and economically balanced societies, requires coordinated efforts and actions across different sectors and levels of government (UN/Committee for Development Policy, 2023). Within this context, education policy has a vital role to play in responding to the needs and demands of the transition, while also shaping the conditions that make it possible. By guiding curriculum changes, resource allocations, governance mechanisms, and strategic priorities, education policy can steer cities and regions toward more resilient and sustainable development trajectories (UNESCO, 2017; OECD, 2018a).

Towards this perspective, international sustainability agendas highlight the importance of education as a foundation for societal transformation, building a more sustainable future. Specifically, the UN 2030 Agenda emphasizes education as a key driver for sustainable development through Sustainable Development Goal 4 (UN, 2015). The OECD's Future of Education and Skills 2030 Project further highlights the importance of fostering learner agency, adaptability and resilience within education systems (see in detail OECD, 2026).

Similarly, the European Green Deal and the Digital Education Action Plan call for developing green and digital skills to support Europe's transition to a climate-neutral and innovation-driven economy,highlighting inclusive policies that reduce inequalities and learning environments which prepare citizens for active participation in societal transformation (European Commission, 2019; European Commission, 2020a). Within this framework, local and regional authorities and bodies have a decisive role in transforming these international priorities into concrete, context-specific actions. Through curriculum initiatives, targeted investments and inclusive strategies, they can directly influence how education policy contributes to sustainable urban and regional development (Burns, Köster & Fuster, 2016; European Commission/DG REGIO, 2024).

The purpose of this paper is to examine how education policy supports sustainable transition, with particular emphasis on strategies implemented at local and regional governance levels towards sustainable transition.

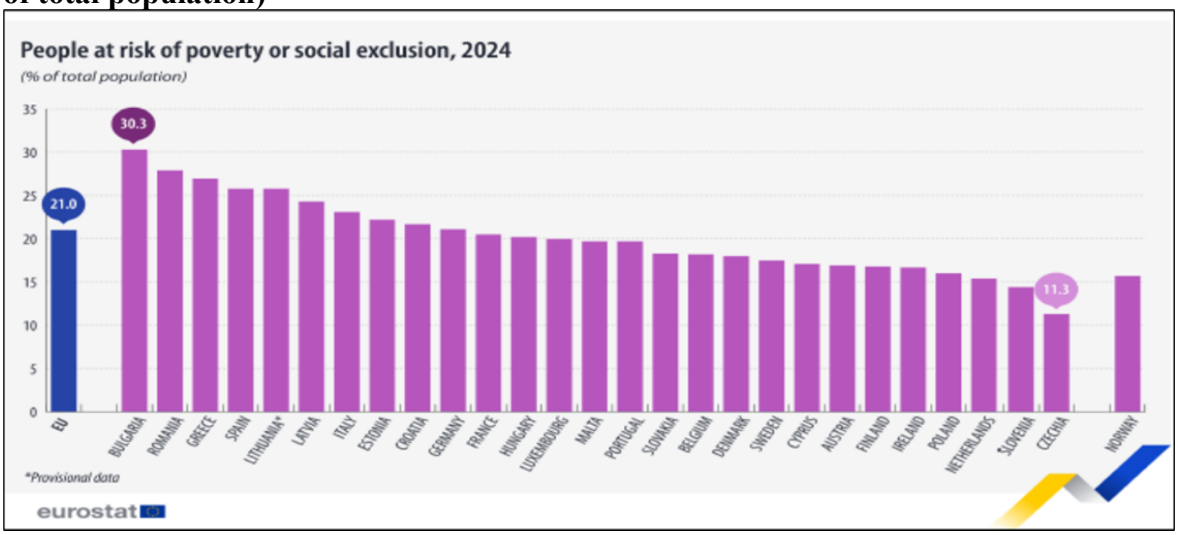
2. THE EU STRATEGY FOR SUSTAINABLE DEVELOPMENT AND THE ROLE OF EDUCATION IN SUSTAINABILITY

The global economic and fiscal crisis, the COVID-19 pandemic and the continuing energy crisis highlight the essential role of the welfare state in protecting citizens from the multiple social risks that are being reproduced, intensified or transformed (Papadakis & Tzagkarakis, 2025). Based on international standards, the majority of people in the European Union benefit from a relatively high standard of living. This is due both to the comparatively high levels of income and wealth within the EU (at least for some households) and to the well-developed social protection systems that offer support to a significant portion of the population with lower incomes. (Eurostat, 2025a).

However, broader societal developments, such as the impact of globalisation combined with successive crises, such as the economic and fiscal recession, the COVID-19 pandemic (health crisis), Russia's war against Ukraine, and the cost-of-living crisis, also constitute major factors that worsen living conditions (see in detail Eurostat, 2025c; Papadakis et al., 2024; Papadakis & Tzagkarakis, 2025; Papadakis & Drakaki, 2025; Drakaki, 2023).

According to Eurostat, in 2024, 21% of the total EU population, equivalent to 93.3 million people, was at risk of poverty or social exclusion, with women being more likely than men to face such risks (women: 21.9%, men: 20%) (Eurostat, 2025b) (see also Figure 1).

Figure 1: Percentage of the EU population at risk of poverty or social exclusion, 2024 (% of total population)



Source: Eurostat (ilc_pees01n) as cited in Eurostat, 2025b: 1.

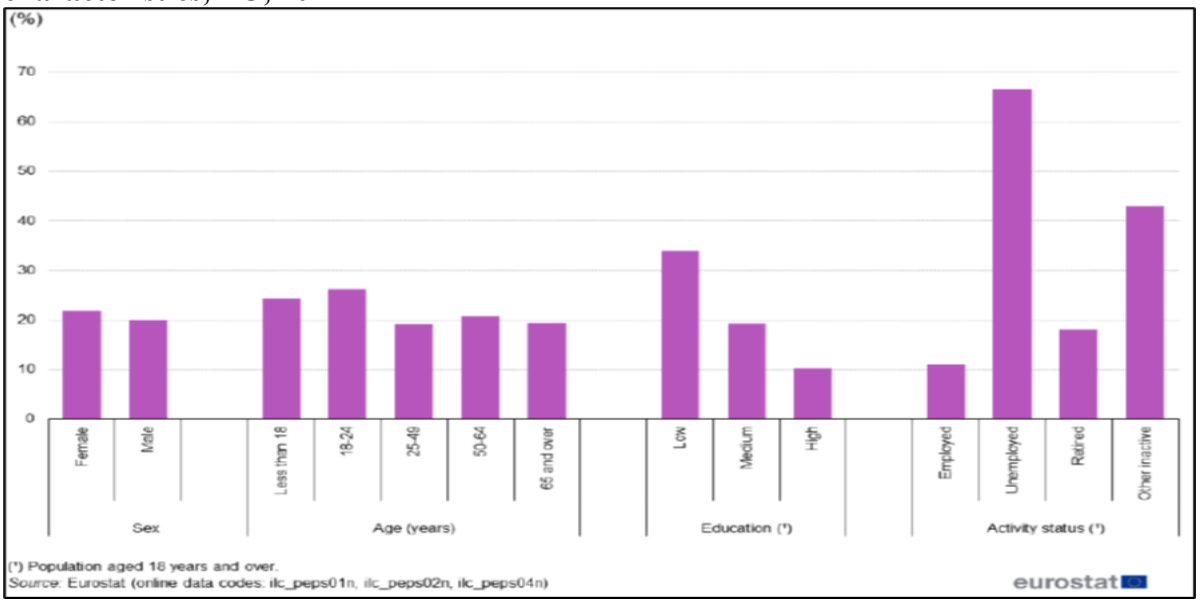
In 2024, at the EU level, employment status appeared to significantly influence the risk of poverty or social exclusion. Specifically, 10.9% of employed people and 66.6% of unemployed individuals were at risk. Additionally, 21.9% of the EU population, meaning more than one-fifth of EU citizens, living in households with dependent children was at risk of poverty or social exclusion in 2024 (Eurostat, 2025b).

Socio-demographic characteristics such as age, educational level, gender, and country of birth/nationality can influence an individual's living conditions (Eurostat, 2025a: 85). Specifically, in 2024 (Eurostat, 2025b: 4) (Figure 2):

- ✓ The risk of poverty or social exclusion in the EU was higher for women (21.9%) than for men (20.0%).

- ✓ Young adults aged 18-24 faced the greatest risk (26.2%), followed by children under 18 (24.2%). Adults aged 25-49 had the lowest risk (19.2%), with rates of 20.8% for those aged 50-64 and 19.4% for people aged 65 and over.
- ✓ Educational attainment played a major role: 33.9% of adults with low education (ISCED 0-2) were at risk, compared with 19.3% of those with medium education (ISCED 3-4) and only 10.2% of those with tertiary education (ISCED 5-8).
- ✓ Employment status was also decisive: In 2024, 66.6% of unemployed people aged 18+ were at risk, while 43% of inactive individuals (excluding retirees) faced similar vulnerability. By contrast, 18.1% of retirees and 10.9% of employed people were at risk of poverty or social exclusion.

Figure 2: People at risk of poverty or social exclusion, analysed by socio-economic characteristics, EU, 2024



Source: Eurostat (online data codes: ilc_peps01n, ilc_peps02n, ilc_peps04n, as cited in Eurostat, 2025b: 4.

Within this context, education constitutes a major parameter for people's personal development, strengthening of their employability and active participation in society as well as their social inclusion (European Commission, 2020b). While OECD (2018) highlights that: *"Education has a vital role to play in developing the knowledge, skills, attitudes and values that enable people to contribute to and benefit from an inclusive and sustainable future. Learning to form clear and purposeful goals, work with others with different perspectives, find untapped opportunities and identify multiple solutions to big problems will be essential in the coming years. Education needs to aim to do more than prepare young people for the world of work; it needs to equip students with the skills they need to become active, responsible and engaged citizens."* (OECD, 2018a: 4).

At the European level, the right to quality, inclusive education, training, and lifelong learning is included in the European Pillar of Social Rights as its first and fundamental principle, while also contributing to the support of the social market economy and democracy by promoting freedom, diversity, human rights, and social justice (European Commission, 2020b).

Furthermore, since sustainable development is: i) a core principle of the Treaty on European Union and ii) a major priority for the EU's internal and external policies (European

Commission, 2025c.), the European Union redefined its development strategy in 2020 on the basis of sustainability, with the green and digital transitions forming its main axes of transformation (European Commission, 2020b).

The overarching aim is to fully align the EU strategy with the 17 UN SDGs and, consequently, to ensure the complete implementation of the UN 2030 Agenda. The E.C. President's political guidelines and the European Commission's annual work programmes constitute the Commission's strategy to implement the SDGs (see in detail European Commission, 2025c) (Figure 3).

Figure 3: The European Commission's holistic governance approach towards the SDGs implementation

Source: European Commission, 2025c.: https://commission.europa.eu/strategy-and-policy/sustainable-development-goals/eu-approach-sdgs-implementation_en?prefLang=en

Education policy at the national, regional, and local governance levels increasingly aligns with international and European sustainability initiatives. Specifically, the UNESCO ESD[42] for 2030 agenda calls for concrete actions and changes in curricula, school governance (leadership), teachers' training and learning environments, encouraging countries to integrate sustainability across all education levels (UNESCO, 2020). Furthermore, the OECD's Future of Education and Skills 2030 framework supports this perspective by highlighting the importance of developing adaptable and resilient learners who can act autonomously and manage uncertainty effectively (OECD, 2018a).

At the European level, the Digital Education Action Plan 2021-2027 identifies digital transformation as a prerequisite for inclusive and sustainable education systems, especially, in reducing the digital divide and enhancing people's digital competences (European Commission, 2020a; European Commission, 2025a). In addition, the European Green Deal initiative emphasizes the need for reskilling and upskilling to support the green economy, placing education policy as a central pillar of Europe's transition towards sustainability (European Commission, 2019; European Commission, 2025b).

Taking into account the above mentioned, local and regional authorities and bodies play and important role in transforming and reshaping these international and European agendas and mega-projects into actionable and manageable policies. Moreover, effective and well-functioning governance processes are essential for ensuring better coordination among the

[42]ESD: Education for Sustainable Development

various levels of educational authorities (central, regional, and local), as well as among schools, teachers (via professional bodies and unions), and parents (through both formal and informal channels, such as parent associations), all of whom shape education policy and service provision (OECD, 2025b). However, disparities in resources, institutional capacity, and governance structures often result in uneven implementation of policies (European Commission/DG REGIO, 2024).

3. EDUCATION POLICY FOR SUSTAINABLE TRANSITION AT LOCAL AND REGIONAL GOVERNANCE LEVELS

The role of education is of vital importance for social inclusion and subsequently for social sustainability. However, in the EU severe and multi-parametric socio-economic inequalities affect education, where the inter-generational transition of educational achievement (or even poverty) is evident all across Europe and affects people's and, mainly, young people's life chances (Papadakis 2022; Papadakis et al 2024; Papadakis & Drakaki, 2025).

Governance in the field of education policy constitutes an issue of major importance and, at the same time, considerable complexity. This is due, on the one hand, to the close interconnection between education policy and two other major public policies, namely employment policy and macroeconomic policy, at the international, supranational, and national levels, and, on the other hand, to the continuously evolving socio-economic, political, and cultural context from the late 20th to the early 21st century. Within this framework, education policy is formulated, designed, implemented, monitored, and evaluated, while prevailing conditions and labour market needs consistently influence and reshape these processes over time (Drakaki, 2018).

Moreover, contemporary education systems have become more complex due to the presence of multiple governance levels and an expanding range of stakeholders (Burns, Köster & Fuster, 2016). In this context, *"multilevel governance can be defined as an arrangement for making binding decisions that engages a multiplicity of politically independent but otherwise interdependent actors -private and public- at different levels of territorial aggregation in more-or-less continuous negotiation/deliberation/ implementation, and that does not assign exclusive policy compétence or assert a stable hierarchy of political authority to any of these levels."* (Schmitter, 2004: 49).

Based on the above mentioned, over the years, several countries have gradually tried to decentralise their education policy, and consequently their education systems towards the autonomy of regional and local authorities and bodies in the fields of resource allocation, teacher professional development/skills development etc., aiming at enhancing efficiency and innovation and addressing social and educational inequalities (Waslander, Pater & van der Weide, 2010; OECD, 2016).

Specifically, in education governance, the central authority is responsible for ensuring high-quality, efficient, and equitable education. However, decentralised decision-making, which introduced to strengthen local steering, requires that all parts of the system work towards shared and common goals (Hooge, Burns & Wilkoszewski, 2012; OECD, 2016). At the same time, the involvement of different stakeholders as well as the management of system complexity, seems to make it difficult to maintain a coherent focus to the whole system, towards sustainable transition. Also, the mismatch between the priorities of local and regional actors and central regulations may create misunderstandings and tensions in accountability and governance processes in the field of education (Hooge et al., 2012).

Based on the above mentioned, education policy plays a crucial role in enabling sustainable transition at local and regional governance levels in the framework of examining the following fields: i. the potential of the sustainability-oriented curricula and ii. the importance of green and digital skills.

Regarding the development of sustainability-oriented curricula toward the integration of sustainability into education systems, it turns out that sustainability-oriented curricula enhance critical thinking and action competences which are essential for individuals within the framework of the transformations occurring in the labour market, environment and society in modern times (UNESCO, 2021). Especially, the transformation of curricula toward a more Education for Sustainable Development (ESD) perspective helps students to develop better thinking skills, problem-solving skills and values for sustainable development, while learning to adapt to evolving complex situations, learning to act as responsible citizens at local, national and international levels in terms of ESD issues and participating in democratic decision making and (Laurie, Nonoyama-Tarumi, Mckeown, & Hopkins, 2016).

At this point, it should be mentioned that the integration of ESD is most effective when i. it adopts a multidisciplinary framework and is embedded throughout the entire curriculum and ii. teachers' capacity and training concerning ESD pedagogy and issues related to sustainable development has improved and carried out respectively (Laurie et al., 2016).

Moreover, green and digital skills have been raised of vital importance policy priorities and strategic goals in the national and European agendas aligned, directly, with the green and digital transition and, consequently with the achievement of SDGs of UN 2030 Agenda (see in detail UN, 2015). Specifically, at European level, the green transition, that is linked with the climate neutrality and emissions reduction and focusing on reshaping the European Union into a contemporary, resource-optimized and competitive economy (European Commission, 2019; European Commission, 2025b), needs skills related to sustainability competences in the following areas valuing sustainability, promoting nature, systems thinking, critical thinking etc. (see in detail European Commission/JRC - Bianchi, Pisiotis & Cabrera, 2022).

Toward this perspective, Vocational Education and Training (VET) is essential for addressing economic and social changes preparing people for the abovementioned transformations, and enabling workforce to transition into greener sectors and occupations (Cedefop, 2022). As Cedefop (2022) highlights the necessity of cooperation among VET, governments, local and regional authorities and bodies as well universities, research centers and institutions and employers.

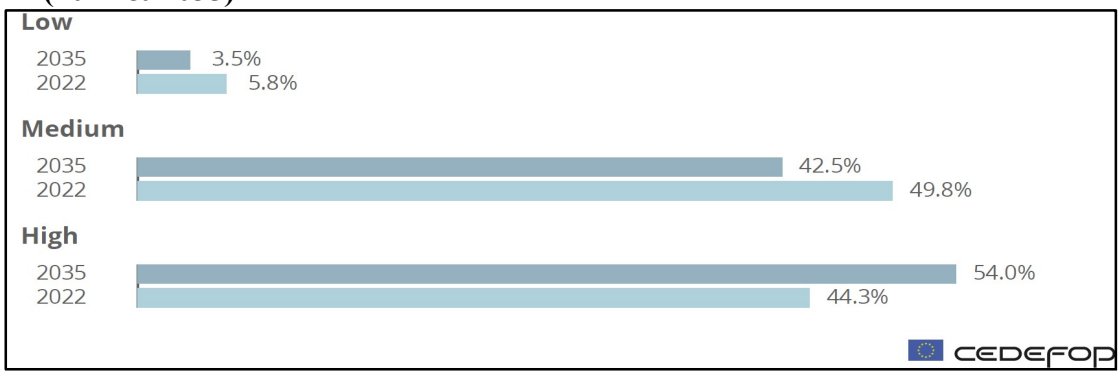
Especially, to implement the European Green Deal, regional bodies should tailor VET programs to local green sector needs, fostering deep structural changes in the economy. This shift will fundamentally alter labor market dynamics, making workforce retraining essential. Such priorities are already deeply embedded in EU VET strategies and the European Skills Agenda to ensure a smooth transition, highlighting upskilling and reskilling as vital tools for managing these labor market changes (see in detail European Commission, 2025d).

At the same time, the digital transition is affecting almost every sector of contemporary societies. Digital literacy, critical digital skills and online problem-solving ability are essential for both employability and active citizenship (van Laar et al., 2017). Furthermore, the digitalisation of the labour market, the automation of work, the growth of the digital economy, and the expansion of teleworking, which increased significantly during the COVID-19 pandemic, are creating new conditions and challenges. These developments increase the need for the workforce to acquire new skills, especially for those with significant digital skill gaps, while also leading to the loss of many jobs as a result of automation and the digital

transformation of the labour market (INE GSEE/Antonopoulou, 2023; European Commission, 2018; OECD, 2018b).

Further, digital technologies and, more broadly, the digital economy have transformed the labour market both in the EU and globally, creating new job opportunities while also automating certain occupations. At the same time, labour demand is shifting toward jobs with higher digital intensity, meaning positions that require digital, and often specialized, skills (Cedefop, 2025a). It is indicative that in 2021, 85% of jobs in the EU required at least basic digital skills, while between 2020 and 2021 about 14% of adult workers saw their job tasks replaced by new digital technologies. According to Cedefop forecasts for 2035, the average share of employment in high-tech occupations in the EU is expected to reach 11.4% (Cedefop, 2025a). While it is expected to decline in traditional forms of employment, such as secretarial support, accounting, administration and low-skilled work (Papadakis, Petousi, Tzagkarakis, 2023) (see also Figure 4).

Figure 4: Cedefop forecasts for future employment (%) by educational level in the EU-27 (2022 & 2035)



Source: Cedefop, 2025b: https://www.cedefop.europa.eu/en/tools/skills-intelligence/trend-focus/future-jobs?etrans=en&etransnolive=1

It is worth mentioning, that based on the "Education and Training Monitor 2025", regarding students' digital skills, the situation is particularly unfavorable, as 42.5% of students do not reach the basic level of proficiency, mainly due to inequalities in access and insufficient teacher training (European Commission/DG EAC, 2025: 6). Furthermore, the state of play is even more difficult with regard to the level of proficiency of adults in digital skills. Specifically, adult participation in Lifelong Learning (LLL) in the EU was 39.5% in 2022, which is still far from the EU target of 60% for 2030. In 2023, only 56% of people aged 16-74 had at least basic digital skills (European Commission/DG EAC, 2025: 8).

As World Economic Forum (2021) has pointed out: *"The profound effects of technological progress on the world economy, taken together with globalization and demographic change, have led to a pressing societal problem: how to equip people with the skills they need to participate in the economy – now and in the future. Governments, businesses and educational institutions are not currently helping people acquire the skills they need to succeed. Millions of people are already being left behind because of volatile market conditions, the effects of COVID-19, or because they work in industries that are being replaced by new sectors. All of this highlights a critical need for reskilling and upskilling. There is an enormous opportunity to reconfigure the world of work at this critical juncture and embark on an upskilling revolution that will give people across the world the ability to participate fully in the future of work, whatever that might be."* (World Economic Forum, 2021: 4)

These priorities for developing and upgrading citizens' digital skills are reflected in the European Commission's Digital Education Action Plan (2021-2027), in which EU's actions and strategies focus on i. promoting the development of a high-quality and effective digital education ecosystem and ii. strengthening digital skills and competences to support the digital transformation (see in detail Alexiadou & Rambla, 2023; European Commission, 2020a; European Commission, 2025a).

As in the green transition, so in the digital transition, synergies and collaborations among schools, universities, research centres and local and regional authorities are essential for effective implementation of education policy within the framework of sustainable development. In particular, coordinated actions and collaborations between education and VET providers (such as the Centres for Training and Lifelong Learning of the Universities (KEDIVIM), Vocational Training Centers etc.), employers and public authorities at local and regional levels is necessary in order to support sustainable regional development and people's skills development and upskilling by implementing evidence-based targeted training-reskilling programmes aligning with regional and local market needs-in-skills (Ramsarup, McGrath & Lotz-Sisitka, 2023; Papadakis, Drakaki & Tzagkarakis, 2026).

The above mentioned, in conjunction with the different dimensions of the broader transformation taking place in the labour market (see in detail Papadakis, 2025), underline the importance of LLL and VET as major education policy mechanisms. In particular, VET, as a key active labour market policy, plays a decisive role both in enhancing employability and in promoting social sustainability at local and regional governance level (see Papadakis & Drakaki, 2025).

4. CONCLUSIONS AND POLICY RECOMMENDATIONS

4.1. Conclusions

The paper examined the role of education policy as a key driver of sustainable transition, focusing on how strategies at local and regional levels can support sustainable development. The analysis confirms that education constitutes a fundamental domain within the Sustainable Development Agenda both at international and European levels (European Commission, 2025c; UN, 2015; UNESCO, 2020, 2021).

Furthermore, education policy supports sustainable transition through i. sustainability-oriented curricula and education for sustainable development for embedding sustainability priorities and goals across education systems (UNESCO, 2021; Laurie et al., 2016), ii. the development of citizens' green and digital skills, which have emerged as major priorities for future economies and labour market transformations, reinforcing the need of education and training systems that can respond to rapidly changing skills demands, reducing inequalities and addressing the digital divide, strengthening, consequently, social cohesion and resilience (European Commission, 2025a, 2025b; European Commission/JRC - Bianchi, Pisiotis & Cabrera, 2022, van Laar et al., 2017; Alexiadou & Rambla, 2023; Cedefop 2022, 2025a).

Within this framework, the study underlines the importance of VET and LLL as crucial fields of education policy for enhancing employability, supporting reskilling and upskilling needs and providing evidence-based targeted training/reskilling programmes, and facilitating labour market transitions at local and regional levels (Papadakis et al., 2026; Papadakis, 2025; Papadakis & Drakaki, 2025).

The study, also, highlights the significance of governance and collaboration arrangements for effective implementation of education policy at sub-national levels (Hooge et al. 2012; OECD, 2016). In particular, the implementation of education policy within a

multi-level governance implementation requires cooperation among education and training providers and relevant regional/local bodies and authorities, especially, in the design and delivery of training and reskilling programmes aligned with regional/local labour market needs (Papadakis et al., 2026; Ramsarup et al., 2023; Cedefop 2022).

4.2. Policy Recommendations

Based on the above mentioned, several policy issues emerge that need to be addressed, especially at local and regional levels:

- Education and training policies should strengthen the alignment between education and training systems and regional and local labour market needs, especially through VET and LLL initiatives that provide training-reskilling and upskilling programmes.
- Effective implementation requires stronger cooperation among education and training providers, local and regional authorities, labour market stakeholders and social partners, particularly in the planning, design and delivery of training-reskilling programmes adapted to local socio-economic and labour market needs and conditions.
- Regional and local education policies should enhance the development of green and digital skills through coordinated initiatives and actions that respond to fast-changing socio-economic and labour market demands.
- Regional and local authorities should support capacity-building and professional development initiatives and actions for teachers and educators in integrating sustainability and digital competences into teaching and learning practices, while encouraging whole-school approaches to sustainability.
- Greater emphasis should be placed on inclusive education policy at local and regional levels aimed at reducing socio-educational inequalities and addressing the digital divide, thus strengthening social cohesion and sustainable regional development.

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THE TEACHER AS AN AGENT OF CHANGE: EDUCATION FOR SUSTAINABLE DEVELOPMENT IN THE SCHOOL COMMUNITY

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Abstract
Education for Sustainable Development has emerged as a critical framework for preparing learners to address complex global challenges, including climate change, social inequalities, and sustainable resource management. Within this context, teachers play a pivotal role as agents of change, shaping values, attitudes, and practices that promote sustainability within the school community and beyond. This paper explores the ways in which teacher education, both initial training and continuous professional development, can integrate the principles of Educational for Sustainable Development to empower educators to become catalysts for transformation.

The study emphasizes the importance of equipping teachers not only with theoretical knowledge of sustainability but also with practical pedagogical strategies such as project-based learning, experiential education, and interdisciplinary approaches. By analyzing examples of innovative practices, the paper highlights how Educational for Sustainable Development can be embedded into diverse subject areas, encouraging critical thinking, problem-solving, and active citizenship among students. Furthermore, it addresses the challenges that educators face, including limited institutional support, lack of training resources, and resistance to change.

The presentation argues that sustainable change in education requires a systemic approach, where teacher professional development is aligned with national educational policies, local community needs, and global sustainability goals. Ultimately, empowering teachers as leaders of Educational for Sustainable Development fosters school environments that cultivate ecological awareness, social responsibility, and collaborative problem-solving as key elements for building more sustainable societies.

Key words: Teacher education,Sustainable Development,Professional development.

PROMOTING SUSTAINABLE DEVELOPMENT THROUGH PRIMARY EDUCATION TEXTBOOKS. CASE STUDY: GREECE

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Abstract
Sustainable Development constitutes the main determining factor for human well-being, as explicitly stated in the 17 United Nations Global Goals to be implemented from 2015 to 2030, since it concerns future international development. Human intellectual advancement and the rapid growth of technology lead to continuous progress, with the fundamental prerequisite being the interaction and interconnection of the pillars of Sustainable Development - Economy, Environment, and Society - for the good quality of life of people worldwide.
Given that environmental issues are constantly increasing at both local and global levels, educating children as the future active citizens of society is deemed necessary. Therefore, a fundamental basis of the 17 Global Goals is the proper teaching of the principles of Sustainable Development through school textbooks and Skills Laboratories, which are taught from the very beginning of children's school life. Finally, within the Greek education system, Primary Education holds the most significant role, and it is there that attention is focused.

Keywords: School Textbooks, Skills Laboratories, Primary Education, Sustainable Development

PLAY & GAMES AS METHODS OF REGENERATIVE ARCHITECTURAL "EDUTAINMENT"

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Abstract
The relationship between architectural education and play is revealed historically through multiple paths, simultaneously at theoretical, design and practical-construction level. This paper proposes a methodological reading of this relationship, structured as a progression from enclosed spaces of early childhood learning to the open fields of social and urban experience.

At its foundation lies Friedrich Froebel's radical kindergarten program, based on purposefully designed play activities that cultivated spatial perception, imagination, and creative skills. Similar principles were later reformulated in Johannes Itten's preliminary courses (*Vorkurs)* at the Bauhaus.

The discussion then moves to outdoor (self-)education environments: from Aldo van Eyck's playgrounds and Isamu Noguchi's *playscapes*, to David Rockwell's portable "Imagination Playground" and the examples of eco-productive, sustainability-oriented playscapes. From there, attention expands to amusement parks and to the diffusion of ludic activities across the public urban realm (e.g., skateboarding, parkour) and the natural landscape (e.g., orienteering).

At the urban scale, play is associated with the Situationists' utopian vision of the "Ludic City" (Constant's *New Babylon*), later extended to a global dimension in Buckminster Fuller's *World Game,*which anticipated current visions of "hybrid-space ludic cities", shaped by video games and internet technologies. This trajectory reaches a peak in the digital environments of City/World-Building (or "God") Games, which act as simulations of complex ecosystems and tools of ecological design.

In contemporary contexts, emerges the figure of the "*Homo Ludens Digitalis"*, inhabiting a hybrid urbanity of *pervasive games*, through augmented reality technologies and gamification applicationsThese practices articulate new spatial and social dynamics, while simultaneously exposing the dual nature of play: as a liberating mode of creativity and as an instrument of normative regulation.

This ambivalence underscores the centrality of play - and its multiple sites (*"playces"*) - as a critical domain for rethinking architectural education in the 21st century. In particular, it positions the subject of *"regenerative playgrounds"* as a most crucial field of experiential, ecosophical learning process, responsive to the multiple environmental, social and psychological challenges of our times, contributing to the vision of *"regenerative cultures"* [Wahl, 2016].

Key words: Play, Games, Game-design, Gamification, Architecture, Educational Entertainment ("Edutainment")

SESSION

"Local and Regional Cultural Development"

Chaired by **Prof Maria Manola** and
Asst Prof Poli Maria

CULTURAL ENTREPRENEURSHIP AND SUSTAINABLE TOURISM DEVELOPMENT IN THE HEROIC ISLAND OF PSARA

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Abstract
This paper aims to investigate cultural entrepreneurship on the island of Psara and examine its contribution to the region's tourism development. Although small in size, Psara possesses a rich historical heritage and natural beauty. Its cultural identity is deeply intertwined with the destruction it suffered in 1824 during the Greek Revolution against the Ottoman Empire. The devastation of Psara is recorded as one of the most tragic historical events and inspired the famous poem by Dionysios Solomos. This research focuses, on one hand, on analyzing the ways the island utilizes its natural and cultural resources to enhance tourism, and on the other hand, on exploring the potential for cultural development based on the opinions of residents, collected through a quantitative survey of 130 questionnaires.

Keywords: Cultural Tourism, Coastal Islands, Cultural Entrepreneurship, Sustainable Development

1. INTRODUCTION

Psara is a small but inhabited island in the northern Aegean Sea, located about 15 nautical miles from Chios, the nearest large town with the municipality of Heroic Island of Psara as its seat. It has a population of 422 inhabitants and an area of 42 square kilometers; it is mainly a barren island.

The island's long history, culminating in the heroic sacrifice of the people of Psarians during the 1821 Revolution, is a major attraction for visitors, combining culture and tranquility away from the popular tourist destinations. Cultural tourism on the island offers authentic experiences. The most tragic historical moment of Psara was the holocaust of Black Raki on 22 June 1824, when the town of Psara fell into the hands of the Turks. Those of the civilians who made it in time fled by boat. The rest were killed or drowned. The 'Black Battle', immortalised by Solomos, was elevated in people's consciousness as a symbol of sacrifice and total commitment to the cause of Freedom. Those Psarians who were saved from the catastrophe fled to the surrounding islands (Kriezis, 2021; Spanos, 2018; Municipality of Psara, 2023).

2. TOURISM AS A MEANS OF SUSTAINABLE DEVELOPMENT IN PSARA

Tourism is one of the main pillars of the Greek economy, but also of the global economy (Poli, 2019). In the case of Psara, tourism has the potential to be directly linked to the cultural heritage of the island, offering a unique opportunity for sustainable development. Although tourism has been studied in many parameters, there is no universal definition of tourism. Tourism is a 'product' of the ever-expanding tourism industry, which is defined by five key factors: facilities, services provided, hospitality, freedom of choice, and tourist experiences (Manola et al.,2022; Manola et al., 2022; Trikalitis & Manola, 2024; Tsatalbassoglou & Manola, 2024; Poli, 2019).

Tourism in Fishery is not only an economic phenomenon, but also a social and cultural phenomenon. As an economic phenomenon, tourism development is influenced by the laws of supply and demand, as visitors choose Psara for the natural beauty of the island, its cultural heritage, and the experiences offered. Socially, tourism leads to interaction between visitors and locals, strengthening social relations and creating new opportunities for social mobility and development. Culturally, tourism in Psara creates a juxtaposition of different cultural stimuli, enhancing local identity and cultural dialogue. Maniou, 2023b; Manola & Koufadakis, 2022; Maniou, 2024).

Further, sustainable tourism development can be achieved through the integration of cultural heritage into the island's tourism product. This requires the development of tourism infrastructure that respects the natural and cultural environment, the promotion of tourism as a cultural experience, and the strengthening of the local economy through sustainable practices (Manola, 2019; Manola, 2022; Manola et al.,2023q; Poli, 2019).

Psara, with its rich history and unique cultural heritage, has the potential to develop sustainable business models based on tourism. The island can leverage its cultural assets, such as the Black Ridge and archaeological sites, to create sustainable tourism businesses that promote the values of the local community while enhancing economic and social well-being. The development of sustainable tourism businesses will require the adoption of policies that ensure the protection of the natural environment, the promotion of local products, and the strengthening of the local community through social entrepreneurship. (Miaoulis, 2021)

3. CULTURAL ENTREPRENEURSHIP IN PSARA AND ARCHEOLOGICAL SITES

Cultural entrepreneurship in Psara represents a key factor for the island's sustainable development, linking its historical and cultural heritage with the modern economy. Organizing cultural routes titled *"In the Footsteps of Heroes"* or creating a cultural park that connects the island's historic monuments could serve as a significant incentive for business development and the enhancement of cultural tourism (Maniou et al., 2024; Maniou et al., 2024a; Maniou et al., 2024b). The promotion of cultural heritage through festivals, educational programs, and experiential tourism activities can contribute to Psara's economic growth by attracting visitors and creating new job opportunities. At the same time, strengthening cultural entrepreneurship could also stem from collaboration with other island communities, utilizing best practices in the fields of cultural tourism and sustainable development. (Maniou & Mitoula, 2025; Maniou et al., 2025a; Poli & Malagas, 2024a).

The use of new technologies and digital tools can play a crucial role in disseminating the island's cultural heritage. Virtual tours, online archives, and interactive applications can enrich the visitor experience, making Psara's cultural heritage more accessible and appealing to the general public (Maniou et al., 2025; Poli & Malagas, 2024).

The destruction of Psara and the holocaust of Mavri Rachi in 1824 was a historical event that shocked all of Europe. In recognition of Psara's contribution to Greek history and the bravery and self-sacrifice of its people, the Hellenic Parliament voted to rename the Municipality of Psara to the *Municipality of the Heroic Island of Psara*. Below is a list of the historical and archaeological sites of this heroic island. Psara possesses a rich cultural heritage with great potential for promotion through organized initiatives, cultural events, and modern forms of tourist development (Kaltsas, 2021; Koumarianou, 2021).

Points of Interest Contributing to the Identity and Tourism Development of the Island

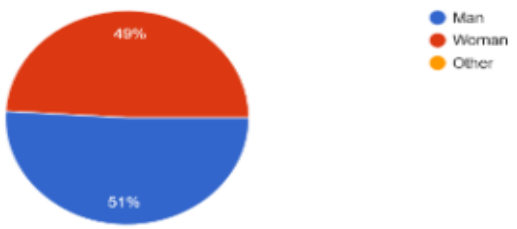
- **Mavri Rachi Hill** is an iconic site of remembrance of the Greek Revolution, where in 1824 the Psarian people chose self-sacrifice rather than surrender to the Ottomans. Today, a modest monument honors their sacrifice, offering opportunities for further development through guided tours and commemorative events.
- **Church of Saint Nicholas**, built in 1793 and closely associated with the destruction of Psara, has been renovated and functions as a significant religious and cultural site. Promoting it through new technologies can boost religious tourism and the local economy.
- **The bust of Konstantinos Kanaris**, located near the church at the site of his family home, enhances historical memory and cultural entrepreneurship through events, storytelling, and festivals that attract visitors.
- **The Spitalia**, an old quarantine station renovated by Aris Konstantinidis, and **the captain's houses (kapetanospita)** in the area of Kavos, reflect the island's maritime tradition and could be key elements in thematic tourism.
- **The Mycenaean settlement at Archontiki** offers valuable insight into prehistoric habitation on Psara, with findings displayed at the Archaeological Museum of Chios, strengthening the island's link with cultural tourism and archaeological research.

Overall, Psara is a land with a rich cultural legacy and strong potential for sustainable tourism and local development (Miaoulis, 2021a; Nikodimou, 1862; Spanos, 1967; Spanos, 1962; Psara-Link, 2023; Exploring Greece, 2023; Ferryhopper, 2023; Karatzas, 2023; Mantis, 2013).

4. RESEARCH METHODOLOGY

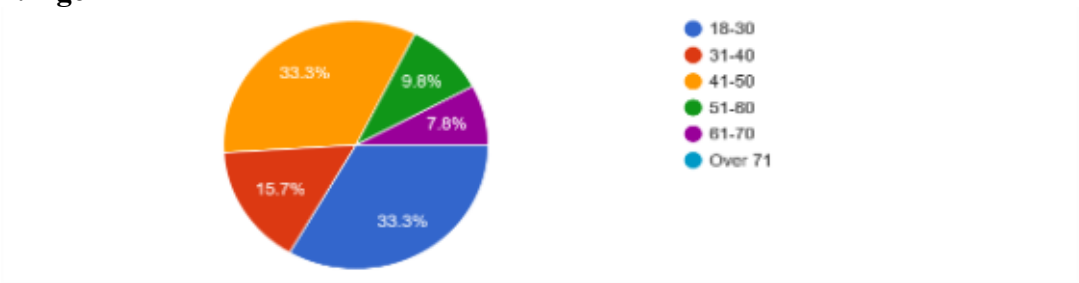
The quantitative research conducted for this study involved questionnaires distributed both to residents of the island of Psara and to individuals originally from Psara who do not reside permanently on the island but visit due to their origin. A total of 130 questionnaires were distributed, and the research lasted for 3 months, from October to December 2024.

1. What is your gender?



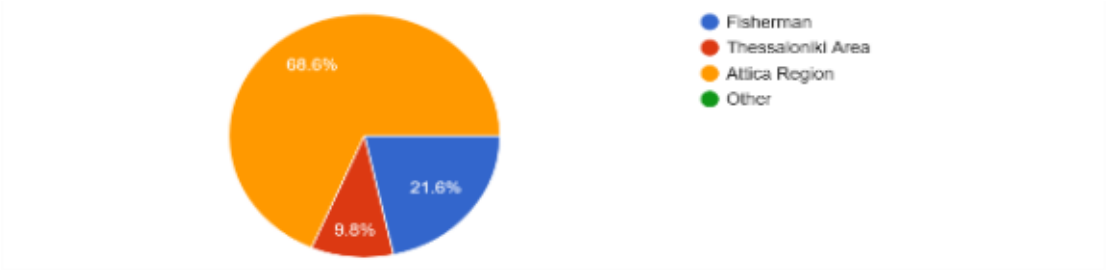
Graph 1: According to the research data, 51% of the respondents were male and 49% were female.

2. Age



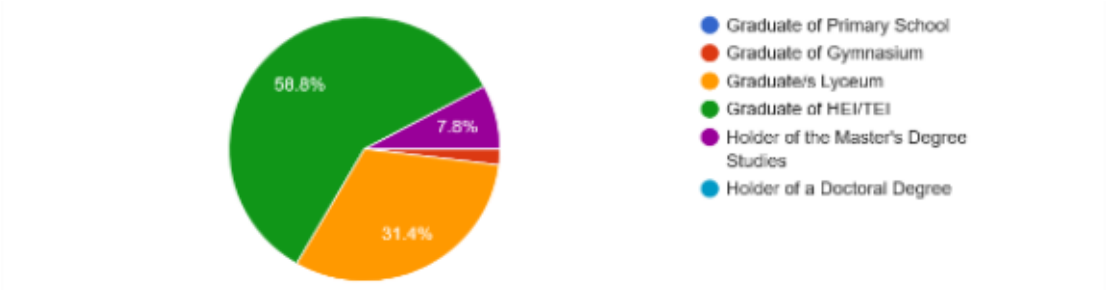
Graph 2: The majority of participants fell into the following age distribution:

3. Place of residence



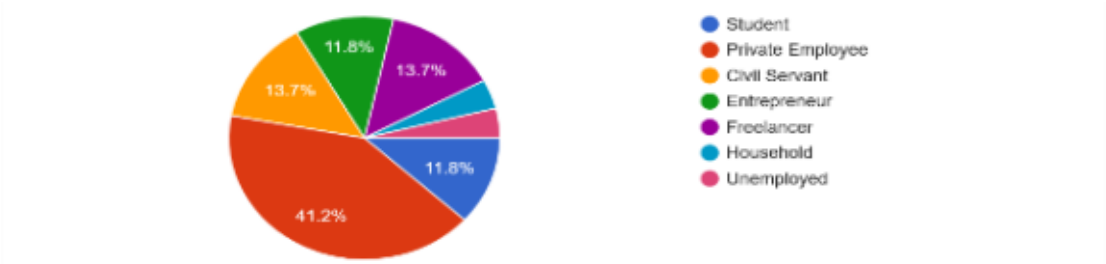
Graph 3: Regarding the respondents' place of residence

4. Level of education



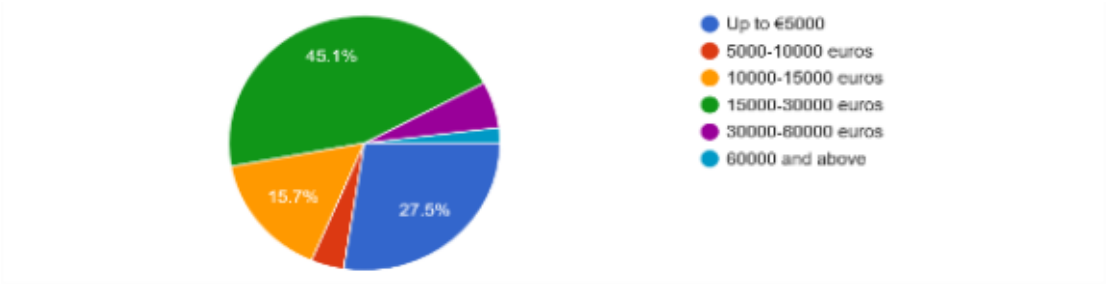
Graph 4: The educational level of the participants is distributed as follows: The sample shows diversity, with a strong representation of university graduates.

5. Occupation



Graph 5: The professional profile of the respondents is as follows: These figures indicate that the majority are in stable employment, primarily in the private sector, which may influence their perception of economic development and opportunities on the island.

6. Personal income

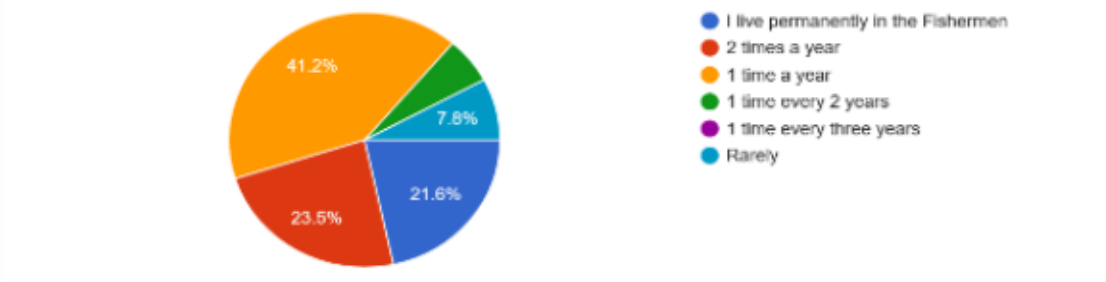


Graph 6: The income levels vary significantly: These results suggest that a large portion has moderate incomes, while a notable percentage has very low income, potentially affecting their priorities and needs regarding the island.

7. Are you from Psara?

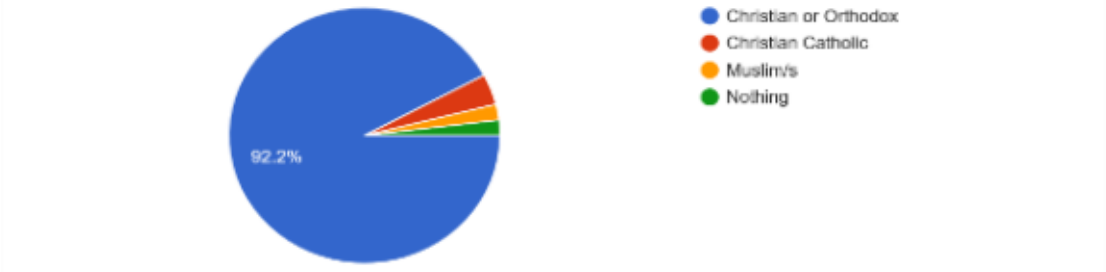
Graph 7: The sample provided a homogeneous response, with 100% indicating that they are originally from Psara.

8. How often do you visit Psara?



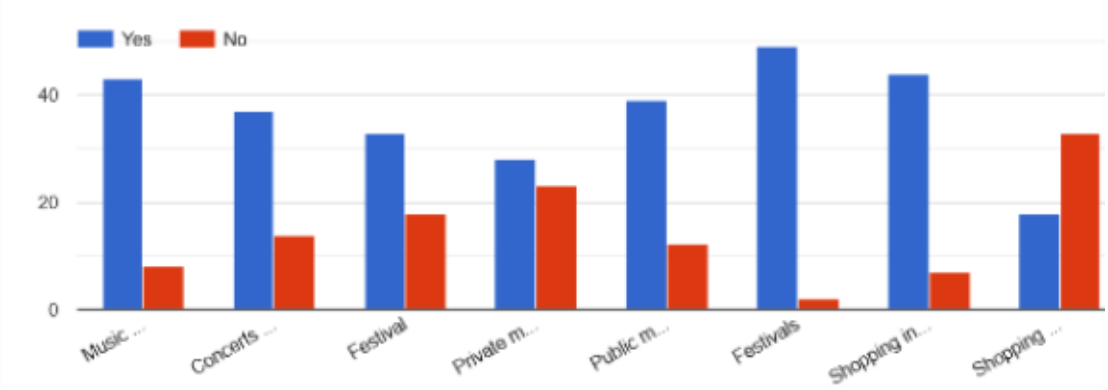
Graph 8: In response to the frequency of visits to Psara:

9. What is your religion?



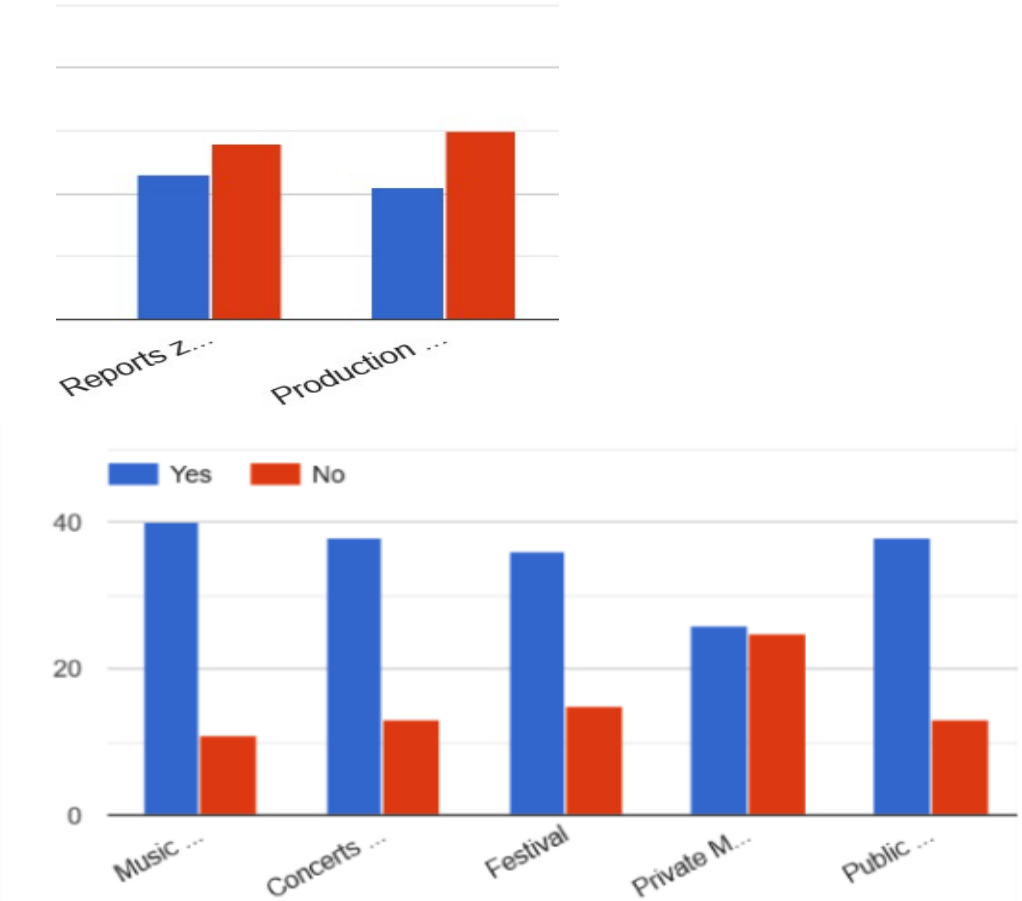
Graph 9: 92.2% of respondents identified as Greek Orthodox Christians, highlighting significant homogeneity relevant to the cultural context of Psara.

10. Do you know which of the following businesses/events exist?

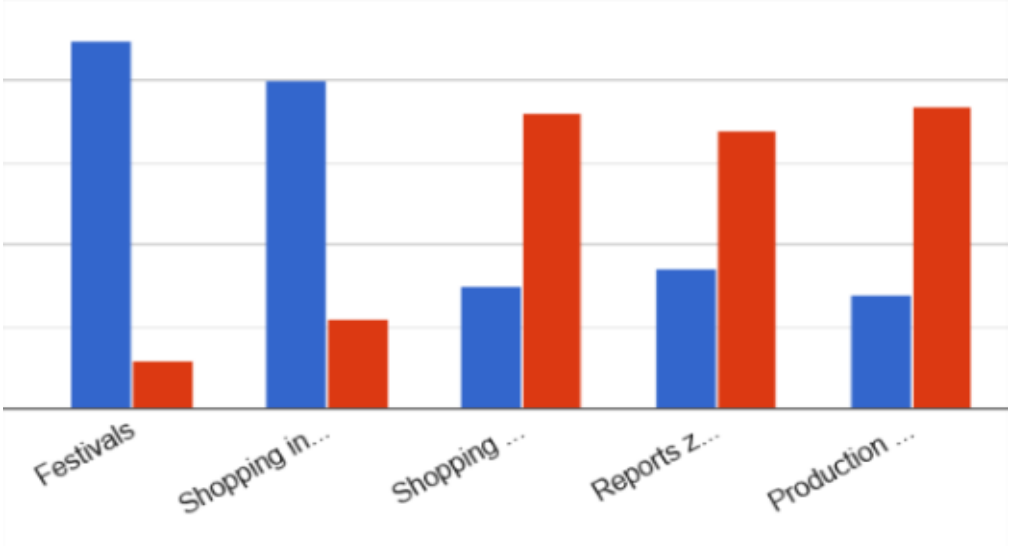


Graph 10: This graph reveals the participants' level of awareness of cultural businesses in Psara. The distribution of answers shows a satisfactory level of awareness for most initiatives.

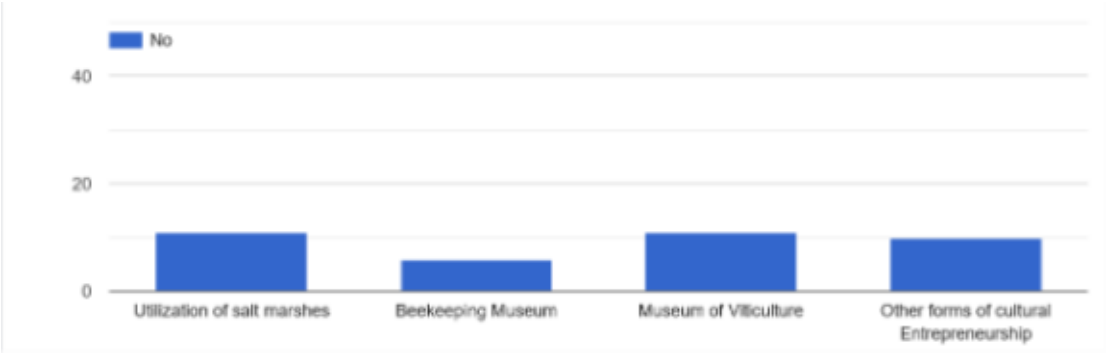
11. Which of the following businesses/events have you visited?



Graph 11: This data reflects which participants have visited cultural businesses or events in Psara. Comparing this graph with the previous one may show similarities between theoretical knowledge and practical participation.

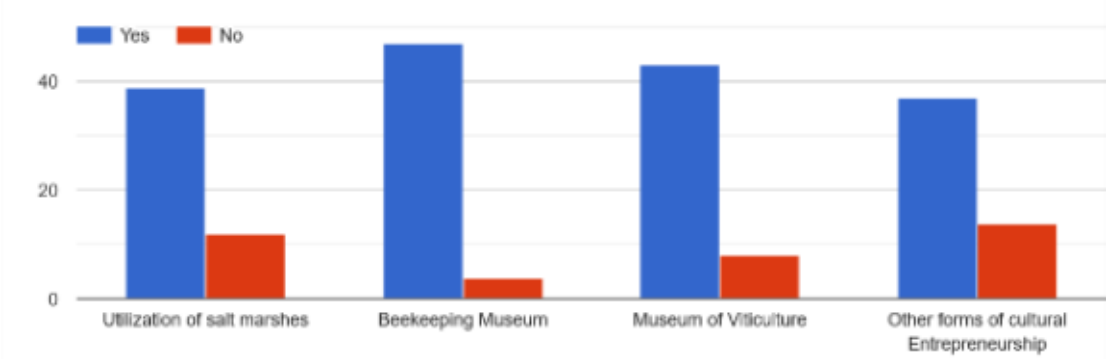


12. The following forms of cultural entrepreneurship do not exist today in Psara. Which of these would you like to exist?



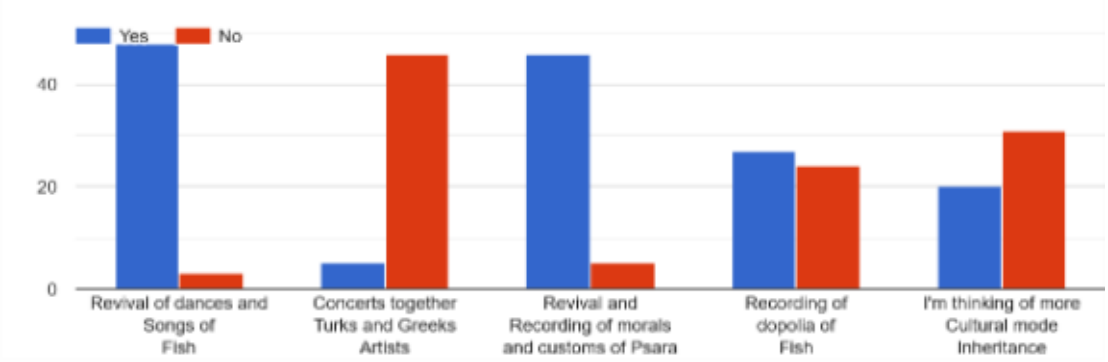
Graph 12: This graph highlights participants' interest in new forms of cultural entrepreneurship. Their preferences reveal potential areas for future development.

13. Would you pay a ticket to visit the forms of cultural entrepreneurship in Psara if they existed?



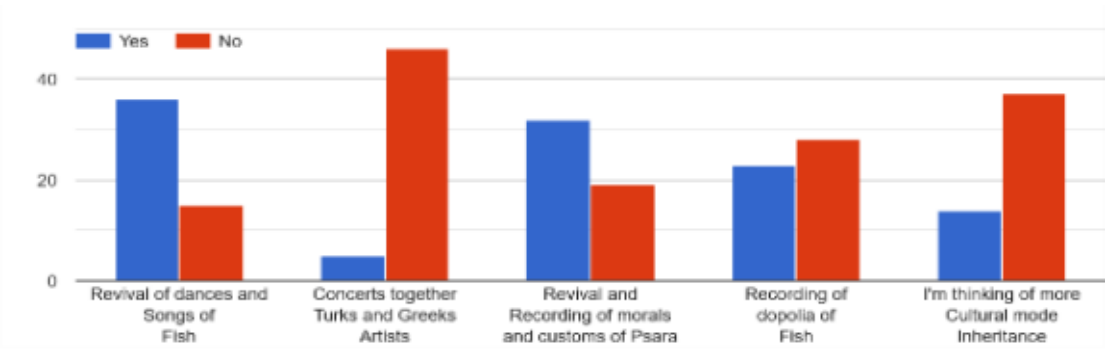
Graph 13: When asked about willingness to pay for entry to cultural ventures, the majority responded positively, suggesting the viability of such actions and a recognition of the island's cultural value 14. Are you aware of any of the following ways of preserving Cultural heritage in Psara?

14. Are you aware of any of the following ways of preserving Cultural heritage that exist in Psara?



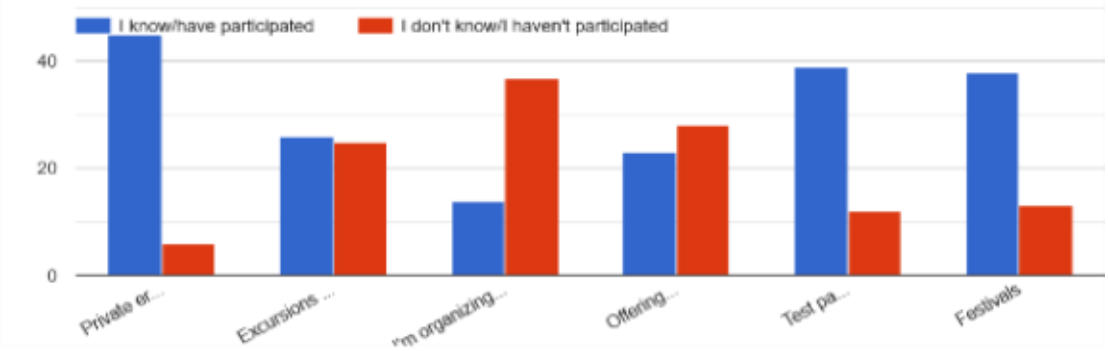
Graph 14: Awareness of heritage preservation methods indicates the population's level of sensitivity and the need for further educational efforts, as a significant portion answered negatively.

15. Have you participated in/attended any of the following intangible cultural heritage events OUTSIDE Psara related to the island of Psara?



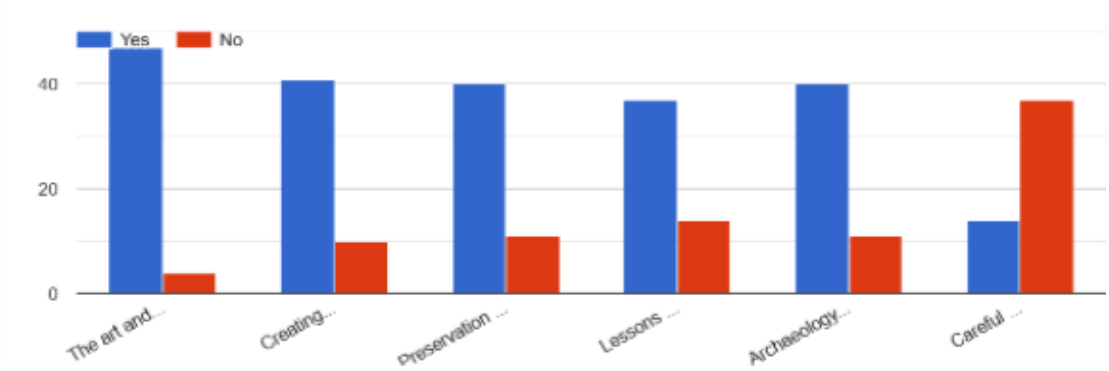
Graph 15. Participation in intangible cultural heritage events outside of Psara indicates the degree of community mobilization for the preservation of the cultural identity of the island. A necessary question for this research, as it shows the potential for future events or initiatives outside of Psara that could enhance the interest and visibility of the island.

16. Are you aware of/have you participated in the following cultural heritage preservation activities taking place on the island of Psara?



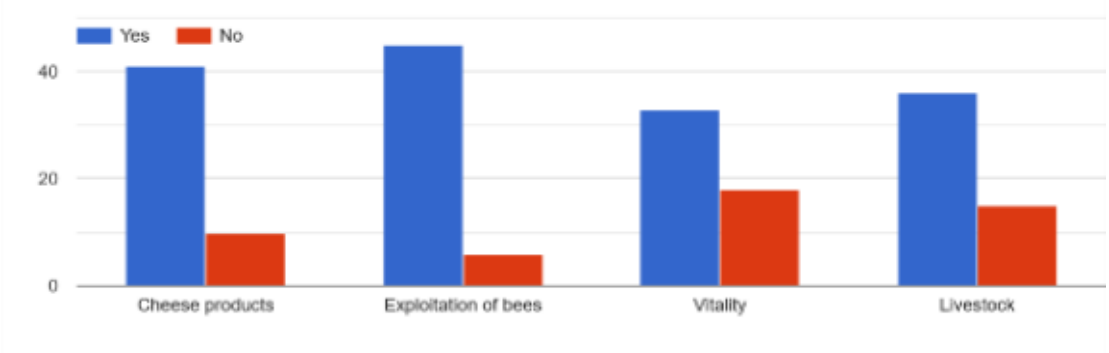
Graph 16. Awareness of or participation in cultural heritage preservation activities on the island of Psara reveals the local activity and the interest of the residents in it, giving varied answers depending on the activity, a positive result as it reveals potential for improvement, but also interest and motivation from the survey participants.

17. Which of the following cultural heritage preservation activities would you like to exist?



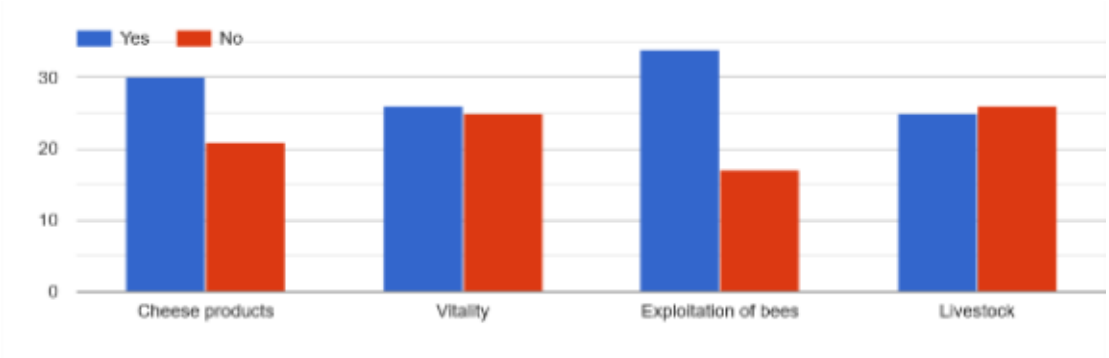
Graph 17: The above graph displays the possible desired cultural heritage preservation activities, revealing which initiatives have a greater chance of success if implemented.

18. Are you aware if actions are being taken to revive traditional farming methods for the following products?



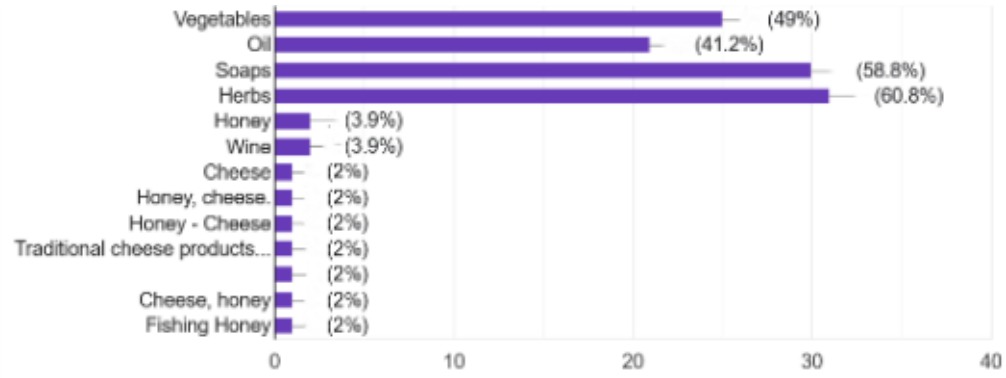
Graph 18: The information on the revival of traditional farming practices shows the respondents' connection to the island's agricultural tradition, indicating that there is a particular emphasis on local cheese products and the island's beehives.

19. Have you participated in promotional activities for the revival of traditional farming methods?



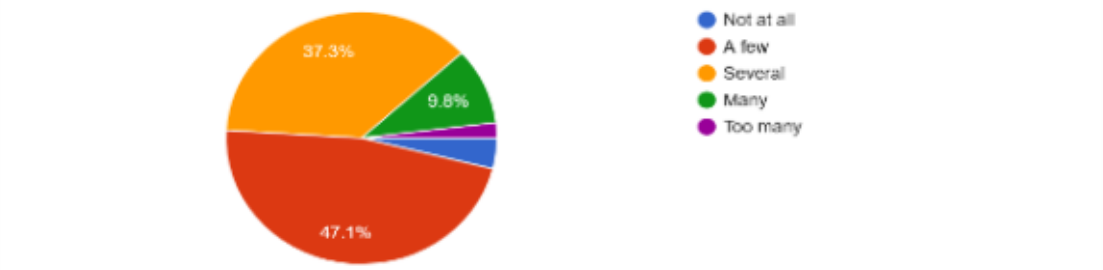
Graph 19: Participation in actions promoting traditional agricultural methods reveals the degree of involvement with agriculture and interest in sustainable development, linking the previous question with the present one, and showing once again the importance of the beehives of Psara for the cultural identity of the island.

20. Which of the following traditional products would you like to be commercially exploited?



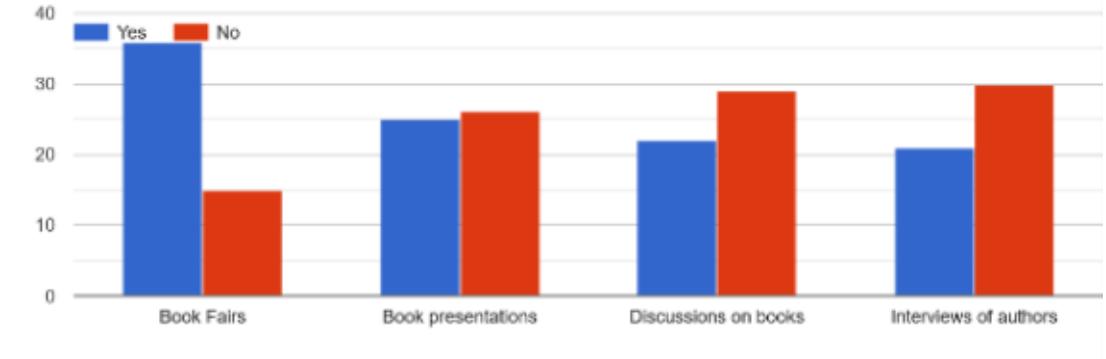
Graph 20: Preferences for commercially exploited traditional products indicate the possible directions of local economic development, with 60.8% choosing herbs as an option, while other possible options seem to be soaps (58.8%), oil (41.2%), and vegetables (49%).

21. Are you aware of any publications that preserve historical memory and heritage in Greece?



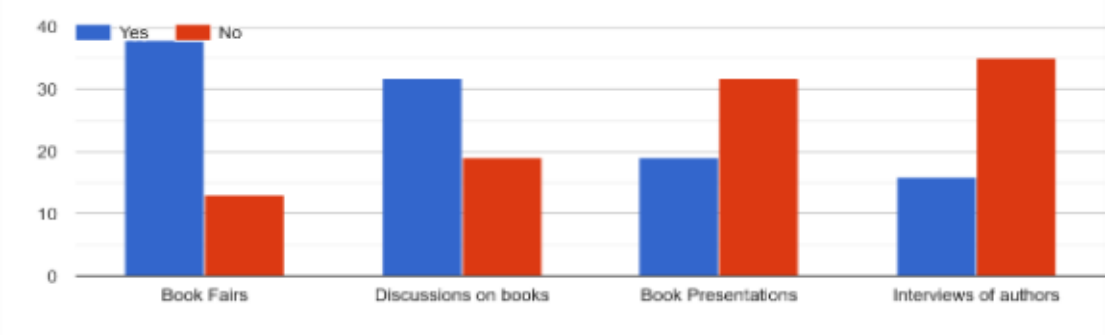
Graph 21: Awareness of publications that preserve historical memory underlines the importance of written documentation on cultural heritage, showing that 47.1% of the sample is aware of only a few corresponding texts.

22. Are you aware of or have you attended any actions WITHIN PSARA for the promotion of books about Psara, such as:



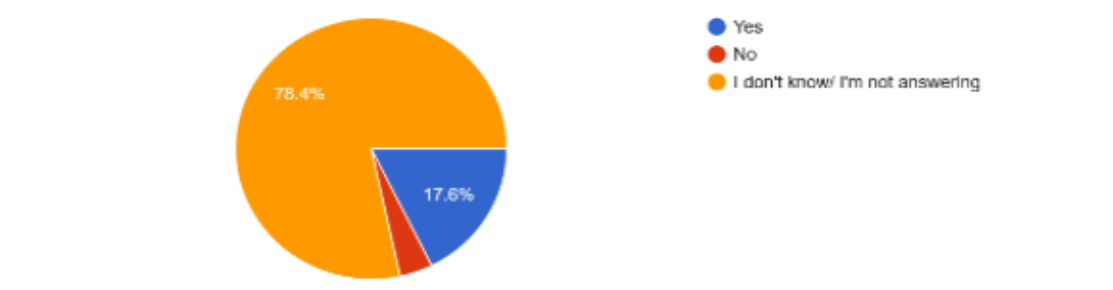
Graph 22: Participation in actions for the promotion of books about Psara within the island shows the need to improve the degree of mobilization of the local community about their literary heritage.

23. Are you aware of or have you attended any actions OUTSIDE PSARA for the promotion of books about Psara, such as:



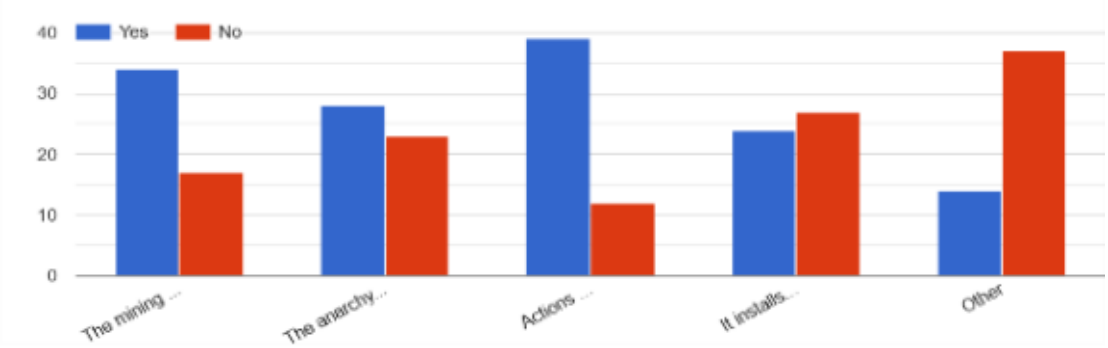
Graph 23: Participation in actions for the promotion of books about Psara outside the island reveals the effort to preserve the cultural identity to a wider audience, another area that needs strengthening.

24. Are you aware if the current legal framework provides subsidies for young entrepreneurs?



Graph 24: Information on subsidies for young entrepreneurs shows the level of information residents have about economic opportunities, with a significant percentage selecting the "don't know/no answer" option.

25. Which of the following business actions affects the sustainable development of the island? (Sustainable Development means development that satisfies present needs without compromising future needs)

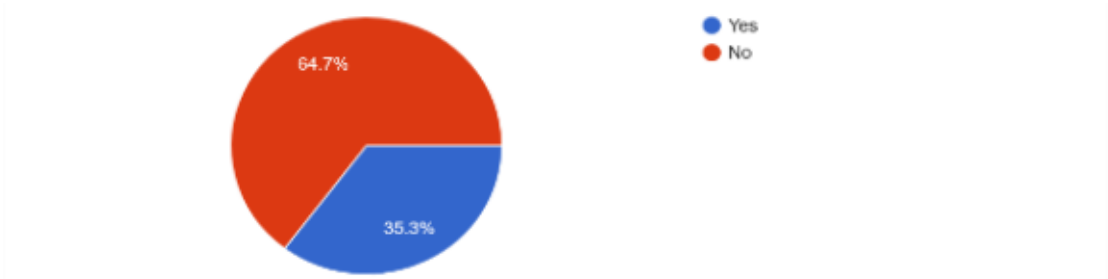


Graph 25: The next question presents the business actions that affect sustainable development and underlines the importance of a balance between economic and environmental well-being.

26. Have you read any of the following books that are related to Psara?

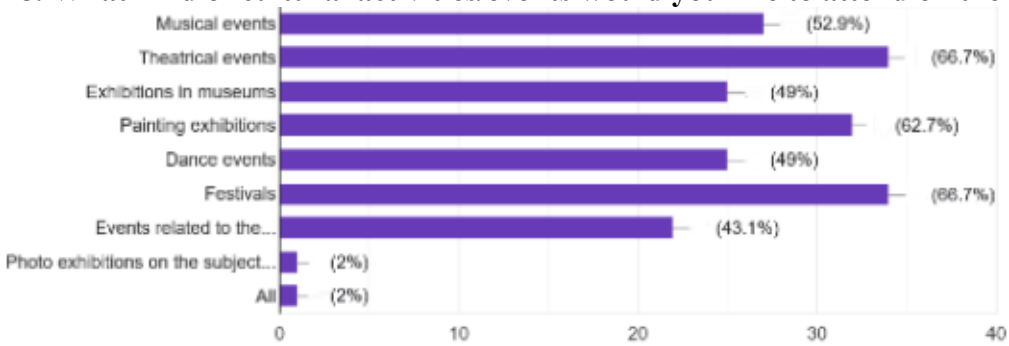
Graph 26: Reading books related to Psara shows interest in local history and cultural preservation, showing a variety of responses, with most participants choosing books about Psara during the Turkish occupation and the history of the island.

27. Are the transportation services (ferry and local transportation) sufficient to serve both the locals and the tourists?



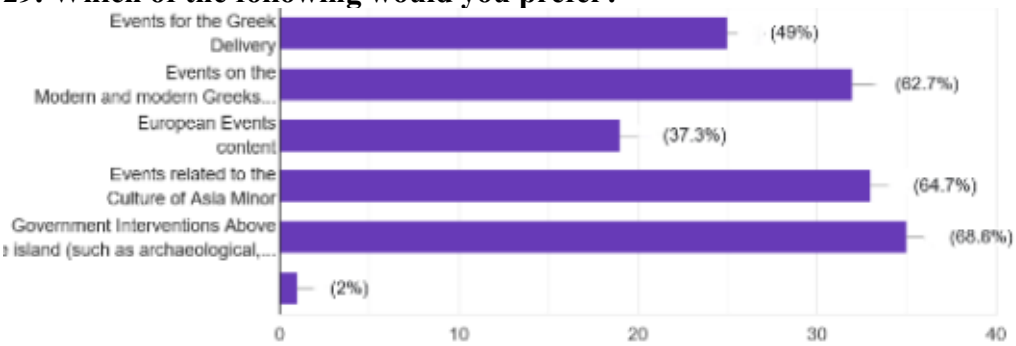
Graph 27: The adequacy of transport services affects both the daily life of the local people and the tourist development, and the answers for such a crucial issue show great room for improvement, as 64.7% of the sample stated that public transport does not work well enough.

28. What kind of cultural activities/events would you like to attend on the island of Psara?



Graph 28: Preferences for cultural events on the island indicate the needs and interests of the public, contributing to the targeted development of cultural activities such as theatre performances (66.7%), art exhibitions (62.7%), and festivals (66.7%)

29. Which of the following would you prefer?



Graph 29: Finally, the choice between different proposals shows the respondents' priorities regarding the cultural and economic development of Psara, a question that revealed that the participants' preferences differ, but that all proposals were chosen by at least 37.3%.

4. FINDINGS OF THE SURVEY ON THE CULTURAL AND ECONOMIC DEVELOPMENT OF PSARA

Participation in book promotion activities for Fishers outside the island highlights the effort to preserve the cultural identity for a wider audience. However, this is an area that requires further strengthening. Similarly, participation in book promotion activities within the island demonstrates the need for greater mobilisation of the local community for its literary heritage.

The knowledge and involvement of residents in initiatives to preserve the cultural heritage of Psara reveal local activism and interest in its protection and promotion. Responses vary according to the activity, suggesting both the potential for improvement and the existing mobilisation of residents. In addition, participation in cultural events outside Psara indicates the degree of community awareness of the preservation of the island's cultural identity and the potential for future activities that could enhance its extroversion and promotion.

In terms of entrepreneurial activity, residents' awareness of grants for young entrepreneurs reflects the level of information about economic opportunities. It is noteworthy that a significant percentage chose the answer "don't know/no answer", indicating the need for better dissemination of information in this area. At the same time, the business actions affecting the sustainable development of the Fishers underline the importance of a balanced approach between economic and environmental well-being.

Reading books about the Fishers is an indication of interest in local history and cultural preservation. Responses varied, with most participants choosing books about the history of the island and the period of Turkish occupation.

A particularly critical issue for the daily life of residents and tourism development is the adequacy of transport services. The responses show considerable room for improvement, with 64.7% of respondents stating that public transport does not adequately meet their needs.

Finally, the choice between different cultural and economic development proposals revealed a variety of preferences among participants. However, each proposed action garnered at least 37.3% of preferences, suggesting an interest in multi-level development on the island.

5. CONCLUSIONS

Cultural entrepreneurship in Psara can act as a driver of sustainable tourism development, using cultural routes, local festivals, and religious events to enhance local identity. It is a key

axis for preserving historical memory and strengthening the local economy. The combination of cultural heritage, tourism, and local traditions can create a sustainable development model that will contribute both to the promotion of the island and to improving the living conditions of its inhabitants

Archaeological sites, such as the Mycenaean settlement at Archontiki, and historical monuments, such as the Black Ridge and the church of Agios Nikolaos, are central points for the promotion of cultural tourism. Their exploitation through organised tours, educational programmes, and digital technologies can enhance the interest of visitors, attracting both researchers and tourists interested in the history and culture of the island

The promotion of the cultural heritage of Psara through cultural entrepreneurship actions can lead to the creation of a resilient and sustainable development model, based on the history, traditions, and natural resources of the island.

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IN THE FOOTSTEPS OF TRAVELLERS: SUSTAINABLE DEVELOPMENT THROUGH TRAVEL TEXTS IN THE REGION OF LASITHI

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Abstract
Travel texts constitute a significant source of cultural memory and identity, as they capture the image of a place through the narratives of foreign travellers. In the case of Lasithi, these texts provide not only historical and geographical references but also opportunities for their integration into strategies of sustainable tourism development.

This paper focuses on the wider areas of Ierapetra and Sitia, places with a rich natural and cultural heritage but also particular challenges related to sustainable development. The aim is to explore how travel texts can be incorporated into local development strategies, strengthening cultural resilience and promoting forms of tourism based on authenticity and locality.

As a case study, two thematic routes were designed on the basis of references in travel texts, highlighting landscapes, monuments and cultural practices of the area. The research component is based on a quantitative survey (N=108), which examined visitors' willingness to combine their holidays with visits to sites included in these routes. The results were encouraging, as the majority of participants expressed positive attitudes, underscoring the potential of travel literature as a driver of local development.

The findings demonstrate that the integration of travel texts into cultural and tourism policies can contribute to cultural interpretation, the reinforcement of local identity and the sustainable tourism development of Lasithi, offering an innovative perspective for the region's strategic promotion.

Key words: travel texts, sustainable development, cultural resilience, Lasithi, thematic routes

1. SUSTAINABILITY AS A STARTING POINT FOR THE CREATION OF CULTURAL ROUTES

Sustainability has become a fundamental starting point for contemporary tourism, as it brings together the environment, the economy and society through the cultural dimension of development. Cultural sustainability is now recognised as the fourth pillar of sustainable development, since the protection and activation of culture are essential for preserving identity and social cohesion (Terkenli & Georgoula, 2022). As Mitoula (2002) notes, the European approach to sustainable regional development is based on a holistic vision that aims not only at the reconstruction of the urban environment but also at encouraging citizens to take an active role in managing space.

Today, the idea of sustainability goes beyond the purely environmental perspective and embraces a more human and cultural one. The cultural aspect of development is a key factor for the resilience of local communities, as their values, traditions and memories act as links of continuity and adaptation to new challenges (Mitoula, 2013). Dhers (2024) reminds us that natural ecosystems are almost always shaped by human practices and traditions. Therefore, including local cultures in biodiversity and landscape conservation strategies is vital for achieving nature-positive results. Local societies are not just passive recipients of sustainability policies; they are active contributors who, through the transmission of knowledge, local wisdom and their connection with the environment, ensure the continuity of both cultural and natural balance.

This same principle lies behind the "Cultural Routes" program of the Council of Europe (1987), which promotes sustainable cultural development as a way to strengthen European identity and intercultural dialogue (COE, 2022). According to its principles, Cultural Routes aim to recongnise diversity, protect shared values, and empower local communities through participatory forms of cultural tourism. A similar vision is expressed in the ICOMOS International Charter for Cultural Heritage Tourism (2021), which emphasises that the protection of cultural heritage and community rights must stand at the centre of any cultural tourism policy or project. The Charter encourages collaboration among all stakeholders — public, regional, professional and social — within a people-centred, rights-based framework aligned with the United Nations Sustainable Development Goals.

Mitoula and Kaldis (2013) argue that cultural routes can become effective tools for branding and local development, not only in cities but also in peripheral regions, provided that the promotion of the place is not limited to a tourist image but is based on authentic values and cultural narratives. Kokkosis and Tsartas (2001) had already pointed out that protecting the natural and cultural environment can be a real competitive advantage when it is fully integrated into tourism planning. Within this framework, cultural routes become multidimensional instruments of sustainable management, linking cultural memory, natural heritage and the traveller's own experience.

Therefore, sustainability should not be seen only as a goal, but also as a starting point for creating cultural routes. A route is not just a touristic product; it is a dynamic mechanism that connects local knowledge with present-day practice, allowing cultural revitalisation and social cohesion to emerge through the active involvement of the community.

2. LITERARY TOURISM AND TRAVEL TEXTS AS A FOUNDATION FOR CULTURAL ROUTES

2.1. From sustainability to literary tourism

One of the most creative expressions of sustainability—beyond ecological balance or

economic resilience—relates to the preservation and activation of cultural capital. This is precisely where literary tourism finds its place. It is a form of cultural tourism that connects travel with literature and with the stories that have captured landscapes, experiences and human figures (Manola, 2019). Literary tourism allows visitors to perceive a place through the written word, to experience a destination not simply as a setting, but as a cultural text where traces of the past and the voices of authors meet the present moment. It is a gentle and reflective form of tourism, based on narration, memory and empathy rather than the consumption of space (Pérez-Martínez, 2022). In this sense, literary tourism becomes a bridge between cultural sustainability and local development, helping to form a more responsible, participatory and meaningful travel experience.

2.2. Literary tourism through travel writings

Literary tourism is closely linked with an older yet equally fruitful form of writing: the *travel text*. The narratives of travellers, from the Renaissance to the nineteenth century, provide first-hand testimonies of how places were perceived, described and interpreted by foreign visitors (Simopoulos, 2000; Viggopoulou, 2005). These texts are at once historical sources, literary works and records of cultural perception, revealing the gaze of the "other" upon the landscape, the people and their traditions. Such accounts can serve as tools that offer new ways of reading the landscape and that enhance sustainability by highlighting the uniqueness of local culture, functioning as early versions of travel guides (Tsatalmpasoglou et al., 2024; Tsatalmpasoglou, 2025).

In the case of Crete, travel writings act as *archives of memory*: they preserve information about urban form, monuments, agriculture, trade, and social life, as well as about the customs and habits of the inhabitants (Tsatalmpasoglou & Manola, 2024; Tsatalmpasoglou et al., 2025). The wealth of these texts—from Buondelmonti and Piacenza to Coronelli, Pococke and Tournefort—forms a multilayered record of the island that can support the creation of modern cultural routes combining knowledge, memory and experience.

Travel texts, therefore, can serve as the foundation for designing sustainable routes, as they connect the natural and cultural environment with the narrative tradition. Through reading, identifying place-names and interpreting the travellers' descriptions, the researcher can retrace the "lines" of early journeys, locate points of interest and transform them into cultural stops. This approach enables the creation of routes with cultural depth and experiential character, where today's traveller repeats—in another time and in a different way—the gaze of the early explorers.

3. CULTURAL ROUTES AND STRATEGIES FOR SUSTAINABLE TOURISM

Hiking trails represent one of the most successful tools of sustainable tourism development, as they combine soft tourist activity with the promotion of both the natural and cultural environment. Through the creation of organized paths, tourism can be decentralized, nature can be protected, and areas often left outside mass tourist flows can be reactivated. Hiking, as a form of slow and conscious travel, strengthens the interaction with the place, the understanding of the landscape and the appreciation of local heritage.

The development of an extended network of hiking routes could become a strategic initiative for enhancing sustainable tourism, linking natural landscapes with the historical and cultural features of each area. When designed in a participatory way and in cooperation with local actors, such initiatives can support the local economy, preserve cultural identity and create an authentic, experience-based tourism product.

At the same time, hiking routes can provide the foundation for developing cultural routes, which use traces of history, local narratives and travel writings as their narrative framework. In this way, the physical experience of walking is connected with memory and cultural interpretation, creating a type of tourism that moves beyond the consumption of landscape and instead integrates knowledge and meaning.

A network of this kind — inspired by the references found in travel texts and in the literary representations of place — could transform the region's cultural capital into a resource for sustainable development. Adopting such an approach allows research and cultural heritage to be connected with strategic tourism planning, reinforcing community participation and destination resilience. The following section presents selected maps and excerpts from travel writings that could serve as the basis for a network of cultural routes in Lasithi, founded on the principles of sustainable tourism development.

4. THE CULTURAL ROUTES OF LASITHI: FROM THE TRAVELLERS' MEMORY TO THE CONTEMPORARY LANDSCAPE

4.1 From the "Regno di Candia" to the Sitia Geopark: Landscape, Memory and Sustainability

The maps *Sito del Paleocastro di Settìa* and *Città di Settia* by Francesco Basilicata (c. 1618–1620) depict with remarkable precision the coastal and mountainous geomorphology of eastern Crete, presenting Sitia as a place where nature, history and human presence exist in constant dialogue. The cartographer records the settlement of Palekastro, the saltpans, the castle and the harbour, revealing the dynamic relationship of the town with both its seafront and its hinterland.

The area represented by Basilicata is now included in the UNESCO Sitia Geopark, one of the most representative areas where geological heritage intersects with rich biodiversity, offering optimal conditions for cultural and nature-based excursions (notably the archaeological sites of Itanos, Roussolakkos and the Monastery of Toplou).The natural vegetation of the region[43] is mainly shrubby and phrygana-type, with clusters of trees along streams and gorges. The *Vai palm forest*, dominated by the Cretan date palm (*Phoenix theophrasti*), stands out, along with small groves of kermes oaks, plane trees and carobs. Within the NATURA 2000 network, the region includes coastal dunes with junipers, steppe and rocky ecosystems, as well as seasonal wetlands in Chiona, Ziros, Maridatis and Zakros—critical habitats for migratory birds and key biodiversity nodes along the Europe–Africa corridor.

Basilicata's cartographic testimony thus provides a valuable foundation for the contemporary interpretation of the landscape: from the maps of the seventeenth century to today's environmental protection programmes, the territory of Sitia maintains an unbroken thread of natural and cultural identity. Through the cultural and nature routes of the Geopark, the visitor can follow the traces of the old cartographers and travellers, experiencing a landscape that unites light, memory and sustainable development.

4.2. Ierapetra – Myrtos – Arvi – Viannos

The southern coast of eastern Crete was already depicted in the seventeenth century through the Venetian engravings of Francesco Basilicata's *Regno di Candia* (c. 1618–1620), republished in the edition *The Kingdom of Crete – Maps* (1994). On map XXVII, entitled *Spiaggia di Mirto*, the beach of Myrtos is represented together with the river flowing into the

[43] informations from the Siteia Geopark's website

sea, the sailing vessels and the mountainous formations—an ensemble where cartography meets painting. Basilicata approaches the landscape as an organic system of nature, navigation and human presence, offering an early testimony to the relationship between space and lived experience.

Today, visitors can follow the course of the Myrtos river upstream towards its sources, along an idyllic route that passes through the scenic Sarakina Gorge, approximately 1.5 kilometres long.

Fig. 1 : The Myrtos Bay (Spiaggia di Mirto)
Resource: Vikelaia Municipal Library (1994 reprint)

Two centuries later, **Robert Pashley (1837)** followed the same southeastern route from Ierapetra to Viannos, giving new dimension to the same landscape. From the olive-covered villages of Myrtos and Sykologos to the valley of Arvi, Pashley combined physiographical observation with mythological recollection. As he writes, *"The road to Myrtos, after leaving the plain, passes through hills presenting points of view which are sometimes picturesque, and is never very far from the sea"* (Pashley 1837: 240). He also mentions the so-called *"Giant's Tomb"*, noting that *"In much more ancient times we find legends of mythical personages, the belief in whose existence is perhaps still more likely to have given rise to the name of the place"* (ibid.: 243–244).

At Arvi, he describes the discovery of a marble sarcophagus: *"Near the shore at Arvi a monument of ancient art was discovered, broken in pieces by peasants who probably sought for gold within. Fragments of marble show parts of a horse and a young female head"* (ibid.: 247–248). Pashley identifies Viannos with ancient *Biennos*, connecting the area with the Giants Otos and Ephialtes, who, according to mythology, defied Zeus.

The juxtaposition of Basilicata's cartographic vision and Pashley's travel narrative reveals the continuity of the same landscape across centuries — from the Venetian imagery of the seventeenth century to the British scientific gaze of the nineteenth. The *Spiaggia di Mirto* is not merely a cartographic representation but a cultural document, attesting to the enduring allure of southeastern Lasithi as a place of memory, myth and travel.

Agia Fotia – Mylonas Gorge – Hiking in Thripti

The map *Spiaggia di Santa Lucia* by Francesco Basilicata (c. 1618–1620) depicts with remarkable accuracy the coastal zone east of Ierapetra, corresponding to what is today known as Agia Fotia. The names recorded by the cartographer — *Gaidouronisi, Peristera, Scaglio* — have remained almost unchanged until the present day, confirming the continuity of the region's toponymic identity.

Fig.2: Basilicatas' Santa Lucia
Resource: Vikelaia Municipal Library

Peristera still designates the characteristic peninsula, while *Gaidouronisi* (today's Gaidouronissi or Chrysi Island) remains one of the most beautiful islands in the Mediterranean, famous for its cedar forest (*Juniperus macrocarpa*). The area is now protected as a fragile ecosystem: access is permitted only for swimming on designated beaches and overnight stay is strictly prohibited due to the pressure of overtourism.

Of particular interest is the small rocky islet marked on the map as *Scaglio*, identified with today's Daskaleio of Ierapetra. The name derives from the Italian *scoglio* (reef or rock islet) and seems to have frequently appeared in Venetian isolari[44]*Isola di Scaglio* — a term which, over time, evolved in Greek as *Daskaleio*. This linguistic transformation (*di Scaglio* → *Daskalio*) explains why dozens of small islets across Greece share the same name: they are linguistic remnants of the Venetian cartographic language.

Building upon this cartographic heritage, modern nature trails could be designed to connect the Mylonas Gorge — with its impressive waterfall — to the nearby Gorge of Agios Ioannis, which unfortunately suffered from wildfires last summer. In this way, visitors would have the chance to experience the Cretan landscape "through the eyes of the past": walking

[44]Nautical maps

along the same paths once painted by seventeenth-century cartographers and described with admiration by early travellers, rediscovering a unity of nature, history and memory.

Fig 3: View of the sea from Thrypti.
Source: personal collection.

The above observations and cartographic evidence served as a starting point for exploring how historical travel narratives can be integrated into the modern tourism development of the area. The next stage of the research focuses on visitors' attitudes towards the connection between literature, landscape and sustainable routes.

5. RESEARCH

5.1.Methodology

The empirical research was conducted during the last week of May and the first week of June 2025 in the region of Lasithi, Crete.The structure and formulation of the questionnaire followed established methodological principles for tourism research (Durbarry, 2020), ensuring clarity, simplicity, and relevance to the objectives of the study.
The sample consisted of 108 adult visitors, all independent travellers (not part of organised groups) who had participated in hiking excursions within the area.

Participants voluntarily responded to τhe instrument included **25 items**, the majority being closed-ended questions, while two allowed for short written responses (country of origin and previous travel experience)designed to explore their perceptions of literary, cinematic, and travel-text-based tourism, as well as their attitudes towards sustainable and alternative tourism forms.

The questionnaire included five demographic questions (gender, country of origin, age, education level, and income) and twenty thematic questions divided into the following sections:

- Literary and Film-Induced Tourism: familiarity with places connected to authors, literary characters or adaptations; preferences between book-based and film-based representations of destinations.
- Travel Texts and Cultural Routes: interest in following routes inspired by historical travel writings; motivations for such participation (e.g., historical, cultural, or experiential reasons); willingness to combine these routes with other tourism forms such as hiking, gastronomic, religious or agritourism.

- Sustainability and Slow Tourism: perceptions of literary tourism as a form of sustainable and low-impact travel; views on the connection between cultural heritage and environmental responsibility.
- Experience and Intention: previous participation in hiking or cultural routes and willingness to recommend literary or travel-text routes to others.

The data collected aimed to identify visitors' level of awareness and interest in literary and travel-text tourism as sustainable practices that foster cultural identity, community engagement, and local development.

5.2 Results

The analysis of the demographic data shows that the sample consisted of 108 participants, with a slight predominance of women (49.1%) over men (30.6%), while 20.4% preferred not to declare their gender. Age distribution is mainly concentrated in the 31–45 age group (43.5%), with smaller groups aged 18–30 (21.3%) and 46–60 (20.4%), indicating that the research primarily addressed active travellers of middle age.

Regarding the level of education, the majority of respondents hold a university degree (31.5%) or a postgraduate qualification (25%), while 7.4% possess a doctoral degree. This finding suggests that the sample is characterised by a high level of educational capital — an element consistent with the nature of literary and cultural tourism, which tends to attract visitors with advanced cultural awareness and interest.

In terms of income, most participants (41.7%) belong to the €30,001–40,000 category, while 32.4% report an income of up to €30,000. This distribution indicates a middle-income group, with the economic capacity to choose thematic travel experiences that require a certain level of financial comfort.

As for country of origin, the sample is multicultural, with major groups from France (26.9%), Germany (24.1%) and the United Kingdom (11.1%), followed by respondents from Italy, the Scandinavian countries and the Benelux region. This geographical diversity reinforces the international dimension of the study and highlights the intercultural appeal of Crete as a destination.

When it comes to sources of inspiration for choosing a destination, most participants mention travel TV series (26.9%) and literary works (21.3%), while personal recommendations (21.3%) also play a significant role. This finding shows that visual storytelling (through television or online series) coexists with literary influence, confirming the contemporary interaction between literature, image and tourism.

The majority (78.7%) consider the combination of literature with other forms of tourism attractive, confirming the interdisciplinary nature of the phenomenon, while 70.4% state that they are very or highly willing to participate in cultural routes based on old travel texts. Furthermore, 51.9% believe that literature has a strong positive impact on the image of a destination, and 37% "quite a lot," highlighting the powerful representational role of literary discourse.

Regarding motivations, the dominant factors are sustainability (39.8%) and cultural identity (29.6%), followed by interest in alternative tourism (13.9%). The emphasis on sustainability demonstrates the close link between literary experience and the principles of environmental and cultural responsibility.

6. CONCLUSIONS

The present study highlighted the importance of travel and literary textts as tools for cultural reconstruction and sustainable tourism development. The findings show that the audience

attracted to such forms of tourism is characterized by a high level of education, cultural sensitivity and a positive attitude towards activities that link literature with the landscape. The strong willingness to participate in routes based on travel writings confirms the potential of literary tourism to serve as a practical means of sustainable engagement with cultural heritage. At the same time, the research demonstrates that connecting the natural and cultural environment with travellers' narratives can serve as a starting point for creating a network of cultural routes, following the model of the Council of Europe. Such a network would strengthen the visibility of Crete as a destination of authentic experience, linking local identity with contemporary cultural interpretation and encouraging the active involvement of local communities.Within this framework, the importance of education and professional training of tourism professionals is also highlighted, as they are called upon to act as mediators between narrative, place, and the visitor, integrating cultural content into hospitality and guiding practices.

Finally, it becomes clear that strategic planning is essential. Integrating travel texts into cultural and tourism policies can open new perspectives for the sustainable development of Lasithi. The connection between research findings, cultural heritage and tourism practice allows for the formation of a coherent management framework — one that transforms memory into experience, narrative into identity, and tourism into a tool of cultural resilience.

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Appendix
Survey on Literary, Film-Induced and Sustainable Tourism in Lasithi, Crete
Section A: Demographic Information

2. Gender: ☐ Male ☐ Female ☐ Other / Prefer not to say
3. Country of origin: _____
4. Age: ☐ 18–30 ☐ 31–45 ☐ 46–60 ☐ 61-70 ☐ 71+
5. Education level: ☐ Secondary ☐ Higher ☐ University ☐ Postgraduate ☐ Doctorate
6. Annual income: ☐<15,000€ ☐ 15,001–30,000€ ☐ 30,001–50,000€ ☐ 50,001–60,000€ ☐>60,001€

Section B: Literary and Film-Induced Tourism
6. Have you ever visited a place related to the life of an author? ☐ Yes ☐ No
7. Have you ever visited a place mentioned in a literary work or connected with a literary character? ☐ Yes ☐ No
8. What most inspired your visit to a destination?
☐ A book ☐ A film ☐ A TRAVEL series ☐ FRIENDS ☐ Other
9. Which experience do you consider more authentic?
☐ Visiting a place linked to literature ☐ Visiting a place known from cinema
10. Do you believe that literature can positively influence a destination's image?
☐ Not at all ☐ Slightly ☐ Moderately ☐ Much ☐ Very much

Section C: Travel Texts and Cultural Routes
11. Would you be interested in following a modern cultural route based on an old travel text?
☐ Yes ☐ No ☐ Maybe
12. What would be your main motivation?
☐ Historical interest ☐ Cultural identity ☐ Contact with nature ☐ Alternative experience ☐ Sustainability
13. Would you be more likely to participate if the route were combined with another type of tourism?
☐ Yes ☐ No
14. If yes, which type would you prefer?
☐ Hiking tourism ☐ Gastronomic tourism ☐ Religious tourism ☐ Agrotourism ☐ Other _____
15. How important do you consider the inclusion of readings or literary excerpts during the

route?
☐ Not at all ☐ Slightly ☐ Moderately ☐ Very ☐ Extremely

Section D: Sustainability and Alternative Tourism

16. Are you familiar with the term "sustainable tourism"? ☐ Yes ☐ No
17. Do you consider literary tourism a form of soft or alternative tourism?
☐ Not at all ☐ Slightly ☐ Moderately ☐ Very ☐ Extremely
18. Do you think such tourism forms help protect natural and cultural heritage?
☐ Yes, greatly ☐ Yes, to some extent ☐ Not much ☐ Not at all
19. Would you prefer activities that promote environmental respect, even if they are less "touristic"?
☐ Yes ☐ Maybe ☐ No
20. Would you support the inclusion of literary and travel-text routes in sustainable tourism programmes?
☐ Definitely yes ☐ Yes, under conditions ☐ No

Section E: Experience and Intention

21. Have you ever participated in an organised cultural or hiking route? ☐ Yes ☐ No
22. If yes, where? _____
23. What do you consider the main value of such routes?
☐ Environmental awareness ☐ Cultural knowledge ☐ Social interaction ☐ Recreation
24. Would you recommend a literary or travel-text route to others? ☐ Yes ☐ Maybe ☐ No
25. How would you describe your overall attitude towards literary tourism?
☐ Negative ☐ Neutral ☐ Positive ☐ Very positive

THE CULTURAL HERITAGE OF TENEDOS AS A DRIVING FORCE FOR LOCAL DEVELOPMENT AND INNOVATIVE BUSINESS ACTIVITIES

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Abstract
Tenedos possesses a rich cultural heritage that serves as a strong element of local identity and an attractive factor for both residents and visitors. Leveraging this heritage through innovative business activities can act as a catalyst for sustainable local development while promoting the preservation and dissemination of traditional customs, historical monuments, and local products. The combined use of cultural initiatives and modern technologies creates opportunities to strengthen the local economy, attract high-quality tourism, and maintain social cohesion. Promoting traditions—such as festivals, viticulture, traditional gastronomy, and historical monuments—through organized cultural entrepreneurship programs contributes to regional revitalization, reinforces local identity, and fosters a sustainable development model that respects the past while looking toward the future.

Keywords: Cultural Heritage, Tenedos, Local Development, Cultural Entrepreneurship

INTRODUCTION

Tenedos (Bozcaada in Turkish), the third-largest island in the northeastern Aegean Sea, had a recorded population of 3,223 in 2018. Geographically, the island occupies a strategic position between the coast of Asia Minor and the island of Lemnos, situated approximately 2.5 nautical miles from the Turkish mainland and 12 nautical miles from the entrance to the Hellespont. Its location, coupled with its natural resources, has played a decisive role in shaping its trajectory of development, particularly in the sphere of tourism over the past few decades, establishing Tenedos as a notable destination within the region. Characterized by its fertile land and the absence of steep mountainous terrain, the island is especially renowned for its longstanding viticultural tradition. Residential activity is primarily concentrated in the settlement of Tenedos and the adjacent port area located on the island's eastern coastline.

Despite its small size, Tenedos has a rich cultural heritage. Its historical path parallels that of Imbros, although it followed a different developmental course due to its exploitation as a summer resort for wealthy Turks since the early 20th century. This development contributed to the alteration of part of its natural environment, in contrast to Imbros, which remained more unaffected by mass tourism. However, Tenedos still retains important architectural and cultural elements, which, combined with its wine tradition, offer opportunities for the development of cultural entrepreneurship with an emphasis on sustainable tourism and cultural revival

ISTORICAL BACKGROUND

Tenedos bears historical traces dating back to the Neolithic Age, with the earliest signs of habitation dating back to the 6th millennium BC. In ancient times, it was an important port and strategic point in the Aegean Sea, while it was known for its agricultural production,

pottery, and—above all—viticulture. The island is said to have taken its name from King Tennes, and is already mentioned in the Homeric epics in connection with the Trojan War. During historical times, it was successively ruled by the Aeolians, Persians, Athenians, Macedonians, Romans, and Byzantines.

During the Byzantine period in particular, Tenedos gained strategic importance due to its proximity to Constantinople. In 1376, it fell to the Venetians, who reinforced its fortifications. During the Venetian-Turkish and Russo-Turkish wars (17th-18th centuries), Tenedos was a point of conflict and was repeatedly deserted and repopulated.

The island was closely linked to the Greek presence, especially during the 19th and 20th centuries, until it became part of Turkish territory with the Treaty of Lausanne (1923). Despite initial provisions for autonomy and respect for the rights of the Greek minority, subsequent policies led to the gradual expulsion and decline of the Greek element. Greek education was abolished in 1964, while military actions and administrative interventions contributed to the complete demographic decline of the minority.

Today, the Greek presence in Tenedos is symbolic, with a small number of inhabitants and a strong element of nostalgic reconnection through cultural activities, restorations, and customary revivals by the Tenedian diaspora. These conditions highlight both the difficulties and the possibilities for cultural entrepreneurship, with a focus on historical memory, cultural revival, and sustainable tourism.

CURRENT CHALLENGES AND OPPORTUNITIES FOR CULTURAL ENTREPRENEURSHIP IN TENEDOS

The case of viticulture

Tenedos is a prime example of a region with dynamic cultural entrepreneurship, thanks to the exploitation of its wine-making tradition. Viticulture, deeply rooted in local history and religious tradition, has been associated since ancient times with Dionysus, the god of wine and fertility. The worship of the god, in the particular form of Dionysus-Zagreus, is found in Tenedos in ritual practices that even included animal sacrifices, such as the sacrifice of calves following their birth, an act symbolically linked to the sacrificial rebirth of the god (Kakridis, 1986; Kerenyi, 2014; Seaford, 2015).

Archaeological finds, such as coins and ritual symbols, confirm the long and uninterrupted presence of viticulture in the economic and cultural life of the island. Tenedos was—and remains—known for its table and wine grapes. The crops included traditional varieties such as "augoustiades,""tsaousia," and, for wine production, "gkoutris,""vasilatsa," and "yapiltsatsa" (Kerkineoglou, 2008).

The process of harvesting and transporting grapes, mainly to Constantinople, was carried out with absolute respect for the fruit and the markets, forming a distribution network that incorporated commercial strategy, know-how, and folk tradition. Local producers used methods such as advance sales of their production or direct cooperation with winemakers, while much of the transport was carried out by caiques or traditional means of transport, which were festively decorated with "chouchlouvitsis" and bells, giving the process the character of a local ritual (Kerkineoglou, 2008).

Viticulture was not limited to the grape harvest; on the contrary, it was a continuous annual system involving tasks such as pruning, trimming, digging, and "disking." In addition, practices such as pruning, grafting, and sulphurization were applied, which required specialized knowledge, observation, and a deep understanding of nature. Until the mid-20th century, farmers used natural materials such as manure and traditional mixtures (e.g., blue stone with lime) to protect their plants. It was only after 1960, when production was severely

affected by downy mildew, that the use of agrochemicals and specialized tools began systematically.
The creation of new vineyards was also based on traditional techniques, such as grafting wild vines with domesticated ones after two years of cultivation. The whole process reveals not only the agricultural know-how of the inhabitants, but also the cultural significance of viticulture as a pillar of identity and the local economy.

Today, traditional viticulture is subject to restrictions due to industrialisation, urbanisation, and tourist pressure. However, it remains a key factor in the cultural identity of Tenedos and a potential lever for cultural entrepreneurship. The potential for developing a sustainable agrotourism model centered on the local wine heritage is significant, provided that it is accompanied by strategies for promoting cultural practices, oral history, and rural art, as well as their interconnection with the contemporary visitor experience. The development of wineries open to visitors, viticulture museums, or cultural routes focusing on vine cultivation and its historical significance could strengthen the local economy and promote Tenedos as an example of cultural exploitation in a cross-border context.

Traditional structures, religious landmarks, and customs as cultural capital. Windmills: technological memories and local identity.

Until the early 20th century, eight windmills dominated the landscape of Deirmen Tepe on Tenedos, serving as important technical and social landmarks for agricultural production and interregional trade. The mills, powered by the island's strong winds, ground grain brought by the inhabitants of the surrounding villages on donkeys or horses. The windmills had twelve sails covered with canvas and were powered by millstones weighing 300 kg. The miller, usually Greek, was paid in cash or with a share of the production. After 1923 and the population exchange, the mills ceased to operate, and the area was altered by newer buildings. Today, only one semi-ruined windmill remains, while restoration programs have been underway since 2019. Their restoration could support the promotion of local craftsmanship and be included in an industrial heritage route (Haidoulis, 2017).

The monastery of Agia Paraskevi: worship, symbol, and reunification of the community

The monastery of Agia Paraskevi, built in 1657 on the lush foothills, is surrounded by eight centuries-old plane trees and overlooks the sea. It is inextricably linked to the religious and social life of Tenedos. Agia Paraskevi is honoured as the patron saint of the island and her feast day, which takes place on 26 July, is a major event that brings together the local and diaspora communities. The festive celebration, with traditional music, delicacies, and a communal meal under the trees, highlights the experiential continuity of tradition.

The church, which constitutes, together with the recently renovated Church of the Assumption of the Virgin Mary - the only functioning Orthodox church on the island, is accompanied by the adjacent Holy Spring - an underground vaulted structure, which needs immediate restoration. Despite the efforts of local associations and the Patriarchate, the relevant permit has not yet been obtained from the Turkish state. The maintenance of the site and its use as a religious and cultural point of interest can serve as a lever for cultural tourism, while maintaining respect for the sacred character of the site (Doumouzis, 2009).

Local museum and collective memory: the case of the Tenedos Local History Research Center

The Tenedos Local History Research Center is housed in the historic Toulmidis family residence, built in 1874. Since 2006, under the supervision of Hakan Guruney, it has been

operating as a museum, housing more than 5,000 objects that document everyday life on Tenedos. The collection was assembled through active collaboration with locals, who donated family heirlooms, photographs, documents, and objects related to viticulture, winemaking, and other traditional professions.

Particular emphasis is given to the way of life during the period 1925–1965, highlighting professions such as winegrower, blacksmith, basket weaver, and sailor. In addition, the museum presents the evolution of taverns and their contribution to the entertainment and cultural expression of the Greek community. The museum provides the basis for the development of experiential activities and educational programs that enhance the sustainability of local cultural entrepreneurship (Haidoulis, 2017; Poli & Malagas, 2024).

LOCAL CUSTOMS: FOUNTOUKERI AND APOKRIES AS LIVING INTANGIBLE HERITAGE

The revival of local customs such as Fountoukeri and Apokries offers strong potential for cultural commercialization while respecting authenticity. Fountoukeri, a gift offered by godparents to their godchildren on the eve of Epiphany, is a characteristic example of a customary gift with rich material and symbolic content. The composition of fruits, nuts, sweets, and candles testifies to the community's solidarity and social cohesion (Vrahopoulou, 2007).

Carnival in Tenedos includes a series of customary practices with costumes, folk festivals, traditional foods, satirical games, and offerings. Distinctive features, such as bear costumes, the custom of halva, and the ritual announcement of engagements, constitute a dynamic field of intangible cultural heritage. Promoting these customs and linking them to festival-based forms of tourism could add value to the local economy and strengthen the intergenerational transmission of tradition (Vrahopoulou, 2007).

PROPOSALS FOR CULTURAL ENTREPRENEURSHIP

Tenedos, with its wealth of intangible and tangible cultural resources, is an attractive but underrated place with significant development potential. The island's traditional viticulture, windmills, monasteries, and local customs are not only evidence of a multifaceted history but can also be promoted as pillars of sustainable cultural entrepreneurship and local development (Maniou, Vlassas & Anastasopoulou, 2022; Maniou, 2023). The exploitation of these elements through the creation of thematic cultural routes, such as the "Wine and Dionysus Route" and the "Paths of Faith and Memory," can significantly boost high-quality tourism, while also making use of modern technologies such as augmented reality and narrative guides (Maniou, 2023b; Maniou, 2024).

At the same time, the restoration and reopening of windmills and the Holy Spring, through collaborations with cultural organizations and international programs, can create new multipurpose spaces for culture and entrepreneurship, strengthening the local economy and promoting the preservation of cultural identity (Maniou, Mitoula & Kostakis, 2024; Maniou et al., 2024d).

The preservation and promotion of local customs, such as Fountoukeri and Apokries, through the organization of annual cultural events and the development of a market for traditional products, strengthens the sustainability of cultural heritage and the participation of the local community (Manola et al., 2025; Maniou & Mitoula, 2025). Furthermore, the use of the Tenedos Museum as a hub for cultural storytelling, with digital documentation and thematic exhibitions, contributes to the promotion of local history and cultural creativity, attracting new visitors and researchers (Maniou, Mitoula & Manola, 2025; Poli, 2019).

The networking of the Tenedian diaspora through digital archives and cultural gatherings strengthens reunification and collective memory, while at the same time mobilising resources and voluntary actions to promote local development (Maniou, Mitoula & Tsatalmpasoglou, 2025; Vouglanis et al., 2025). Cultural entrepreneurship in Tenedos, as in other island regions, can be a key driver not only of economic development but also of social cohesion, strengthening local identity and ensuring the intergenerational continuity of traditions (Maniou, 2023; Maniou et al., 2025).

The success of such ventures requires the active cooperation of local actors, academic institutions, and cultural organizations, with the aim of sustainable management of cultural heritage and innovation in entrepreneurship, always with respect for historical memory and social cohesion (Maniou, 2024).

COMPARATIVE STUDY OF GOOD PRACTICES IN CULTURAL ENTREPRENEURSHIP IN LESBOS, IMBROS, AND SIFNOS

A comparative study of cultural entrepreneurship practices in island regions with common characteristics can offer valuable lessons for promoting Tenedos as a destination for cultural tourism and sustainable development. The cases of Lesbos, Imbros, and Sifnos highlight different models of cultural capital exploitation based on local identity, innovation, and community participation.

Lesvos - Culture as a tool for regional development

Lesvos is becoming an important centre of gastronomy, culture, and sustainable tourism development, through the organisation of numerous gastronomic festivals, such as the Lesvos Food Fest, the Ouzo Festival, the Sardine Festival, the Octopus Festival, and the Trahanas Festival, as well as traditional festivals, such as the Tavros in Agia Paraskevi. These events combine wine and gastronomy with architectural and cultural heritage (Maniou, 2023; Maniou et al., 2024), using modern digital tools such as augmented reality (AR) applications and guides through QR codes, which enhance the visitor's experience and attract new age groups, as typically observed in the area of Agiasos.

In addition, women's cultural cooperatives and local cultural communities play a key role in the organisation, management, and implementation of these activities, promoting participatory development, empowering the local community, and preserving cultural heritage sustainably and innovatively.

Imbros - Reconnecting the diaspora and reviving cultural life

The case of Imbros is a model of reviving cultural practices through close links with the diaspora and the active return of the Imbrios (Maniou, 2024). The restoration of schools, churches, and community buildings, carried out in collaboration with the diaspora and with the valuable contribution of the Ecumenical Patriarchate, has led to the creation of new spaces of cultural encounter and revitalisation of local identity (Poli, 2019).

At the same time, the preservation of traditional customs - such as festivals, music and cooking - is accompanied by the development of modern forms of cultural entrepreneurship, such as the operation of small museums, craft and pastry workshops and catering businesses, which are mainly concentrated in the villages of Imbros, thus contributing to the economic and cultural revitalisation of the island.

Sifnos - The example of gastronomic entrepreneurship

Sifnos successfully exploits its gastronomic heritage through the Cycladic Gastronomy Festival "Nikolaos Tselementes", an institution with international recognition. The festival combines traditional flavours, local products, live cooking demonstrations, cultural events,

and interactive experiences for young and old alike. It creates an environment of authentic participation, enhancing the local economy and the extroversion of the island. Parallel events highlight pottery, customs, and folk arts. The involvement of the local community and producers is a key component of its success. Sifnos is turning tradition into sustainable cultural entrepreneurship (e-sifnos.com).

CONCLUSIONS

Tenedos has a wealth of cultural resources, which remain largely unexploited, despite their significant development potential. The island's cultural heritage, both tangible and intangible, can act as a powerful driver of local development and sustainable entrepreneurship if a targeted and innovative approach is applied. The promotion and protection of traditional elements such as viticulture, windmills, monasteries, and local customs, combined with modern technologies and interactive experiences, can attract quality tourism and create new jobs.

The cooperation of local actors with scientific and cultural organisations, as well as networking with the Ténédia diaspora, is a key factor in the implementation of sustainable cultural activities and business initiatives. Cultural entrepreneurship in Tenedos is not only limited to the economic dimension, but contributes significantly to strengthening local identity, social cohesion, and intergenerational continuity of traditions.

Finally, the sustainability of the proposed actions requires a holistic approach that combines the protection of historical memory with innovative, digital, and participatory practices. In this way, Tenedos can strengthen its competitiveness as a cultural and sustainable tourism destination and become an example of successful cultural entrepreneurship in island regions.

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FROM STRATEGIC NAVAL BASE TO CULTURAL ASSET - THE MILITARY HERITAGE OF LEROS

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Abstract
Leros, a picturesque island of the Dodecanese, combines striking natural beauty with a distinctive and multifaceted historical heritage. Its history is deeply marked by the period of Italian occupation (1912–1943), when the island was strategically chosen by the Italian authorities as a central naval base in the southeastern Aegean. During this period, Leros was transformed into one of the most heavily fortified sites in the Mediterranean, with an extensive network of military infrastructures such as coastal batteries, tunnels, barracks, naval facilities, and command centers. These constructions, built in harmony with the natural relief yet imposing in scale and design, continue to shape the built environment of the island today.

The legacy of this fortification program is particularly significant, as it not only altered the urban and rural landscape but also created a cultural layer that reflects the geopolitical ambitions of the early twentieth century. Following the end of the Second World War and the incorporation of the Dodecanese into Greece, many of these structures were abandoned or repurposed, yet their presence remains tangible, contributing to the island's unique character.

In contemporary times, Leros has been developing as a tourist destination that balances traditional island culture with alternative forms of tourism. The coexistence of military heritage and natural landscapes offers new opportunities for cultural, educational, and experiential tourism. By reinterpreting the Italian fortifications not merely as remnants of conflict but as cultural resources, they can serve as focal points for thematic routes, open-air museums, and heritage trails that narrate broader Mediterranean histories of occupation, resistance, and adaptation.

This article explores how the Italian fortification works have shaped the identity and spatial organization of Leros and how they can be reimagined within the framework of sustainable tourism planning. It argues that integrating military heritage into the tourism profile of the island fosters both preservation and innovation, creating immersive experiences that connect visitors with the natural beauty of Leros, its architectural legacy, and its layered historical narratives. Ultimately, the study emphasizes the potential of Leros to emerge as a paradigm of cultural tourism development, where memory, history, and landscape are interwoven into a coherent and sustainable strategy for the future.

Key words: Leros, Dodecanese, Italian occupation, Military fortifications, Naval base, Cultural heritage, Historical, Sustainable tourism

SUSTAINABLE DEVELOPMENT OF THE ANCIENT GREEK THEATRE, THE CASE STUDY OF PHILIPPI

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Abstract
Culture is a fundamental pillar of human history, especially in times of multifaceted crises. Today's society faces the effects of ongoing climate change, which poses a significant threat to cultural heritage. The primary objective is the protection of human culture through a dynamic framework of sustainable design, tailor-made for each type of heritage.

This paper investigates the protection and management of heritage that combines both cultural and natural elements. Sustainability and contemporary development - guided by technological progress, are key components of the proposed management plan, which must be adapted to each specific heritage case. The case study presented in this research is the ancient Greek Theatre of Philippi, located in northern Greece,within the archaeological site of Philippi, which is situated in the Kavala region of Eastern Macedonia in Greece. This theatre is integrated into the natural environment, forming a cultural landscape, and represents a recognizable historical structure including the cavea, the orchestra and stage *(skene)*.

To assess the risks and vulnerabilities of the theatre related to climate change, the methodology involves a combination of risk assessment and vulnerability analysis, along with the collection of climatic data of the location of heritage, retrieved from the meteorological station of Kavala. Based on this analysis, the aim is to develop a sustainable management plan that respects the heritage values, reflects the identity of the theatre, and preserves the spirit of the place of Philippi.

Key words: cultural heritage, climate change, management plan, spirit of the place

SESSION

"Digital transformation and sustainable development"

Chaired by **Assoc Prof Menshikova Maria** and **Assoc Prof Zamfir Natalia**

SUSTAINABLE URBAN REGENERATION IN MEDITERRANEAN CITIES: URBAN PLANNING PERSPECTIVES ON DIGITALIZATION AND ARTIFICIAL INTELLIGENCE

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Abstract
Sustainable urban regeneration is a critical challenge for Mediterranean cities, where historic layers, compact built environments, and social complexity intersect with climate change pressures. In this context, digital transformation is reshaping urban planning and regeneration practices. Artificial Intelligence (AI), digital twins, Building Information Modelling (BIM), and Virtual Reality (VR) are increasingly employed in urban interventions, promising more resilient and adaptive futures while also raising questions of governance, ethics, and inclusiveness.

This paper explores the role of digital tools in advancing sustainable regeneration in Mediterranean cities. The methodology combines a critical review of emerging digital applications with case studies of innovative projects. Emphasis is placed on the contribution of digital tools to environmental assessment, quality-of-life indicators, and integrated planning, as well as on the risks of technological determinism and social inequality.

Findings indicate that digital technologies can optimize resource efficiency, support climate adaptation, and enhance participatory planning. For example, digital twins simulate the impact of adaptation strategies at neighborhood scale, while AI-driven models improve energy and mobility management. VR and AR tools enable citizens to visualize and co-design regeneration projects, strengthening public engagement. However, challenges persist: financial and technical demands often exceed municipal capacities, particularly in smaller Mediterranean cities, and ethical issues such as privacy and algorithmic bias threaten democratic governance. Importantly, digital divides risk excluding vulnerable populations from digitally driven regeneration processes.

The study concludes that sustainable urban regeneration requires balancing digital innovation with the cultural and environmental specificities of Mediterranean urbanism. Compact urban forms, historic centers, and strong community ties must guide the adaptation of digital tools. Interdisciplinary approaches that link urban design, digital technology, and social sciences are essential to ensure that the digital transition enhances, rather than undermines, sustainability, resilience, and equity.

Key words: Urban regeneration, mediterranean cities, sustainable development, artificial intelligence, digital twins, virtual reality, smart cities

INTRODUCTION

Mediterranean cities constitute complex urban ecosystems shaped by historical continuity, dense spatial configurations, and strong socio-cultural identities. These characteristics, while

representing significant cultural capital, simultaneously intensify contemporary urban challenges related to environmental sustainability, climate resilience, and social cohesion (UN-Habitat, 2020). In recent decades, the need for sustainable urban regeneration has emerged as a central priority for Mediterranean urban policy and planning, particularly as cities confront escalating climate pressures, demographic transformations, and socio-economic inequalities. Sustainable urban regeneration is increasingly conceptualized as a multidimensional process integrating environmental, social, economic, and cultural dimensions of urban development (Dixon et al., 2008; Kalemis, 2024).

Mediterranean urban environments are particularly vulnerable to climate-related risks, including heat island effects, water scarcity, coastal degradation, and infrastructure stress caused by extreme weather events. At the same time, the preservation of historic urban fabrics and cultural heritage presents additional constraints for regeneration strategies, requiring interventions that balance conservation with innovation. Urban sustainability in such contexts extends beyond environmental performance to encompass social inclusiveness, democratic participation, and cultural continuity. As Amin (2006) argues, sustainable cities must promote equitable urban citizenship and social interaction while maintaining spatial and cultural diversity. Similarly, ecological urbanism approaches highlight the need for integrated planning strategies that align environmental adaptation with urban design innovation and socio-cultural values (European Commission, 2019).

Within this evolving planning landscape, digital transformation has emerged as a significant driver reshaping urban regeneration practices. Advances in digital technologies are enabling new forms of urban analysis, modelling, and participatory planning, transforming traditional planning methodologies into data-driven and simulation-based decision-making processes. Technologies such as Building Information Modelling (BIM), digital twins, artificial intelligence (AI), and immersive visualization environments, including Virtual Reality (VR) and Augmented Reality (AR), are increasingly employed to support sustainable urban interventions. These digital tools facilitate integrated urban management by enabling real-time environmental monitoring, predictive modelling, and improved coordination between stakeholders and governance levels.

BIM technologies, for instance, support lifecycle sustainability assessment and resource optimization across built environment projects, enhancing planning accuracy and cost efficiency (Kamari et al., 2020). Digital twins extend these capabilities by allowing real-time simulation of urban systems, supporting climate adaptation planning, infrastructure resilience, and energy optimization strategies (Post et al., 2017; Boyes et al., 2018). Artificial intelligence further strengthens urban resilience through predictive analytics, automated decision support, and smart infrastructure management. However, algorithmic governance also introduces ethical challenges concerning transparency, accountability, and social equity, raising concerns about data privacy, algorithmic bias, and democratic legitimacy in urban decision-making processes (Sharma, 2025).

Simultaneously, immersive digital environments such as VR and AR are transforming participatory urban planning by enabling citizens to visualize, experience, and co-design regeneration proposals. These technologies enhance public engagement and improve communication between planners, policymakers, and local communities, contributing to more inclusive and socially sustainable regeneration processes (Jamei et al., 2017; Nikolić & Whyte, 2021). Moreover, the emergence of human-centric digital design frameworks emphasizes the importance of aligning technological innovation with societal needs and ethical governance principles, reinforcing the concept of digital humanism in urban planning (Najafi et al., 2025).

Against this background, this study aims to explore the role of digital technologies in advancing sustainable urban regeneration within Mediterranean cities. The research investigates how AI, BIM, digital twins, and immersive visualization tools contribute to environmental sustainability, urban resilience, and participatory governance while addressing the socio-cultural specificities of Mediterranean urban contexts. Particular attention is given to the opportunities and risks associated with digital urban transformation, including technological determinism, digital divides, and governance challenges.

Methodologically, the study adopts a qualitative research approach combining a critical literature review with the analysis of selected case studies from Mediterranean urban environments. The literature review examines theoretical frameworks and empirical research concerning digital urbanism, sustainability planning, and socio-technical governance. Case studies are used to illustrate practical applications of digital tools in urban regeneration projects, providing insights into their effectiveness, limitations, and transferability across Mediterranean cities. Through this combined analytical framework, the study seeks to contribute to the ongoing discourse on sustainable urban regeneration by proposing integrated and human-centered digital planning strategies tailored to Mediterranean urban realities.

MEDITERRANEAN URBANISM: ENVIRONMENTAL AND SOCIO-SPATIAL CHALLENGES

Mediterranean urbanism is defined by a distinctive convergence of historical continuity, compact morphology, climatic exposure, and deeply embedded socio-cultural practices. Cities across the Mediterranean basin have evolved through layered historical processes, producing dense urban fabrics in which contemporary life coexists with archaeological strata, vernacular building typologies, and enduring public space traditions. This morphological density has long supported walkability, mixed uses, and intense social interaction. Yet under conditions of climate change, socio-economic restructuring, and digital transition, the same structural characteristics now generate complex environmental and governance challenges.

Unlike Northern European or globally standardized metropolitan models, Mediterranean cities are characterized by narrow street canyons, deep urban blocks, high building coverage ratios, and semi-private courtyard systems. Historically, such compactness provided climatic advantages, such as shading, wind protection, and passive cooling, contributing to energy-efficient vernacular environments. However, rising temperatures and prolonged heatwaves have altered this balance. Spatial configurations that once mitigated climatic extremes increasingly intensify urban heat island (UHI) effects, restrict air circulation, and exacerbate heat accumulation.

Empirical research on Mediterranean urban morphology confirms that street canyon geometry plays a decisive role in thermal performance. High height-to-width (H/W) ratios are associated with reduced air exchange and increased thermal stress during heatwave events (Tsirigoti & Tsikaloudaki, 2018). More recent studies demonstrate that canyon orientation, surface materials, albedo values, and vegetative cover significantly influence solar exposure and nocturnal heat retention cycles (Tsirigoti, 2025b). These findings suggest that Mediterranean urban density, once a climate-adaptive strategy, now contributes to overheating, with direct implications for energy consumption, livability, and public health.

The environmental challenges of Mediterranean cities extend beyond heat stress. Dense block structures limit permeable surfaces and reduce opportunities for vegetation and ecological connectivity. Fragmented open spaces constrain the implementation of large-scale nature-based solutions, while heritage preservation requirements restrict extensive

infrastructural redesign (IPCC, 2022). As Mostafavi and Doherty (2016) argue within ecological urbanism discourse, sustainable regeneration in such contexts must integrate environmental systems with cultural landscapes through adaptive, multi-scalar approaches rather than standardized interventions.

A defining yet often overlooked element of Mediterranean morphology is the inner courtyard. Present in the majority of multi-storey urban blocks, courtyards function as semi-private micro-urban ecosystems with substantial environmental and social potential. Recent research identifies inner courtyards as microclimatic sinks capable of lowering local air temperatures, enhancing ventilation, and supporting small-scale cooling strategies (Tsirigoti, 2025a). Vegetative integration, permeable paving, reflective surfaces, and vertical greening systems can significantly improve courtyard thermal performance. Moreover, simulation studies demonstrate that block-scale renovation scenarios, combining façade retrofits, roof interventions, and courtyard upgrading, reduce energy demand and enhance comfort conditions (Tsirigoti, Zenginis & Bikas, 2021; 2022).

Courtyards, however, are not merely environmental devices. They hold strong socio-cultural significance as communal gathering spaces embedded in everyday Mediterranean life. Historically serving as semi-public nodes of domestic and social interaction, they contribute to collective identity and place attachment. Their regeneration therefore intersects environmental resilience with cultural sustainability, a concept extending beyond heritage preservation to include intangible practices, social networks, and lived urban memory (Crang, 2015; Travis, 2017).

Environmental vulnerability in Mediterranean cities is closely intertwined with socio-economic inequality. Access to thermally comfortable public space remains unevenly distributed, with marginalized populations often disproportionately exposed to heat stress. Tourism-driven development, speculative housing markets, and demographic change further intensify spatial polarization in historic centers. As Amin (2006) argues, the quality of the "good city" depends not only on physical performance but on equitable access to urban resources and meaningful civic participation. Colantonio and Dixon (2011) similarly emphasize social sustainability as a central dimension of urban regeneration, highlighting participation, cohesion, and place-based identity as critical factors in long-term transformation.

In this context, sustainable urban regeneration in Mediterranean cities cannot be reduced to physical upgrading or environmental optimization. It must reconcile environmental adaptation, social justice, and cultural continuity. The complexity of Mediterranean urban fabrics, morphologically dense, climatically vulnerable, socially layered, requires integrated planning approaches that combine microclimatic knowledge, morphological sensitivity, and participatory governance.

At the same time, governance structures often remain fragmented, with limited integration between environmental monitoring systems, spatial planning instruments, and digital data infrastructures. The adoption of digital tools, ranging from environmental sensing to immersive participation platforms, introduces both opportunities and risks. While digital transformation offers enhanced modelling capacity and real-time climate monitoring, digital divides may reproduce socio-spatial inequalities if participation mechanisms are not inclusively designed (Ridell, 2008).

Recent regeneration initiatives illustrate these tensions. Barcelona's Superblocks program demonstrates how public space reallocation, mobility restructuring, and environmental monitoring can reinforce neighborhood-scale social life while mitigating heat and pollution. In contrast, large-scale redevelopment projects such as Athens' Ellinikon reveal the complexity of balancing investment-driven regeneration with inclusive governance and

metropolitan integration, reducing the effects of urban sprawl in the waterfront location (Theodora & Spanogianni, 2022; 2026). Similarly, cities such as Naples and Málaga must reconcile tourism-led growth with environmental resilience and cultural authenticity.

These cases underline a central insight: Mediterranean urbanism constitutes a critical testing ground for sustainable regeneration models that must operate within historically layered, climate-sensitive, and socially embedded contexts. Sustainability in this region cannot be imported as a generic smart city formula. It must be culturally grounded, climatically responsive, and spatially adaptive.

The environmental and socio-spatial challenges outlined above establish the foundation for examining how emerging digital technologies (BIM, Digital Twins, AI-driven analytics, and immersive systems) can operationalize microclimatic intelligence, support adaptive design, and foster inclusive governance. Digital transformation, when aligned with the morphological and cultural specificity of Mediterranean urbanism, becomes not a technocratic overlay but a strategic mediator between climate resilience, spatial form, and social sustainability.

DIGITAL TRANSFORMATION AND SMART URBAN REGENERATION

The growing complexity of urban challenges has accelerated the adoption of digital technologies in urban planning and regeneration processes. Over the past two decades, the concept of the "smart city" has evolved from a technology-driven model focused on efficiency and automation toward a broader paradigm of digital urbanism that emphasizes integration, adaptability, and human-centered design. This shift reflects increasing recognition that technological solutions alone cannot address urban sustainability without consideration of social, cultural, and governance dimensions.

Digital urbanism encompasses a range of interconnected technologies that support data-driven decision-making, system integration, and participatory planning. Among these, Building Information Modelling (BIM) has emerged as a foundational tool for sustainable urban development. BIM enables the creation of detailed digital representations of buildings and infrastructure, supporting lifecycle assessment, resource optimization, and coordinated planning across disciplines. In the context of urban regeneration, BIM facilitates sustainability-oriented design decisions by integrating environmental performance, cost analysis, and maintenance considerations throughout the project lifecycle (Kamari et al., 2020).

Building upon BIM, digital twins represent a significant advancement in urban modelling and simulation. Digital twins are dynamic, data-driven replicas of physical urban systems that enable real-time monitoring, scenario testing, and predictive analysis. At the urban scale, digital twins support energy modelling, climate adaptation strategies, and infrastructure resilience by simulating the impacts of policy interventions and environmental changes. When combined with Internet of Things (IoT) infrastructures, digital twins enable continuous feedback loops between the physical city and its digital counterpart, enhancing responsiveness and adaptive capacity (Batty, 2018).

The integration of BIM, Geographic Information Systems (GIS), and digital twins further enhances spatial holism in urban planning. GIS provides the geospatial framework necessary to contextualize building-level data within broader urban systems, enabling multi-scalar analysis of land use, mobility, environmental conditions, and socio-economic patterns. This integrated digital ecosystem supports more informed and coordinated regeneration strategies, particularly in dense and historically complex Mediterranean urban environments.

Artificial intelligence (AI) plays a complementary role by enabling advanced analytics, pattern recognition, and predictive modelling across urban systems. AI-driven tools are increasingly applied to optimize traffic flows, energy consumption, waste management, and climate risk assessment. In regeneration contexts, AI supports scenario evaluation and decision-making under uncertainty, enhancing urban resilience and operational efficiency. However, the growing reliance on algorithmic systems also raises critical concerns regarding transparency, accountability, and social equity (Kalemis, 2025c).

The risk of technological determinism, where technological capabilities drive planning decisions without adequate social or ethical scrutiny, remains a central challenge in digital urban regeneration. Algorithmic governance may reinforce existing inequalities if data biases, unequal access to digital tools, and opaque decision-making processes are not adequately addressed. Human-centric digitalization frameworks argue for the alignment of technological innovation with democratic values, participatory governance, and social inclusion (Kalemis, 2025c). In this perspective, digital tools should function as enablers of collective intelligence rather than substitutes for human judgment and civic deliberation.

In Mediterranean cities, where social interaction, cultural identity, and public space play a fundamental role in urban life, the human-centric approach to digital transformation is particularly critical. Digital technologies must be adapted to local contexts, supporting inclusive participation, cultural sustainability, and context-sensitive regeneration rather than imposing standardized smart city models. By integrating BIM, digital twins, AI, and participatory digital platforms within a coherent socio-technical framework, digital urbanism offers significant potential to enhance sustainable urban regeneration while respecting the unique characteristics of Mediterranean urban environments.

ARTIFICIAL INTELLIGENCE AND URBAN RESILIENCE

The increasing frequency and intensity of environmental, social, and infrastructural disruptions have elevated urban resilience as a central objective of contemporary planning and regeneration strategies. Urban resilience refers to the capacity of cities to anticipate, absorb, adapt to, and recover from environmental shocks, socio-economic crises, and technological disruptions while maintaining essential urban functions and social stability. Within this framework, artificial intelligence (AI) is emerging as a transformative tool capable of enhancing adaptive urban governance, predictive planning, and integrated infrastructure management.

AI-driven urban systems rely on large-scale data collection, machine learning algorithms, and predictive analytics to support decision-making processes across multiple urban sectors. In climate-sensitive Mediterranean cities, where environmental vulnerability intersects with dense urban morphology and socio-cultural complexity, AI offers substantial opportunities to strengthen adaptive planning. Through the analysis of environmental data, mobility patterns, and energy consumption, AI systems enable early warning mechanisms, real-time monitoring, and optimization of urban services. These capabilities support proactive rather than reactive urban management, enhancing resilience against climate-related hazards such as heatwaves, flooding, and air pollution.

One of the most significant applications of AI in urban resilience relates to environmental monitoring and climate adaptation. Machine learning algorithms can process large environmental datasets derived from satellite imagery, sensor networks, and digital twins to identify vulnerability hotspots and predict climate risks. AI-driven climate modelling supports urban heat mitigation strategies, flood risk mapping, and optimization of green

infrastructure planning (European Commission, 2023). Such data-driven approaches allow urban planners to simulate alternative regeneration scenarios and evaluate their environmental and social impacts before implementation. Beyond environmental applications, AI also contributes to infrastructural and mobility resilience. Intelligent transport systems utilize AI algorithms to manage traffic flows, reduce congestion, and optimize public transportation networks. These systems improve urban accessibility and reduce greenhouse gas emissions, contributing to both environmental sustainability and economic efficiency. Additionally, AI supports predictive maintenance of urban infrastructure by identifying structural vulnerabilities and forecasting maintenance needs, reducing long-term operational costs and enhancing infrastructure reliability (Kalemis, 2025b).

Despite these advantages, the integration of AI into urban governance introduces significant ethical, social, and political challenges. Algorithmic decision-making processes often operate through opaque computational models, raising concerns regarding transparency, accountability, and democratic legitimacy. As Werthner et al. (2024) emphasize, algorithmic governance risks reinforcing existing social inequalities if data biases and digital exclusion are not adequately addressed. Urban data infrastructures frequently reflect existing socio-economic disparities, potentially marginalizing vulnerable communities if AI systems prioritize efficiency over equity.

In response to these concerns, human-centric AI frameworks advocate for participatory governance, ethical algorithm design, and inclusive data practices. Digital humanism perspectives emphasize that AI systems should support collaborative decision-making rather than replace human agency. In Mediterranean cities, where community identity and social interaction are fundamental components of urban life, such human-centered approaches are particularly relevant. Urban resilience therefore depends not only on technological capacity but also on governance models that integrate citizen participation and cultural sensitivity.

The application of AI and related digital technologies in Mediterranean urban regeneration can be illustrated through emerging case studies. In Barcelona, the Superblocks (Superilles) initiative integrates digital monitoring systems and data analytics to evaluate environmental and social impacts of traffic reduction strategies (Frago & Morcuende González, 2024). Urban data platforms and sensor networks support real-time monitoring of air quality, noise levels, and mobility patterns, enabling adaptive policy adjustments and evidence-based planning. AI-supported urban analytics contribute to the optimization of pedestrian networks, public space allocation, and climate mitigation strategies, reinforcing Barcelona's transition toward human-centered urban resilience.

Athens provides a contrasting yet equally instructive example through the large-scale regeneration project at the Ellinikon Metropolitan Park development. Digital modelling tools, including BIM and digital twin technologies, have been employed to support environmental simulation, infrastructure planning, and energy optimization within the redevelopment process. AI-driven analytics are increasingly explored for mobility management, energy efficiency modelling, and climate adaptation strategies within the broader metropolitan region (The Ellinikon, 2026). However, the project also illustrates governance challenges associated with large-scale digital urban projects, including questions of public participation, social inclusiveness, and equitable access to regenerated urban spaces (Theodoropoulou, 2025).

In Naples, digital mapping and data analytics are being used to support heritage preservation and tourism management. AI-assisted cultural heritage monitoring allows planners to track visitor flows, structural stress on historic sites, and environmental impacts of tourism, supporting sustainable heritage management strategies (Aria et al., 2023; Sommella & D'Alessandro, 2021). Similarly, Málaga has invested in smart urban platforms that

integrate energy monitoring, public service optimization, and environmental data analysis (Barke & Newton, 1995). These initiatives demonstrate how AI-driven urban management can support both economic development and environmental sustainability, particularly in tourism-dependent Mediterranean economies.

The comparative analysis of these case studies highlights the importance of integrating AI within broader socio-technical planning frameworks. Successful AI-based urban resilience strategies require the coordination of digital infrastructure, governance mechanisms, and community participation. Mediterranean cities demonstrate that technological innovation alone cannot ensure sustainable regeneration without consideration of cultural identity, social equity, and participatory governance structures.

Consequently, AI should be conceptualized not merely as a technological instrument but as a component of integrated urban knowledge systems. By combining AI with digital twins, BIM, and participatory digital platforms, urban planners can develop adaptive, evidence-based regeneration strategies capable of addressing complex urban challenges. In Mediterranean contexts, where environmental vulnerability intersects with strong cultural and social identities, AI-driven urban resilience must prioritize human-centered innovation, ensuring that digital transformation enhances both environmental sustainability and urban inclusiveness.

IMMERSIVE TECHNOLOGIES (VR/AR) AND PARTICIPATORY URBAN PLANNING

While artificial intelligence and digital twins enhance predictive capacity and infrastructural optimization, immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) expand the social and participatory dimensions of digital urban regeneration. In the context of Mediterranean cities, where public space, social interaction, and collective identity constitute core elements of urban life, immersive digital environments provide significant opportunities to strengthen democratic engagement and co-creative planning practices (Kalemis, 2025a).

Participatory planning has long been recognized as essential for socially sustainable regeneration, particularly in culturally dense and historically layered urban environments (Amin, 2006; Colantonio & Dixon, 2011). However, conventional participatory mechanisms, such as public hearings, static masterplans, and two-dimensional representations, often limit citizens' ability to fully comprehend spatial transformations or evaluate alternative design scenarios. Immersive technologies address this limitation by enabling experiential visualization of proposed interventions, allowing users to "inhabit" projected urban futures before their physical realization.

Virtual Reality applications allow planners, stakeholders, and residents to explore regeneration scenarios in three-dimensional, interactive environments. Such tools improve spatial understanding, enhance transparency in planning processes, and facilitate informed public deliberation. Jamei et al. (2017) demonstrate that VR-based visualization significantly improves citizens' comprehension of complex urban proposals, particularly in dense environments where spatial impacts are difficult to interpret through conventional drawings. Similarly, Nikolić and Whyte (2021) argue that immersive modelling environments foster collaborative learning and shared decision-making among multidisciplinary actors.

In Mediterranean cities, where urban regeneration frequently involves interventions in historic centers, waterfronts, and culturally sensitive public spaces, immersive technologies can function as mediating platforms between conservation and innovation. For example, VR simulations can evaluate the visual impact of pedestrianization schemes, green infrastructure

integration, or façade restoration projects within historic urban fabrics. By enabling stakeholders to compare alternative scenarios, immersive tools reduce conflict, enhance negotiation processes, and support culturally sensitive design outcomes.

Augmented Reality further extends participatory capabilities by overlaying digital information onto existing urban spaces. Through AR interfaces, citizens can visualize proposed interventions in situ, using mobile devices or wearable technologies. This real-time contextualization supports site-specific engagement and strengthens the relationship between digital representation and lived urban experience. AR tools are particularly relevant in tourism-intensive Mediterranean cities such as Naples and Málaga, where heritage interpretation, visitor management, and public space enhancement must be carefully balanced.

Barcelona's Superblocks initiative provides an illustrative example of how immersive and digital visualization tools can support participatory urban transformation. The reallocation of street space from vehicular traffic to pedestrian and community uses required extensive public communication and scenario testing (López et al., 2020). Digital simulations and interactive visualizations facilitated public understanding of traffic redistribution, environmental benefits, and public space redesign, strengthening citizen acceptance and adaptive governance processes. Immersive visualization thus complemented data-driven AI analytics and environmental monitoring systems, reinforcing an integrated digital ecosystem (Anguelovski et al., 2023).

In Athens, large-scale regeneration initiatives such as the Ellinikon Metropolitan Park redevelopment highlight both the potential and limitations of immersive planning tools. While digital modelling and visualization technologies have been employed to present masterplan proposals and environmental simulations, questions remain regarding the depth of participatory integration and inclusiveness. Immersive technologies, when embedded within transparent governance frameworks, can enhance civic dialogue; however, when used primarily as promotional visualization tools, they risk reinforcing top-down planning approaches. This distinction underscores the importance of aligning immersive technologies with democratic planning principles.

Beyond visualization, immersive environments increasingly intersect with emerging concepts such as the metaverse and hybrid digital-physical public spaces. These developments open new possibilities for civic interaction, urban experimentation, and digital co-production of space. Mystakidis (2022) conceptualizes immersive virtual environments as platforms for collaborative learning and social interaction, suggesting that metaverse-like systems may support new forms of urban engagement. At the policy level, the European Commission (2023) emphasizes both the opportunities and regulatory challenges associated with virtual worlds, particularly concerning data governance, digital rights, and social inclusion.

Nevertheless, the expansion of immersive planning technologies also raises critical concerns. Digital participation risks excluding populations with limited access to digital infrastructure or technological literacy, potentially reinforcing socio-economic divides. Moreover, immersive simulations may create persuasive visual narratives that influence public perception without fully disclosing underlying assumptions or data constraints. As with AI-driven analytics, immersive technologies must therefore operate within transparent, accountable, and human-centered governance frameworks.

In Mediterranean urban contexts, where social cohesion and cultural identity are foundational elements of urban resilience, immersive technologies should be conceptualized as facilitators of collective imagination rather than deterministic planning instruments. When integrated with AI analytics, BIM systems, and digital twins, VR and AR platforms can bridge the gap between technical expertise and community knowledge. This integration

supports not only environmentally optimized regeneration strategies but also socially embedded and culturally responsive urban futures.

Ultimately, immersive technologies expand the scope of digital urbanism by incorporating experiential and participatory dimensions into sustainable urban regeneration. In Mediterranean cities, their effective deployment depends on balancing technological sophistication with inclusiveness, cultural sensitivity, and democratic accountability. By fostering informed citizen engagement and shared spatial understanding, immersive digital tools contribute to a more resilient, adaptive, and socially grounded model of urban transformation.

COMPARATIVE DISCUSSION AND INTEGRATED FRAMEWORK PROPOSAL

The comparative analysis of Mediterranean urban regeneration initiatives demonstrates that sustainable transformation cannot be achieved through isolated technological interventions or fragmented planning strategies. Instead, resilience and sustainability emerge from the integration of environmental adaptation, socio-cultural continuity, participatory governance, and digital innovation within a coherent socio-technical framework.

The cases of Barcelona, Athens, Naples, and Málaga reveal differentiated trajectories of digital urbanism. Barcelona's Superblocks initiative illustrates a relatively mature integration of data-driven governance, environmental monitoring, and participatory communication tools. Here, AI-supported analytics, mobility simulations, and digital visualization platforms operate within a broader human-scale urban design strategy. Digital tools are not ends in themselves but instruments reinforcing pedestrianization, environmental quality, and neighborhood-level social interaction.

In contrast, the Athens Ellinikon redevelopment project reflects the complexities of large-scale metropolitan regeneration in economically constrained contexts. While advanced BIM systems, environmental simulations, and digital modelling technologies support design and infrastructure optimization, tensions remain regarding inclusiveness, social accessibility, and participatory depth. The case highlights the risk of digital sophistication coexisting with limited democratic integration.

Naples and Málaga demonstrate hybrid models in which smart urban platforms, tourism management systems, and environmental monitoring tools are progressively integrated into heritage-sensitive urban fabrics. These examples underline the importance of aligning digital innovation with local socio-economic structures and cultural identity.

Across these cases, three recurring patterns emerge:

1. *Digital Integration Enhances Environmental Performance.* The combination of BIM, GIS, digital twins, and AI analytics improves lifecycle assessment, climate modelling, infrastructure resilience, and mobility optimization.

2. *Participatory Digital Tools Strengthen Social Legitimacy*. VR/AR visualization and interactive platforms enhance transparency and stakeholder.

3. *Governance Structures Determine Outcomes*. Technological capacity alone does not guarantee equitable regeneration. Institutional design and regulatory frameworks shape whether digital transformation fosters inclusiveness or reinforces.

Table 1. Integrated Mediterranean Urban Regeneration Comparative Matrix

City	Environmental Stress & Climate Strategy	Digital Integration (BIM–DT–AI–VR)	Social Equity & Participation	Governance & Ethical Digitalization
Naples	High density; waste & tourism pressure; adaptive reuse strategies.	Limited systematic BIM/DT deployment; sector-specific analytics.	Citizen perception studies in tourism sustainability; socio-economic inequality visible.	Municipal-regional coordination; digital governance less institutionalized.
Málaga	Tourism-driven growth; energy sustainability focus.	Energy modelling and sectoral digital tools; moderate smart systems.	Consultation within tourism & mobility policy; moderate inclusion mechanisms.	Municipal planning-driven governance; limited AI-driven regulation.
Barcelona	Heat islands; traffic congestion. Superblocks reduce car dominance and enhance microclimate & air quality.	Advanced use of data analytics; digital mobility modelling; emerging digital twin logic.	Strong participatory urbanism tradition; equity debates around redistribution of space.	High municipal capacity; growing emphasis on transparency and public accountability.
Athens	Heat stress; coastal sprawl; large-scale regeneration (Ellinikon, Double Regeneration).	BIM in project-level planning; limited urban-scale digital twins; AI potential emerging.	Participation fragmented; risk of gentrification in flagship developments.	Mixed state–private governance; limited formal AI accountability framework.

Toward an Integrated Mediterranean Digital Regeneration Framework

Building on the comparative analysis of Mediterranean regeneration initiatives, this study proposes an Integrated Mediterranean Digital Regeneration Framework (IMDRF) structured as a coherent socio-technical system rather than a collection of discrete technological tools. The framework conceptualizes digital transformation as an embedded, multi-layered architecture that aligns environmental intelligence, spatial coordination, participatory engagement, and ethical governance within the specific morphological and cultural conditions of Mediterranean urbanism.

At its foundation lies an environmental intelligence layer, designed to enhance adaptive capacity in climate-vulnerable urban contexts. Mediterranean cities, characterized by dense fabrics and increasing heat stress, require real-time and predictive environmental knowledge systems. This layer integrates AI-driven climate modelling, urban digital twins capable of dynamic simulation, and distributed sensor networks monitoring temperature, humidity, air quality, and energy performance. Through predictive analytics and scenario modelling, municipalities can evaluate heat mitigation strategies, optimize water management systems, and assess energy performance across multiple temporal scales. Rather than reacting to climatic events, planning institutions are equipped to anticipate and simulate environmental impacts before implementing physical interventions. In this sense, environmental intelligence transforms sustainability from a reactive objective into a continuous adaptive process.

The second pillar, the spatial integration layer, ensures coherence across scales of intervention. Mediterranean regeneration often unfolds simultaneously at building, block, district, and metropolitan levels. Fragmented planning tools frequently undermine systemic sustainability by isolating architectural retrofits from broader territorial strategies. The integration of Building Information Modelling (BIM) for lifecycle management, Geographic Information Systems (GIS) for territorial analysis, and urban-scale digital twins for scenario

coordination enables multi-scalar alignment. BIM contributes detailed material, structural, and energy performance data at the building level, while GIS situates these interventions within broader environmental and socio-spatial patterns. Urban digital twins synthesize these datasets into interoperable platforms capable of modelling cumulative impacts. This spatial integration layer thus bridges the gap between microclimatic retrofitting, such as courtyard upgrading or façade interventions, and metropolitan sustainability objectives, including mobility restructuring, green infrastructure networks, and carbon neutrality targets.

Complementing environmental and spatial intelligence, the participatory immersive layer embeds civic engagement within digital regeneration processes. Mediterranean cities possess strong traditions of public life and collective spatial identity; regeneration strategies that neglect this social dimension risk eroding legitimacy and cultural continuity. Through VR and AR platforms, interactive digital consultations, and scenario-based co-design tools, citizens can experience proposed transformations in immersive environments prior to implementation. Such tools enhance transparency, facilitate informed deliberation, and reduce conflict by allowing stakeholders to compare alternative design scenarios in real time. Importantly, immersive participation should not function as a merely representational device but as a deliberative infrastructure enabling co-production of urban futures. When integrated with environmental modelling systems, immersive platforms allow communities to visualize the climatic and spatial consequences of planning decisions, strengthening both accountability and collective ownership.

The fourth pillar, the governance and ethical layer, anchors the technological architecture within democratic principles. The expansion of AI-driven analytics, predictive modelling, and algorithmic optimization in urban management introduces critical questions concerning transparency, accountability, and data justice. This layer incorporates mechanisms for explainable AI governance, algorithmic auditing, data protection safeguards, and digital inclusion policies. In Mediterranean contexts where socio-economic inequalities and fragmented institutional responsibilities often shape regeneration outcomes, ethical governance becomes indispensable. Technological systems must augment human decision-making without obscuring political responsibility. Clear accountability structures, open data frameworks, and inclusive access to digital participation tools ensure that innovation reinforces democratic urbanism rather than technocratic centralization (Kalemis, 2025c).

Taken together, these four pillars form an integrated ecosystem rather than a hierarchical sequence. Environmental intelligence informs spatial planning; spatial integration supports immersive participation; participatory inputs shape governance priorities; and ethical oversight regulates the deployment of artificial intelligence and digital infrastructures. The framework thus operates as a dynamic feedback system in which data, design, and deliberation are continuously interlinked.

Conceptually, the IMDRF advances beyond conventional smart city paradigms in three principal ways. First, it embeds the socio-cultural specificity of Mediterranean urbanism within digital transformation processes, recognizing that dense morphologies, courtyard systems, and public space traditions require context-sensitive technological mediation. Second, it rejects technological determinism in favor of digital–human symbiosis, positioning AI and modelling systems as collaborative instruments within participatory governance structures. Third, it reframes resilience as a socio-technical construct, emerging from the interaction between environmental modelling, spatial design, civic engagement, and ethical regulation.

Rather than interpreting digital transformation as a purely infrastructural upgrade, the framework conceptualizes it as an adaptive knowledge ecosystem. Within this ecosystem, environmental data, spatial intelligence, cultural memory, and civic participation are

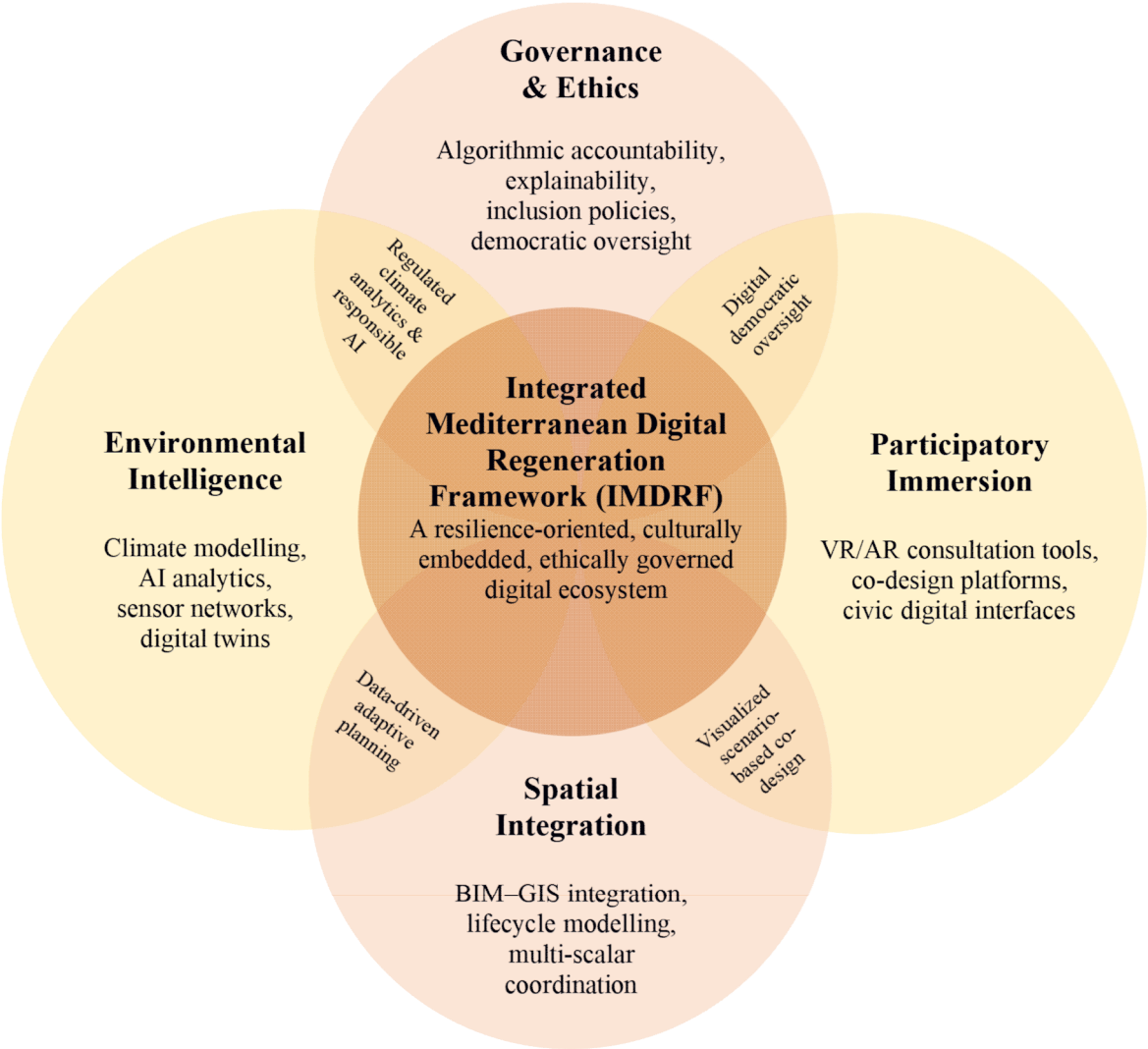
continuously mediated through interoperable digital platforms. Sustainable regeneration in Mediterranean cities, therefore, is not achieved through isolated smart interventions but through the orchestration of integrated digital capacities aligned with climatic realities, morphological constraints, and democratic values.

Governance, Ethics and Human-Centered Digital Urbanism

As digital technologies become structurally embedded within urban governance systems, questions of power, legitimacy, accountability, and equity move to the forefront of planning discourse. The evolution from early smart city infrastructures toward fully digitally mediated governance environments does not merely introduce new technical tools; it transforms decision-making architectures, redistributes institutional authority, and reconfigures the relationship between citizens and the state. In this transition, urban management increasingly relies on data-driven processes, predictive modelling, and algorithmic optimization, thereby reshaping how priorities are defined, resources allocated, and risks assessed.

Algorithmic systems and AI-driven analytics now influence domains ranging from mobility regulation and infrastructure maintenance to environmental monitoring and security management. Predictive tools can enhance administrative efficiency, support rapid responsiveness, and optimize complex urban flows. However, the growing reliance on automated decision platforms also raises critical concerns. When political choices are embedded within technical systems, governance risks being reframed as neutral optimization rather than value-laden deliberation. As Yeung and Lodge (2024) argue, algorithmic regulation may introduce forms of opacity that complicate democratic oversight and blur institutional accountability. Decisions that affect public space, environmental distribution, or service provision may become difficult to scrutinize if embedded in proprietary or technically complex systems.

Figure 1: The IMDRF Conceptual Framework



These challenges acquire particular significance in Mediterranean contexts, where urban public space historically functions as a locus of civic expression, collective identity, and political engagement. The piazza, the waterfront, and the neighborhood street are not merely spatial infrastructures but arenas of social negotiation and democratic life. Consequently, digital governance in Mediterranean cities must be especially attentive to transparency, inclusiveness, and public legitimacy. Technological systems should not displace deliberative processes but rather support them. Human-centered digitalization frameworks emphasize precisely this principle: digital infrastructures must augment human agency, enabling informed participation and collaborative problem-solving rather than substituting political judgement (Saha A., 2025).

Within this perspective, several ethical dimensions require systematic integration into urban digital strategies. First, transparency and explainability are foundational. AI-driven urban systems must generate interpretable outputs that allow policymakers, professionals, and citizens to understand the assumptions and trade-offs embedded in algorithmic models. Without explainability, trust erodes and democratic deliberation weakens. Second, data justice and inclusion are critical to preventing digital transformation from reinforcing socio-economic divides. Participation platforms, sensor networks, and data-driven services must be accessible

to diverse populations, including those with limited digital literacy or infrastructural access. Inclusive engagement mechanisms and proactive outreach are therefore integral components of ethical digital urbanism.

Third, cultural sensitivity is essential in historically layered Mediterranean environments. Digital planning tools often originate in globally standardized smart city models that prioritize efficiency and scalability. Yet Mediterranean urbanism is deeply shaped by place attachment, informal practices, and localized cultural identities. Digital systems must therefore adapt to contextual realities rather than impose uniform technological templates. Fourth, democratic accountability must remain clearly anchored within institutional structures. While AI-assisted systems may inform decision-making, they cannot replace political responsibility. Clear lines of authority, regulatory oversight, and mechanisms for contestation are necessary to ensure that algorithmic support does not translate into technocratic displacement of democratic governance.

These ethical considerations signal a broader paradigm shift: the movement from a technocratic smart city model toward digital humanism in urban planning. Digital humanism reframes technology as embedded within social, cultural, and normative contexts rather than as an autonomous driver of urban transformation. In this paradigm, artificial intelligence becomes a collaborative analytical partner that enhances evidence-based deliberation. Digital twins function as collective decision-support environments where alternative scenarios can be evaluated transparently. Immersive platforms serve not merely as visualization tools but as arenas for democratic co-production of space.

For Mediterranean urban regeneration, this shift is particularly consequential. Historical continuity, social density, and cultural memory demand context-sensitive approaches that respect lived experience and community identity. A purely technocratic digital modernization risks undermining precisely the qualities that make Mediterranean cities resilient and vibrant. By contrast, a human-centered digital framework recognizes that environmental intelligence, spatial modelling, and immersive participation must operate within ethical governance structures grounded in democratic values.

Ultimately, sustainable urban regeneration in Mediterranean cities depends not solely on technological modernization but on the cultivation of digitally enabled civic ecosystems. Such ecosystems integrate environmental analytics, multi-scalar spatial intelligence, participatory immersion, and accountable governance into a coherent and adaptive strategy. In this model, digital infrastructures do not supersede public life; they reinforce it. Technology becomes a mediator between data and deliberation, between modelling and memory, and between optimization and justice. Through this integration, Mediterranean urbanism can navigate the complexities of climate vulnerability, socio-economic inequality, and cultural preservation while sustaining democratic legitimacy in an increasingly digital age.

CONCLUSIONS

This study has examined the evolving relationship between sustainable urban regeneration and digital transformation in Mediterranean cities, situating artificial intelligence, BIM, digital twins, and immersive technologies within a broader socio-technical and cultural framework. By integrating environmental, spatial, participatory, and governance dimensions, the paper has argued that digital urbanism must move beyond technological optimization toward human-centered and context-sensitive regeneration strategies.

Mediterranean urban environments present distinctive structural and cultural characteristics: historical continuity, compact morphology, dense social interaction, and

strong public space traditions. These attributes simultaneously strengthen urban resilience and complicate environmental adaptation. Climate vulnerability, particularly heat stress, water scarcity, and infrastructure strain, intersects with socio-economic inequalities and heritage preservation constraints. As a result, sustainable urban regeneration in Mediterranean contexts demands multi-layered approaches that reconcile ecological performance, cultural continuity, and social inclusion.

The analysis demonstrated that digital technologies significantly enhance the capacity of cities to address such complexity. BIM systems contribute to lifecycle sustainability management and resource efficiency, supporting informed design decisions and integrated infrastructure coordination. Digital twins expand this capacity by enabling real-time simulation, environmental monitoring, and scenario modelling for climate adaptation and infrastructure resilience. Artificial intelligence further strengthens urban adaptability through predictive analytics, optimization of mobility systems, and data-driven governance. Immersive technologies, including VR and AR, extend digital urbanism into the participatory domain by fostering experiential understanding and collaborative design.

However, the comparative analysis of Barcelona, Athens, Naples, and Málaga underscores that technological deployment alone does not guarantee sustainable outcomes. Barcelona's Superblocks initiative illustrates how digital monitoring and data analytics can reinforce pedestrian-oriented, human-scale urban design. Conversely, the Athens Ellinikon redevelopment reveals tensions between advanced digital modelling and broader issues of inclusiveness and governance transparency. These cases confirm that digital transformation must be embedded within participatory planning cultures and accountable institutional frameworks.

The Integrated Mediterranean Digital Regeneration Framework proposed in this paper conceptualizes sustainable digital urbanism as a four-layered system: environmental intelligence, spatial integration, participatory immersion, and ethical governance. This framework contributes to the literature by synthesizing smart city technologies with Mediterranean socio-cultural specificity and resilience theory. Rather than replicating universal smart city models, the framework advocates for adaptive digital ecosystems tailored to historically layered, climate-vulnerable urban contexts.

Crucially, the study highlights the need to address ethical and governance implications of algorithmic urbanism. As AI-driven systems increasingly influence urban decision-making, issues of transparency, accountability, and data justice become central to democratic legitimacy. Human-centered digitalization approaches provide a normative anchor for aligning technological innovation with civic values, ensuring that digital tools augment rather than replace collective deliberation.

The theoretical contribution of this research lies in reframing digital transformation as a socio-technical mediator between environmental resilience and cultural sustainability. In Mediterranean cities, where identity, memory, and public space play foundational roles, digital urban regeneration must remain sensitive to lived experience and social cohesion. Technological sophistication must be balanced with inclusiveness, accessibility, and participatory depth.

Future research should further explore empirical performance metrics of AI-integrated regeneration projects, longitudinal impacts of immersive participation tools, and governance models capable of ensuring algorithmic accountability. Additionally, comparative studies beyond the Mediterranean basin may test the transferability of the proposed framework to other culturally dense and climate-sensitive regions.

Ultimately, sustainable urban regeneration in Mediterranean cities depends not solely on technological capability but on the cultivation of integrated digital-human ecosystems. By embedding environmental intelligence, spatial modelling, participatory immersion, and ethical governance within coherent planning strategies, Mediterranean urbanism can evolve toward resilient, inclusive, and culturally grounded futures.

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TOWARD ETHICAL AND SOCIALLY GROUNDED DIGITAL SUSTAINABILITY: HUMAN-CENTERED TECHNOLOGY AND THE METAVERSE IN INDUSTRY 5.0

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Abstract
This paper explores the role of Industry 5.0 as a paradigm shift that transcends the boundaries of Industry 4.0, proposing a human-centered and ethically oriented approach to technological design. At the core of this study lies the metaverse, which emerges not only as an innovative technological environment but also as a cultural and social framework with the potential to foster digital citizenship, experiential education, and participatory design. The analysis is grounded in a critical review of international literature and a systematic thematic synthesis that draws on insights from the fields of the ethics of technology, science-society studies, and digital sustainability.

Specifically, the paper examines the philosophical and political foundations of Industry 5.0, emphasizing resilience, collaborative intelligence, and fairness in access to digital infrastructures. It further analyzes metaverse applications in areas such as education, environmental management, healthcare, and social inclusion, while also identifying risks related to digital exclusion, algorithmic control, and environmental burdens. Special attention is given to the importance of transparency and accountability in digital design, as well as to the need for shaping frameworks of technological citizenship that advance democratic participation and ethical responsibility.

The study argues that digital sustainability cannot be reduced to technical approaches of energy efficiency, but requires a holistic perspective that integrates social, cultural, and ethical dimensions. The proposed theoretical and practical framework demonstrates how the metaverse can serve as a field for practicing new forms of technological humanism, strengthening collective resilience and institutional transparency. From this standpoint, Industry 5.0 is revealed not merely as a technological evolution but as a profound cultural and social shift that redefines the human-technology relationship toward a more just, inclusive, and sustainable future.

Key words: Industry 5.0, metaverse, digital sustainability, technology ethics, social justice, digital citizenship, technological humanism

INTRODUCTION

The trajectory of industrial and technological development over recent decades has been marked by the rapid digitalization of production, the convergence of the physical and digital worlds, and the emergence of a technological ecosystem that redefines the relationship between human beings, machines, and society. The Industry 4.0 paradigm, focused on automation, artificial intelligence, and networks of cyber-physical systems, has delivered significant achievements in efficiency and innovation; however, it has simultaneously exposed profound ethical, social, and environmental imbalances (Van de Poel & Royakkers, 2023).

Industry 5.0, as defined by the European Commission and analyzed in contemporary literature, does not constitute a mere technological continuation but rather a paradigmatic shift from technocentrism toward human-centered, sustainable, and socially responsible innovation (Bielicki, 2024; Mohammed et al, 2026). It emphasizes resilience, collaborative intelligence, and equitable access to digital infrastructures—elements that bring the value-laden dimension of technology back to the forefront and reframe engineering practice as an act of social responsibility (Werthner et al., 2024).

Within this context, the metaverse emerges as a landmark domain of the new industrial era. It is not merely a collection of virtual or augmented worlds, but a comprehensive socio-technological sphere in which humans participate simultaneously as users, creators, and citizens (Bibri, 2022; Dwivedi et al., 2022). Virtual and augmented reality platforms, as extensions of collective experience, offer new modes of communication, education, participation, and design, redefining concepts such as digital identity, community, and democratic participation (Lee et al., 2024).

However, this technological prospect is accompanied by a wide range of ethical and social challenges. Dependence on algorithmic systems and the concentration of data within global digital ecosystems generate new forms of surveillance, exclusion, and inequality (Robinson et al., 2020; Graham & Wood, 2003). The question of digital autonomy and personal identity in cyberspace (Elliott, 2015) thus becomes a central concern of a technological ethics grounded in transparency, accountability, and empathy.

The present study seeks to illuminate this cultural turn toward ethically grounded digital sustainability by linking the concepts of technological human-centeredness, social justice, and digital citizenship. It examines the role of the metaverse both as a space for social experimentation and democratic education, and as a domain of risk associated with the hyper-mediation of experience and the governance of information.

The core hypothesis of this paper is that digital sustainability cannot be confined to technical approaches such as energy efficiency or technological upgrading, but instead requires a holistic, socially grounded, and human-centered perspective. From this viewpoint, Industry 5.0 constitutes not merely a technological innovation, but a cultural project that reshapes the relationship between humans and technology toward a just, participatory, and transparent future (Braidotti, 2013).

Criterion	Industry 4.0	Industry 5.0	Interpretive Commentary
Central Objective	Automation, efficiency	Human-centered and socially responsible innovation	Shift from technocracy to human–technology collaboration
Role of Technology	Mechanistic, instrumental	Collaborative, supportive	Technology becomes a partner rather than a replacement for humans
Conception of the Human	User / producer	Creator, citizen, co-designer	Humanistic re-signification of technology
Ethical Foundation	Neutral	Normative, value-based (transparency, inclusion)	Ethics of technological responsibility
Social Perspective	Competition, efficiency	Cooperation, collective intelligence	Industry 5.0 as social innovation

Table 1: Industry 4.0 vs Industry 5.0 in a Comparative Perspective

AIMS, RESEARCH QUESTIONS, AND STRUCTURE OF THE PAPER

The present paper aims to investigate the ethical, social, and cultural dimensions of the technological transition toward Industry 5.0, with particular emphasis on how the development of the metaverse can function as a laboratory for digital sustainability, participatory innovation, and technological humanism.

In contrast to earlier phases of industrialization, where humans were primarily regarded as agents required to adapt to machines, Industry 5.0 seeks to restore a symmetrical relationship between humans and technology by introducing new forms of co-creation, empathy, and ethical responsibility (Salimova et al., 2020; Van de Poel & Royakkers, 2023). Within this framework, the metaverse is not treated merely as a technological environment, but as a cultural and social construct capable of significantly shaping the notions of digital identity, citizenship, and sustainable development (Doueihi, 2014).

Within this framework, the present study seeks to elucidate the philosophical and ethical foundations of Industry 5.0, focusing on concepts such as resilience, collaborative intelligence, and social justice in relation to access to digital infrastructures. At the same time, it examines the metaverse as a complex socio-technological environment capable of fostering forms of experiential learning, social inclusion, and environmental awareness, functioning as a space for experimentation and critical reflection on sustainable digital practices. Particular emphasis is placed on the transformations of digital identity and subjectivity in cyberspace, as well as on the risks arising from mechanisms of algorithmic control and phenomena of digital exclusion. Finally, the study proposes an ethically and socially grounded framework of digital sustainability that links transparency, accountability, and democratic participation to the design and implementation of technological systems.

The study is organized around **four central research questions**:

1. How is the concept of technological ethics redefined within the framework of Industry 5.0, and what is its contribution to the development of socially responsible technologies?
2. In what ways can the metaverse function as a field for practicing technological humanism, enhancing participation, creativity, and sustainability?
3. What new forms of digital identity and subjectivity emerge in cyberspace, and what ethical and political dilemmas do they raise for the notion of the "person" in the digital age?
4. How can digital sustainability be defined as a synthesis of technological, social, and ethical parameters that contribute to democratic and sustainable development?

In order to address the aforementioned research questions, the paper is organized into seven interrelated sections. It begins with an introduction that outlines the theoretical and historical context of the transition from Industry 4.0 to Industry 5.0 and clearly defines the central research problem. The second section develops the theoretical framework, examining the philosophy and ethics of technology, its intersections with posthumanist thought, and the emergence of digital humanism as a normative paradigm. The analysis then turns to the metaverse as a socio-technological environment, exploring its potential as a space of co-creation, education, and social interaction, while critically assessing the opportunities and risks it entails.

Subsequently, the paper investigates the construction of digital identity and subjectivity in cyberspace, with particular attention to practices of surveillance and the ethical implications of self-representation. The discussion then expands to the concept of digital citizenship, analyzing its relationship to transparency, trust, and participatory decision-making processes.

This is followed by a section presenting concrete applications and case examples that illustrate the implementation of Industry 5.0 principles in fields such as education, environmental policy, and social innovation. Finally, the concluding section synthesizes the main findings and advances a framework of ethical sustainability intended to inform and guide future technological transitions.

THEORETICAL FRAMEWORK: ETHICS, HUMANISM, AND DIGITAL SUSTAINABILITY

The discussion surrounding Industry 5.0 brings back to the forefront an enduring yet ever-relevant question: what is the place of the human being in technological progress? In contrast to Industry 4.0, which emphasized efficiency, automation, and the integration of cyber-physical systems, Industry 5.0 seeks a new equilibrium between technological rationality and ethical reasoning. The concept of human-centered design constitutes a cornerstone of this new era, as it reframes technological development as a process of human empowerment rather than human replacement. Werthner et al. (2024), within the framework of Digital Humanism, emphasize that technology is not value-neutral; it embodies cultural assumptions, institutional structures, and forms of power. From this perspective, Industry 5.0 must recognize technology as a carrier of social relations, rather than merely as a technical instrument.

The ethics of technology has evolved into a distinct field of inquiry that examines how technical decisions embed values, preferences, and forms of social power (Van de Poel & Royakkers, 2023). The transition toward Industry 5.0 requires an ethics-by-design approach; a methodology in which principles such as transparency, accountability, and justice are integrated from the earliest stages of technological design. In the same vein, Robison (2024) argues that engineering activity is inherently normative: every design choice constitutes a decision about who benefits and who is excluded. Consequently, engineering ethics becomes a foundational element in the construction of responsible technological systems capable of sustaining social trust and ensuring equitable access to digital goods. As Bielicki (2024) notes, the human-centered transition of Industry 5.0 does not merely presuppose respect for the user, but rather the creation of co-creation frameworks, in which humans and machines collaborate toward shared objectives. This collaborative intelligence establishes a new ethical ecology of technology, wherein human judgment remains the decisive regulator of system autonomy.

Posthumanism and Digital Humanism

The philosophical foundations of Industry 5.0 draw upon the dialogue between posthumanism and digital humanism. Rosi Braidotti (2013) conceptualizes posthumanism as a theoretical current that deconstructs the anthropocentrism of modernity and recognizes the entanglement of the human, the artificial, and the natural. From this perspective, the human ceases to function as the measure of all things and instead becomes a relational node within a network of material, digital, and biological processes. Digital humanism reasserts the critical responsibility of the human as creator and steward of technology. It advocates a form of technological humanism that combines innovation with social sensitivity, where progress is measured not solely by productivity indicators, but also by indices of well-being, transparency, and justice.

Together, these theoretical approaches allow Industry 5.0 to be understood as a cultural shift, rather than merely a technological evolution: an effort to reconnect the technical with the ethical, and the digital with the human.

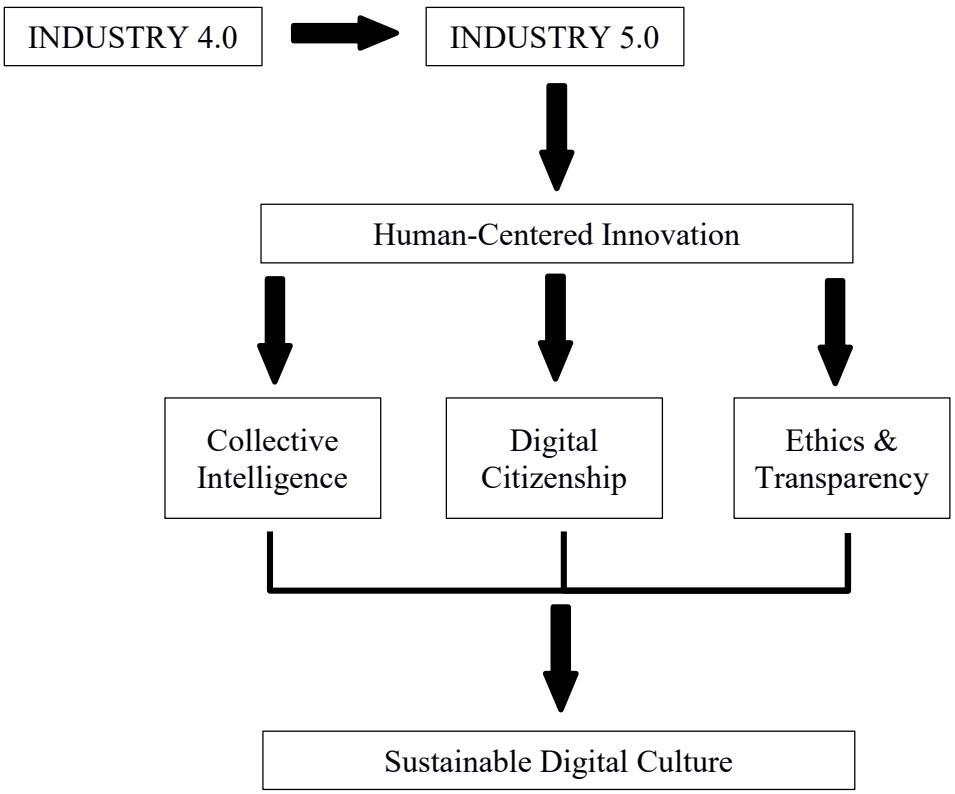

Figure 1: Conceptual Framework of Industry 5.0

From Ecological to Digital Sustainability

In the contemporary era, the concept of sustainability extends beyond the environmental domain to encompass social, cultural, and digital dimensions of development. Digital sustainability refers to the capacity of technological systems to persist, evolve, and contribute to social cohesion without generating new forms of inequality or environmental burden.

Within this context, Allam et al. (2022) proposes viewing the metaverse as an alternative form of a "smart city," where digital participation and collective content creation can strengthen sustainable urban governance. Similarly, Bouzguenda et al. (2019) emphasize that active citizen participation in digital environments can function as a mechanism of social sustainability.

The transition from "green" to digital ecology, therefore, presupposes a new form of responsibility; an ethics of digital culture in which data consumption, resource management, and collective knowledge are governed by principles of transparency, justice, and equal access (Morton, 2013; Crist, 2019).

THE METAVERSE AS A SOCIO-TECHNOLOGICAL FIELD

In recent years, the concept of the metaverse has emerged as a multidimensional space that integrates immersive technologies, digital identities, innovative forms of collaboration, and new economies of content creation. Beyond its popular interpretation as a "virtual world," the metaverse is increasingly defined as an ecosystem of interactions that shapes social practices, cultural representations, and new forms of digital life (Lee et al., 2024).

Within the framework of Industry 5.0, the metaverse does not merely constitute a technological innovation, but rather a domain for the practical application of human-centered and collaborative intelligence. It incorporates principles of participatory creation and distributed experience, transforming users from passive recipients into active co-creators of digital and social environments (Chung, 2025).

Definition and Evolutionary Dynamics of the Metaverse

The term metaverse derives from the combination of the words meta (beyond) and universe, symbolizing a form of hyper-reality in which the physical and digital coexist within a continuous spectrum through technologies such as virtual reality (VR), augmented reality (AR), mixed reality (MR), and blockchain (Lee et al., 2024). According to Dwivedi et al. (2022), the metaverse represents a new phase of digital transformation in which the internet experience ceases to be two-dimensional and becomes experiential and socially participatory. In this sense, individuals do not merely "navigate" the internet; they inhabit it. This dynamic positions the metaverse as a potential implementation space for Industry 5.0, where technology serves human creativity, learning, and social coexistence. The convergence of the metaverse and Industry 5.0 may give rise to forms of collective intelligence that combine artificial and human systems for socially beneficial purposes.

The Metaverse as a Social and Cultural Environment

Beyond its technical definition, the metaverse constitutes a cultural rupture. It is a space in which users construct identities, participate in communities, and develop new forms of cultural expression (Kalemis, 2025a). Its social dimension rests on the premise that virtual worlds are not mere "replicas" of reality, but arenas for the production of social relations, values, and meanings (Johnson, 2023). Arghashi (2024) emphasizes that the metaverse offers users the experience of fluid and adaptable identity, allowing subjects to reconstruct themselves through aesthetic and social practices. This fluidity resonates with early theories of the *cyberself* developed in the 1990s (Jones, 1998), now reinterpreted in light of immersive technologies. At the same time, community within the metaverse acquires cultural significance. Virtual user groups give rise to forms of collective creation, dialogue, and social learning reminiscent of *communities of practice*. These emerging forms of digital sociality can function as laboratories for democratic education, intercultural coexistence, and the ethics of collaboration (Frau-Meigs et al., 2021).

Ethical and Social Challenges of the Metaverse

Despite its potential and advantages, the metaverse generates a set of ethical and social challenges related to privacy, transparency, environmental sustainability, and users' psychosocial well-being.

1. Privacy and data control: Behavioral, movement, and biometric data collected within immersive virtual environments create unprecedented forms of surveillance. Skinner-Kravchenko et al. (2025) warn that the "liminal experiences" of digital immersion may lead to violations of personal space that exceed traditional conceptions of privacy.
2. Algorithmic bias and lack of transparency: Yeung and Lodge (2024) describe the phenomenon of *algorithmic regulation*, whereby digital algorithms shape behavioral norms and acquire regulatory power without adequate social oversight.
3. Environmental footprint: Despite its "digital" nature, the metaverse requires substantial energy consumption. Triantafyllidou and Zabaniotou (2021) argue that a

"green" digital transition must account for the environmental footprint of virtual infrastructures.

4. Digital exclusion and social inequality: Agarwal and Alathur (2023) highlight the risk of creating a new "post-digital elite"; those with access to immersive technologies, while others remain excluded from the virtual ecosystem.

These challenges underscore the need for an ethical architecture of the metaverse—an approach in which technological design is guided by social responsibility rather than innovation alone.

Summary Perspective

From the above, it can be concluded that the metaverse can be understood not only as a technological innovation, but as a socio-cultural ecosystem that embodies the defining characteristics of Industry 5.0: collaborative intelligence, human-centered ethics, and participatory knowledge creation.

The essence of this approach is captured in the triadic formulation:

$$\text{Metaverse} = \text{Technology} \times \text{Culture} \times \text{Ethics}$$

Its success depends not on the sophistication of its algorithms, but on its capacity to cultivate relationships, trust, and collective identity within digital environments.

DIGITAL IDENTITY AND SUBJECTIVITY IN CYBERSPACE

The development of the metaverse and immersive environments signals a radical transformation in the concept of identity. Within the framework of Industry 5.0, technological progress no longer concerns only the optimization of machines, but also the reconfiguration of the human subject itself. Identity ceases to be static or unitary and becomes fluid, multilayered, and continuously negotiated within the networks of interaction that define cyberspace (Elliott, 2015).

The transition from the physical to the digital body, from the "person" to the "avatar", introduces a new form of technological subjectivity in which the boundaries between experience, representation, and self-determination become porous. This transition is not merely technological but ontological, as it reopens the fundamental question: *what does it mean to be human in environments of digital coexistence?*

The Construction of the Self in Digital Environments

According to Milad Doueihi (2014), identity in cyberspace is not a simple transfer of physical personality but the outcome of an ongoing negotiation between the subject and their technological traces. The digital self does not preexist technology; rather, it is continuously shaped through interactions, connections, and representations generated online. This constantly evolving data-self is characterized by the diffusion and reproducibility of digital information. Identity no longer belongs exclusively to the individual but is shared with the digital environments that host it, environments that often determine how individuals perceive themselves (Van Dijck, 2013; Ernst, 2013). Elliott (2015) adds that in the postmodern condition, identity is experienced as relation rather than essence: it emerges through continuous communicative interaction and social mirroring. In this sense, the metaverse functions as a new psychosocial laboratory in which the experience of the self becomes experimental and multiple.

The use of avatars in virtual environments operates as an embodiment of the digital person. According to Arghashi (2024), the interaction between realism and awe in immersive environments produces a form of hybrid consciousness, in which users simultaneously experience the "self" and the "other" through technology. This dual experience recalls the ancient Greek concept of *prosōpon* (mask), a form of social and theatrical representation. Just as the theatrical mask expresses a role without exhausting the actor's identity, the avatar in the metaverse expresses the self without fully defining it. This interpretation is reinforced by Braidotti's (2013) work, which argues that digital subjectivity is not merely technologically enhanced humanism, but a posthuman experience, in which identity is produced through flows of information and relations.

The emerging forms of identity in cyberspace are deeply embedded in political and economic structures. Control over personal data, algorithmic recommendation systems, and the commodification of attention constitute new fields of digital power. Aradau and Blanke (2019) introduce the concept of algorithmic reason, suggesting that algorithms function as a new mode of governing the self: they predict, categorize, and influence user behavior. Huberman (2024) characterizes this phenomenon as the "spirit of digital capitalism," in which identity becomes an economic resource. From a legal perspective, Albers and Sarlet (2024) argue that the protection of personality and privacy in cyberspace must rest not only on regulatory measures, but also on the recognition of the person as a subject of information. Digital autonomy therefore presupposes the safeguarding of each individual's capacity to control their representation, data, and data usage.

Identity, Trust, and Social Inclusion

Digital identity concerns not only individual self-perception but also social belonging. Sebastião (2015) introduces the concept of *Digitania*© to describe the "demystification of digital citizenship": the need to understand technology not as a substitute for society, but as a reflective tool for examining the values and relationships that constitute community.

Within this framework, digital identity acquires an ethical dimension, encompassing trust, recognition, and responsibility toward others. Tsilis (2016), drawing on the sociology of the Greek cyberspace, emphasizes that online identities are not "virtual" in the sense of being false; they represent new forms of social existence that coexist with physical ones.

Industry 5.0 can play a decisive role in shaping frameworks of technological citizenship, in which digital identity is recognized not as a commodified profile, but as a right to participation and expression within a just digital public sphere.

The examination of digital identity leads to two overarching conclusions:

1. Technology reshapes forms of subjectivity, generating new domains of experience, creativity, and sociality.
2. The governance of this identity requires new forms of ethical and political accountability, ensuring that digital existence remains compatible with the principles of human dignity, freedom, and self-determination.

From this perspective, Industry 5.0 emerges as the first technological paradigm to integrate identity as an ethical and political parameter in system design. The challenge is no longer the technical capacity for immersion, but the democratic consciousness of digital presence.

DIGITAL CITIZENSHIP AND DEMOCRATIC PARTICIPATION IN INDUSTRY 5.0

The transition to Industry 5.0 redefines not only the relationship between humans and technology, but also the nature of citizenship itself. In an era where political, social, and

cultural interactions are increasingly mediated by digital infrastructures, citizenship can no longer be understood solely within the boundaries of the nation-state. Instead, it acquires a digital dimension, encompassing participation, responsibility, and agency within networked public spheres (UNESCO, 2022).

Digital citizenship within Industry 5.0 is not limited to technical competence or access to platforms. It entails a normative framework grounded in ethical participation, critical awareness, and co-responsibility for the technological systems that shape collective life. As such, democratic participation becomes inseparable from technological design and governance.

Traditional conceptions of citizenship emphasized legal status, rights, and obligations within a defined political community. In contrast, digital citizenship expands these notions to include participation in digital decision-making processes, data governance, and algorithmic transparency (Isin & Ruppert, 2020).

Frau-Meigs et al. (2021) argue that digital citizenship requires the cultivation of *civic online reasoning*, enabling individuals to critically evaluate information, engage in deliberation, and resist manipulation in digital environments. Polizzi (2020) similarly emphasizes the importance of media and information literacy as a foundation for democratic resilience in the digital age. Within Industry 5.0, citizenship thus becomes an active practice rather than a passive status, one that depends on the capacity of individuals to shape, contest, and co-design the technological systems they inhabit.

Participation, Co-Creation, and Collective Intelligence

A defining feature of Industry 5.0 is the emphasis on participatory innovation. Digital platforms, immersive environments, and the metaverse enable new forms of co-creation in which citizens are not merely users of technology but contributors to its development and governance. Tapias et al. (2024) highlight the role of design thinking and collaborative platforms in fostering collective intelligence. These processes allow diverse actors—citizens, engineers, policymakers, and educators—to collaboratively address complex social challenges, from environmental sustainability to urban planning.

Such participatory frameworks challenge technocratic models of governance by reintroducing deliberation, plurality, and shared responsibility into technological decision-making. In this sense, Industry 5.0 aligns technological innovation with democratic values.

Risks to Democratic Participation in Digital Environments

Despite its emancipatory potential, digital participation also entails significant risks. Algorithmic curation, misinformation, and platform monopolies can distort public discourse and undermine democratic deliberation (Skinner-Thompson, 2024). The concentration of power within large digital corporations raises concerns about platform governance and the privatization of public space. As Katzenbach and Ulbricht (2019) argue, algorithmic systems increasingly act as political actors, shaping visibility, relevance, and participation without democratic accountability.

Moreover, digital divides, whether based on access, skills, or cultural capital, risk excluding significant segments of the population from meaningful participation. Without targeted policies of inclusion, digital citizenship may reproduce or even exacerbate existing social inequalities. In response to these challenges, Industry 5.0 calls for a shift toward democratic governance of technology, integrating ethical principles, legal safeguards, and participatory mechanisms into system design. Key elements of such governance include transparency in algorithmic decision-making, protection of personal data and digital identity,

inclusive access to digital infrastructures, and institutional frameworks for citizen participation in technological policy. In this view, digital citizenship is not an auxiliary feature of technological progress, but its ethical foundation.

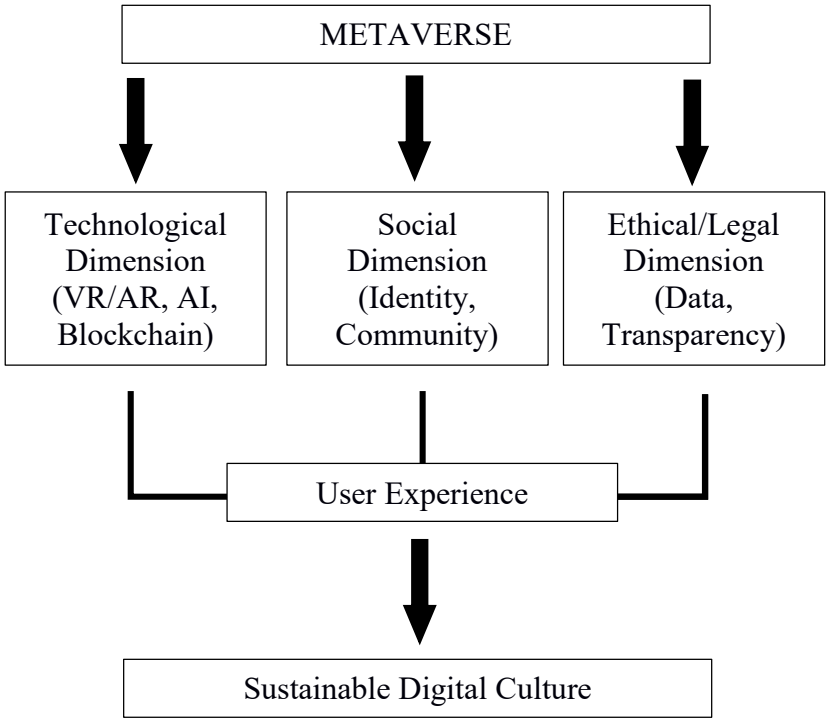

Figure 2: The Metaverse as a Hub of Coherence between Technology, Culture, and Ethics

APPLICATIONS AND CASE EXAMPLES: INDUSTRY 5.0 IN PRACTICE

The principles of Industry 5.0—human-centeredness, ethical responsibility, and digital sustainability—are not merely theoretical constructs but are increasingly reflected in applied practices across education, environmental governance, urban planning, and social innovation. This section presents indicative applications and case examples that demonstrate how the metaverse and related digital technologies can be deployed in socially meaningful and democratically grounded ways. Rather than offering an exhaustive empirical survey, the cases discussed below function as illustrative paradigms, highlighting the transformative potential of Industry 5.0 when technological development is aligned with ethical and social objectives.

Education and Experiential Learning in the Metaverse

One of the most promising application domains of the metaverse within Industry 5.0 is education. Immersive learning environments enable experiential, participatory, and collaborative forms of knowledge acquisition that extend beyond traditional classroom models (Kalemis, 2025b). Virtual campuses, laboratories, and simulations allow learners to engage actively with complex phenomena, ranging from environmental systems to historical reconstructions, thereby fostering critical thinking and embodied understanding. UNESCO (2022) emphasizes that such environments, when ethically designed, can enhance inclusive education, particularly for learners who face geographical, physical, or social barriers.

From the perspective of digital humanism, educational metaverse applications reposition learners as co-creators of knowledge rather than passive recipients. This shift aligns with Industry 5.0's emphasis on creativity, empathy, and collaborative intelligence.

Environmental Awareness and Sustainable Development

Digital environments also provide innovative tools for promoting environmental awareness and sustainability. Simulations within the metaverse can visualize climate scenarios, ecosystem dynamics, and the long-term consequences of policy decisions, enabling citizens and decision-makers to grasp abstract environmental data in intuitive and experiential ways (Triantafyllidou & Zabaniotou, 2021). Jaimei et al. (2017) argues that such applications can transform environmental governance by integrating digital participation into sustainability planning. Virtual participatory platforms allow communities to engage in co-design processes for urban resilience, energy transition, and ecological restoration. These practices exemplify digital sustainability in action: technology is not merely optimized for efficiency but employed as a medium for collective ecological responsibility.

Social Innovation, Inclusion, and Community Building

Industry 5.0 emphasizes social cohesion and inclusion as central design principles. In this context, the metaverse can function as a space for social innovation, offering marginalized or geographically isolated groups new opportunities for participation, expression, and community formation (Thompson et al., 2025). Virtual communities of practice enable users to collaborate across cultural and national boundaries, fostering intercultural dialogue and collective problem-solving. Bouzguenda et al. (2019) highlight that such digitally mediated participation can strengthen social capital and reinforce democratic engagement when supported by inclusive governance frameworks. However, these benefits are contingent upon equitable access to technology and the mitigation of digital divides. Without deliberate policies of inclusion, the metaverse risks reproducing existing inequalities rather than overcoming them.

Institutional and Policy-Oriented Applications

Beyond grassroots initiatives, Industry 5.0 principles are increasingly influencing institutional and policy-level applications. Governments and public organizations are experimenting with digital twins, virtual consultations, and immersive policy simulations to enhance transparency and citizen engagement.

Afzalan et al. (2018) suggest that the integration of design thinking into public digital platforms can facilitate participatory policymaking, allowing citizens to visualize trade-offs, test alternatives, and contribute meaningfully to decision-making processes. Such applications illustrate a shift from technocratic governance toward deliberative digital governance, where technology supports, not replaces, democratic institutions.

Domain	Application	Human / Social Dimension	Sources
Education	Immersive learning in the metaverse	Active participation, empathy	Shi & Park (2024), Waquar et al. (2024)
Environment	Digital simulations, "green citizenship"	Climate awareness, collective action	Triantafyllidou & Zabaniotou (2021)
Health	Therapeutic VR environments	Empathy, personal empowerment	Dwivedi et al. (2022), Bibri (2022)
Social Inclusion	Virtual communities, inclusive design	Accessibility, participatory culture	Johnson (2023), Agarwal & Alathur (2023)

Table 2: Application Domains and Human-Centric Impacts of Industry 5.0

CONCLUSIONS AND PERSPECTIVES

The transition from Industry 4.0 to Industry 5.0 marks a critical moment in the contemporary technological paradigm. Rather than representing a linear continuation of automation and digitalization, Industry 5.0 constitutes a normative and cultural reorientation that places the human being, ethical responsibility, and social sustainability at the center of technological development.

This study has argued that the metaverse, as a socio-technological ecosystem, embodies both the promises and the contradictions of this transition. On the one hand, it offers unprecedented opportunities for creativity, participation, education, and collective intelligence. On the other hand, it intensifies existing challenges related to surveillance, data commodification, environmental impact, and digital exclusion. The metaverse thus functions as a critical testing ground for the principles of digital humanism and ethical technology.

A central conclusion of this paper is that digital sustainability cannot be reduced to technical optimization or energy efficiency alone. It must be understood as a holistic framework that integrates ethical design, democratic participation, social justice, and environmental responsibility. Within this framework, technology is no longer perceived as a neutral tool, but as a socio-cultural force that shapes identities, institutions, and values.

Industry 5.0 emerges, therefore, not merely as an industrial strategy but as a cultural project, one that calls for a renewed social contract between humans and technology. This project requires the active involvement of citizens, educators, policymakers, and engineers in the co-creation of technological systems that respect human dignity and promote collective well-being.

From a forward-looking perspective, several key directions emerge as essential for shaping inclusive and sustainable digital futures. First, there is a pressing need for the development of ethical-by-design frameworks that are embedded directly into immersive and algorithmic systems, ensuring that values such as transparency, accountability, and human dignity are incorporated from the earliest stages of technological development. Equally important is the institutionalization of participatory governance mechanisms within digital environments, enabling users and communities to play an active role in decision-making processes that affect their digital lives. At the educational level, the integration of digital citizenship education across both formal and informal learning contexts is crucial, equipping individuals with the critical, civic, and ethical competencies required in complex digital societies. Finally, advancing interdisciplinary research that bridges technology, the humanities, and the social sciences will be fundamental to fostering holistic approaches capable of addressing the multifaceted challenges of contemporary digital transformation.

Ultimately, the success of Industry 5.0 will not be measured by the sophistication of its technologies, but by its capacity to foster trust, inclusion, and sustainability in an increasingly interconnected world. The metaverse, if guided by the principles outlined in this study, can become not a space of escapism, but a shared digital common, a domain where technological innovation serves democratic and human-centered futures.

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HR SPECIALIST PROFILE IN THE DIGITAL ECONOMY: EVOLUTION OF SKILLS AND ATTITUDES THROUGH A GENDER PERSPECTIVE

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Abstract
The role of Human Resources (HR) professionals is being reshaped by digitalisation, hybrid work, and sustainability imperatives, yet evidence on whether women and men bring distinct competency profiles to HR remains limited. This study examines gender-based differences in companies' expectations regarding the skills and attitudes of new entrants to HR departments in Italy in 2024, drawing on data from the Excelsior Information System (EIS). We compare mean scores (five-point Likert) across eight skills - communication skills in the Italian language; communication skills in foreign languages; mathematical and IT skills; digital competencies; problem-solving abilities; teamwork skills; ability to work independently; and capacity to apply Industry 4.0 technologies - and three attitudinal dimensions (flexibility/adaptability, energy-conservation orientation, intercultural competence). The scores were assigned by Italian employers recruiting new HR specialists.

Findings indicate broad convergence in demand for foundational soft skills to be possessed by both women and men: high levels of teamwork, problem-solving, and independent working (>3.5/5) are required in 2024. However, some differences emerge. Employers more often associate the "male" profile with higher digital competencies, mathematical/IT skills, and application of Industry 4.0 technologies, whereas "female" candidates are more frequently expected to excel in foreign-language communication. In attitudinal terms, the projected male profile of the future HR specialist is associated with greater flexibility/adaptability and a stronger energy-saving orientation, while women are expected to show higher intercultural sensitivity. These patterns suggest complementary strengths that, when combined, can enhance the HR function's ability.

The study extends knowledge, skills, and attitudes (KSA) research through a gender-sensitive lens and offers managerial implications for recruiting, role design, and targeted HR development. The analysis provides useful insights for HR leaders and educators seeking to design gender-balanced teams and curricula aligned with the digital economy. Limitations include the Italian, single-year scope and the absence of direct 'knowledge' indicators in the EIS. Future research should incorporate longitudinal and cross-country comparisons and examine whether mixed-gender HR teams translate complementarity into superior organisational outcomes.

Key words: HR skills; HR attitudes, Gender Differences; KSA Framework; Digital Economy; Industry 4.0; Italy

DIGITALIZATION OF THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS AS A TOOL FOR INTEGRATING THE SUSTAINABLE DEVELOPMENT GOALS

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Abstract
Even today, deficiencies in access to public services provided by environmental institutions, as well as issues related to integrity and transparency, persist despite alignment with a significant number of European Union standards. The digitalisation of the Environmental Impact Assessment (EIA) process is therefore necessary to respond to the growing demand for transparency and efficiency, and to integrate sustainability principles into decision-making processes.

Traditional EIA procedures based on paper documentation, fragmented communication among stakeholders and limited public access to information constitute major obstacles to sustainable development at local and national levels. These shortcomings delay decision-making, reduce public participation and limit the accountability of the relevant authorities. This leads to frequent criticism of projects for neglecting environmental and social dimensions, thereby undermining alignment with the Sustainable Development Goals (SDGs).

Digital transformation provides practical solutions to these challenges in the form of online platforms for submitting, reviewing, and monitoring EIA documentation. Such systems can ensure real-time data access, enhanced transparency and more efficient workflows between the relevant authorities, developers, and the public. Integrating digital tools with geospatial databases, big data analytics and environmental indicators that align with SDG monitoring frameworks establishes a foundation for aligning project-level assessments with national and international sustainability objectives. By enabling open access to information and interoperability, these platforms can strengthen public engagement and trust in decision-making processes, as well as regional cooperation, while ensuring compliance with EU directives and global sustainability agendas. Thus, digitalisation is not just a technical upgrade, but also a governance innovation that establishes EIA as a vital tool for achieving sustainable development.

The article also offers proposals to guide policymakers and practitioners in adopting digital solutions to strengthen the effectiveness of the EIA process and its contribution to the SDGs.

Key words: environment, digitalisation, sustainable, development goals, impact assessment

TRANSFORMING TRANSFER OF DEVELOPMENT RIGHTS (TDR) INTO DIGITAL ASSETS: BLOCKCHAIN, SMART CONTRACTS, PROPERTY TITLES, AND THE REIMAGINED DIGITAL LAND BANK (DLB)

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Abstract
Transfer of Development Rights (TDR) is a complex institutional mechanism relying on trust and transparency to generate demand for building coefficients. Within this framework, the Digital Land Bank (DLB) emerges as a mechanism for recording and managing development rights, functioning as a specialized cadastre for TDR titles and related property rights. This research explores the transformation of TDR titles into digital, tradeable assets through blockchain technology and Smart Contracts. The central research question investigates whether blockchain can act as a property institution comparable to legal mechanisms. Through a systematic review of literature and international practices, we propose a lifecycle model for TDR titles encompassing creation, transfer, and utilization within a blockchain-based DLB.

Key words: Transfer of Development Rights (TDR), Blockchain, Smart Contracts, Digital Land Bank (DLB), Tokenization, Property Rights, Urban Development

1. INTRODUCTION

Property titles represent the essential institutional foundation for individual wealth and national economic growth. According to (De Soto, 2000), formalizing property rights turns land ownership from "dead capital" into productive leverage for credit, investment, and entrepreneurship. However, urban planning plays a contradictory role in this process. While it unquestionably increases land value through zoning and organized infrastructure (Brueckner, 2011), it also imposes regulatory restrictions—such as environmental protection—that limit development potential (Fischel, 2001). This conflict creates a regulatory paradox where planning acts simultaneously as a value-enhancer and a value-restrictor (Webster & Lai, 2003).

To reconcile these competing interests, the Transfer of Development Rights (TDR) has emerged as a robust market-oriented policy instrument. By permitting owners of restricted parcels to sell unused building capacity to developers in designated "receiving areas," TDR compensates the former while facilitating managed density (Pruetz & Standridge, 2009). Theoretically, TDR unbundles the right to develop from the right to own, creating a floating entitlement that circulates independently of the soil (Machemer & Kaplowitz, 2002; Renard, 2007). Yet, efficacy depends on institutional rigor. Successful implementation demands transparent legal frameworks and the administrative capacity to validate transactions (Kaplowitz et al., 2008). Without such clarity, TDR markets often underperform or stall (Linkous, 2016).

In Greece, this mechanism is institutionalized as the Transfer of Building Coefficient (Metafora Syntelesti Domisis, MSD). Law 4759/2020 introduced the Digital Land Bank (DLB), an electronic platform designed to register and trade these floating coefficients.

Functioning as a specialized digital cadastre for development rights, the DLB creates a financing channel for urban regeneration. For the first time, MSD transactions are executed electronically, signaling a paradigmatic shift toward digital spatial governance (Christodoulou, 2023).

Despite this modernization, the DLB's success relies on trust and verification. Distributed Ledger Technologies (DLT), specifically blockchain and Smart Contracts, offer a technical architecture capable of reinforcing these attributes through immutability. Recent scholarship explores blockchain's utility in geospatial data (Chafiq et al., 2024), participatory planning (Melissas, 2022), and land registration (De Filippi, 2018; Öğüdücü et al., 2021). Unlike centralized cloud registries, which remain vulnerable to manipulation, blockchain offers systemic resilience. A preliminary review of the Scopus database confirms this trajectory: research on "blockchain and land registration" significantly outpaces inquiries into "cloud and land registration," underscoring its recognition as a transformative technology.

This research operates on the premise that a TDR title functions as a property title. As argued in prior work (Christodoulou, 2023), the TDR certificate is a quasi-property right—a transferable, enforceable entitlement analogous to fee-simple ownership. However, a significant gap persists regarding the management of derivative rights. While blockchain frameworks have been modeled for traditional land titling, detached TDRs have received minimal attention. Existing studies are either purely theoretical (Patil, 2024; Allam & Jones, 2019) or lack empirical validation (Dwivedi et al., 2023). This oversight is critical: TDRs require tailored mechanisms to ensure transparency and enforceability—requirements that blockchain is theoretically optimized to meet.

This study synthesizes the evidence into a techno-institutional framework to operationalize the TDR lifecycle within a Digital Land Bank. The Central Research Question (CRQ) asks: "Can blockchain technology function as a property institution equivalent to traditional legal mechanisms, and how can it operationalize the complete lifecycle of TDR titles within a DLB framework?"

Since property rights are dynamic institutional formations created and extinguished through regulated processes, demonstrating equivalence requires evidence that a decentralized system can perform the full suite of constitutive acts: registration, transfer, subdivision, and enforcement. The study consequently evaluates blockchain's capacity to govern the TDR lifecycle, assessing both technical feasibility and institutional adequacy.

Situating the DLB within debates on computational institutions (Pagallo, 2017) and decentralized governance (Ishmaev, 2017; De Filippi & Wright, 2018), this research examines whether blockchain-based systems can satisfy essential property conditions—recognition, enforcement, and transferability—without a central authority. This positions blockchain as an institutional architecture capable of embedding normative rules directly into code. The analysis shifts from isolated technical efficiencies to whether decentralized systems can reproduce functions traditionally monopolized by legal regimes.

The objective is to formalize structural components of a computational architecture that resolves challenges of institutional completeness and transparency. These components support a blockchain-based DLB capable of efficiently financing urban development. Key elements include deploying Smart Contracts to automate processes like title transfers (Mik, 2017; Rizzo, 2020), and tokenizing TDR titles to transform them into tradable digital assets (Hassan & De Filippi, 2021; Paech, 2020).

To operationalize this inquiry, the research focuses on the DLB as a blockchain-native platform for end-to-end TDR lifecycle management. This encompasses every phase: from tokenized issuance to verification, transfer, and retirement. The DLB integrates technical

subsystems—including tokenization standards (e.g., ERC-721 / ERC-1155) and decentralized storage (IPFS)—to define the digital existence of the TDR title. Methodologically, the study utilizes a systematic literature review guided by the PICOS framework, synthesizing contributions from the Scopus database to construct a lifecycle model against which blockchain's institutional affordances are evaluated.

The paper structure follows: Section 2 establishes TDR legal equivalence; Section 3 reviews blockchain as an institutional technology; Section 4 details the SLR protocol; Sections 5–7 synthesize the architectural model; and Section 8 concludes with implications.

2. THEORETICAL AND INSTITUTIONAL FRAMEWORK: PROPERTY RIGHTS AND TDR EQUIVALENCE

2.1. Conceptual Foundations of Property Rights

Property rights constitute a cornerstone of market economies. From an institutional perspective, well-defined rights enable individuals to internalize investment benefits and support credit systems (De Soto, 2000). Legally, real rights are enforceable against third parties, granting exclusive power to use or transfer ownership objects. The distinction between absolute ownership and derivative real rights underpins property law, balancing private autonomy with collective objectives (Fischel, 2001).

In urban planning, these intersect with public regulation: zoning and conservation shape permissible uses while preserving public goods (Brueckner, 2011). Such interventions modify underlying real rights. Property rights are contextually contingent, reflecting negotiations between individual entitlements and societal priorities (Webster & Lai, 2003). Within this space, TDRs redistribute development potential while preserving ownership integrity.

2.2. The Legal and Institutional Nature of TDR Titles

Transferable Development Rights (TDR) function as a radical institutional severance, effectively unbundling the "right to develop" from the "right to own" the underlying soil. As (Hou, Chan, and Li, 2018) argue, TDRs are not merely administrative permits but distinct, tradeable entitlements—quasi-property rights that can be inherited, exchanged, and collateralized. While they convey no physical possession, they establish legally enforceable interests. This separation provides planning authorities with a fiscal escape valve: they can pursue regulatory objectives—such as heritage preservation—and compensate affected owners through market mechanisms rather than direct public expenditure (Renard, 2007).

In the Greek regulatory landscape, this mechanism is codified as the Transfer of Building Coefficient (Metafora Syntelesti Domisis – MSD). This instrument allows owners of constrained properties to mobilize unexploited building density, transferring it to parcels located within designated receiving zones. (Makris, 1998) posits that the right embedded in an MSD certificate constitutes a genuine real right (Greek: 'empragmatiko dikaioma'), i.e., a right enforceable erga omnes and registrable in the relevant public records. This distinction is vital. It situates TDR squarely within the domain of property law rather than administrative discretion, endowing the certificate with the substantive attributes of ownership: exclusivity, transferability, durability, and enforceability.

2.3. Trust and Institutional Credibility

Trust acts as a necessary precondition for market functionality. As demonstrated in (Christodoulou, 2023), the historical trajectory of TDR schemes in Greece reveals that failure often stems less from defective legal formulation than from a deficit in the credibility of administering institutions. Viewed through the lens of institutional economics, trust serves

primarily to reduce transaction costs by eliminating the need for constant, costly verification (North, 1990; Micelli, 2002).

When property transactions occur within transparent, auditable architectures, risk perception drops; liquidity rises. Conversely, opacity and administrative friction generate institutional uncertainty, which directly erodes the value of the TDR certificate. International empirics corroborate this dynamic: TDR markets sustain volume only where regulatory clarity and administrative capacity are unimpeachable (Pruetz & Standridge, 2009; Linkous, 2016). Consequently, enhancing institutional trustworthiness is not an optional upgrade—it is a structural prerequisite for transforming a dormant regulatory instrument into a functional market.

2.4. The DLB: Transitioning from Analog to Digital

Yet, despite introducing digital efficiency, the DLB remains a "Web 2.0" solution tethered to centralized data management. Centralized databases contain inherent vulnerabilities—single points of failure, susceptibility to bureaucratic opacity, and the potential for data manipulation. The current DLB thus represents a transitional institutional form. To fully operationalize TDRs as liquid assets, the underlying infrastructure must evolve: shifting from reliance on administrative promises of trust to systems guaranteeing technological certainty.

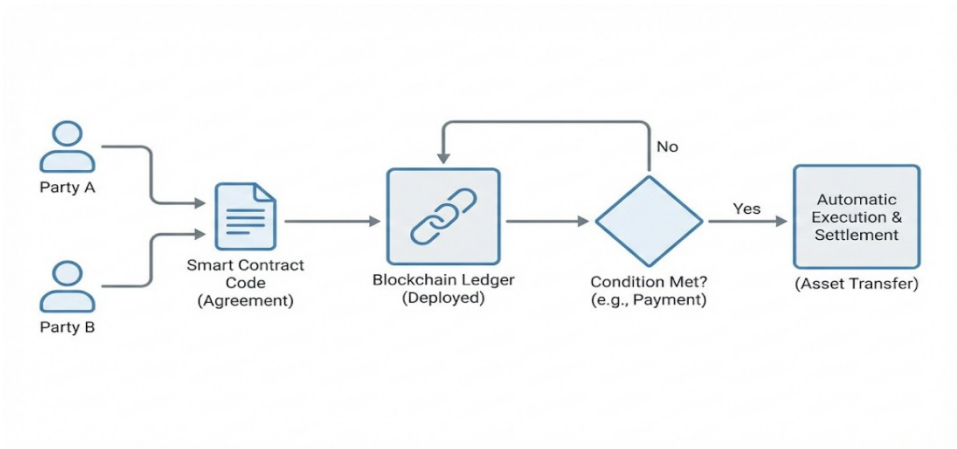
3. TECHNOLOGICAL FRAMEWORK: BLOCKCHAIN AND DECENTRALIZED GOVERNANCE

3.1. Blockchain Technology and Smart Contracts

Blockchain-based ledgers can reallocate trust from centralized record-keepers to cryptographic verification and distributed consensus mechanisms, subject to governance and oracle design choices. As a subset of DLT, blockchain operates as a decentralized, immutable registry where transactions are not filed centrally but "mined" into blocks, cryptographically chained to their predecessors (Nakamoto, 2008). This architecture ensures that data, once entered, remains resistant to retroactive alteration without network consensus. Consequently, it creates a "trustless" environment where confidence is vested in cryptographic proofs rather than fallible human intermediaries (De Filippi & Wright, 2018).

The operational capacity of this infrastructure expands significantly with the "Smart Contract"—self-executing scripts deployed on platforms like Ethereum. These protocols automatically enforce agreement terms once pre-conditions are satisfied (Szabo, 1997), as illustrated in Figure 1.

Figure 1: Conceptual workflow of a Smart Contract executed on a Blockchain ledger (Source: Author).



In the specific domain of property rights, smart contracts can govern the entire asset lifecycle—minting titles, executing transfers upon payment receipt, and extinguishing rights upon utilization—bypassing the manual verification steps traditionally performed by notaries or legal clerks (Mik, 2017).

3.2. Applications in Land Administration and Case Studies

Transitioning from theoretical abstraction to administrative praxis, blockchain pilots in land registries have proliferated, driven by the imperative to eliminate fraud, reduce transaction friction, and enhance transparency.

- **Sweden:** The Swedish mapping authority, Lantmäteriet, pioneered a multi-phase pilot (2016-2019) focused on transactional velocity. Leveraging a private blockchain, the project demonstrated a reduction in the contract-to-registration interval from months to mere hours. It successfully modeled a digital workflow where signatures trigger irrevocable ledger updates across banks, buyers, sellers, and the land registry (Kempe, 2016; Lantmäteriet, 2018).
- **Republic of Georgia:** In contrast, Georgia adopted a hybrid verification model in 2016. The National Agency of Public Registry partnered with Bitfury to anchor the cryptographic "hash" of every land title to the public Bitcoin blockchain while retaining a centralized primary registry. This architecture allows citizens to independently verify title authenticity, reinforcing public trust in the security of property rights (Shang & Price, 2019).
- **Ghana:** In contexts characterized by weak formal institutions, initiatives like Bitland have utilized blockchain to formalize extra-legal settlements. Here, immutable ledgers record GPS coordinates and land claims to substantiate ownership where state cadastres are either absent or compromised (Kritikos, 2018).

Collectively, these cases suggest that the primary bottleneck is no longer technical feasibility but legal integration—specifically, the statutory recognition of digital signatures and smart contracts as valid instruments for the transfer of in rem rights (Bennett et al., 2019).

3.3. Blockchain as a Property Institution

Framing blockchain as a property institution rather than a mere database represents a substantive shift in analytical framing. Historically, property institutions have derived their legitimacy exclusively from centralized state authorities (Deininger & Feder, 2009). Blockchain challenges this monopoly. It provides a decentralized infrastructure that satisfies three constitutive functions of a property system: rights representation (tokenization), ownership verification (consensus), and entitlement transfer (smart contracts).

(Ishmaev, 2017) argues that by providing universally accessible, tamper-resistant records, blockchain satisfies the formal criteria of a property institution. (De Filippi, 2018) characterizes this emergence as "computational property systems," architectures capable of automating the creation and division of rights. When applied to TDRs, the technology does more than record an asset; it instantiates the right as a digital token—unique, tradeable, and resistant to double-spending—thereby creating functional equivalence between the legal certificate and the digital token.

4. RESEARCH METHODOLOGY: ANALYTICAL FRAMEWORK AND PROTOCOL

To interrogate the intersection of blockchain technology and land administration, this study employs a Systematic Literature Review (SLR) methodology, adhering to the guidelines established by (Kitchenham et al., 2009). The review process began with the precise formulation of research questions to strictly delimit the scope of inquiry. A structured search strategy was subsequently executed, primarily leveraging Scopus due to its extensive multidisciplinary coverage—encompassing both the technical and legal-institutional dimensions of land administration. Complementary searches and snowballing techniques were employed to capture relevant grey literature and seminal works outside the primary index.

Following initial retrieval, duplicate entries were purged. Predefined inclusion and exclusion criteria were then applied sequentially to titles, abstracts, and finally, full texts to ensure relevance. Backward and forward snowballing further refined the corpus. This systematic filtering resulted in a final selection of 40 primary studies, distilled from an initial pool of 134 papers. To mitigate the selection bias inherent in single-author research, the selection process was conducted by the author through strict, iterative adherence to the established protocol.

4.1. Research Scope and Definition (PICOS Framework)

To ensure systematic, unbiased literature selection relevant to operationalizing Transferable Development Rights (TDRs) within a DLB, this study employs the PICOS framework, delineating search boundaries and eligibility criteria.

- **Population (P):** Land Administration Systems, Property Rights regimes, and TDR markets, specifically fragmented or paper-based registries managing heterogeneous property rights.
- **Intervention (I):** Blockchain Technology (DLT), Smart Contracts, Tokenization (ERC standards), and Decentralized Identity (DID) applied to land governance and the DLB concept.
- **Comparison (C):** Traditional Land Registries, conventional cadastre systems, and paper-based legal mechanisms for transferring development rights.
- **Outcome (O):** Institutional Equivalence (security, legitimacy), Lifecycle Operationalization (minting to transfer), Market Liquidity, Interoperability, and Technical Scalability.
- **Context (S):** Global Context, focusing on architectural frameworks, pilot implementations (e.g., Ghana, Sweden, Dubai), and theoretical models of crypto-spatial governance.

4.2. Hierarchical Research Questions

The study is guided by the CRQ, addressing both institutional legitimacy and technical execution of blockchain in land administration, deconstructed into four subservient questions.

SRQ 1 (Asset Definition): How can blockchain technology and smart contracts transform heterogeneous property rights, such as TDRs and air rights, into fungible digital assets, enabling unified lifecycle management within modern land administration frameworks?

SRQ 2 (System Architecture): What is the conceptual and architectural framework for a blockchain-based DLB managing the entire lifecycle of TDR titles as tokenized real property assets, ensuring interoperability with traditional cadastre or land registry?

SRQ 3 (Barriers & Transition): What are the primary institutional, legal, and technical challenges and opportunities in transitioning from traditional, fragmented land registries to unified blockchain-based systems managing both conventional property titles and specialized development rights like TDRs?

SRQ 4 (Market Impact): To what extent does tokenization of building rights and TDRs on blockchain platforms enhance market liquidity, transparency, and security compared to conventional, paper-based mechanisms?

4.3. Data Extraction and Synthesis: The 10 Critical Analytical Axes

To operationalize lifecycle analysis and bridge the gap between abstract literature and Research Questions, ten critical analytical axes were identified through iterative scanning of contemporary blockchain–land administration literature. Each axis corresponds to a core institutional function of property systems, serving as targeted search directions during screening and technical indicators during synthesis.

Phase I: Creation and Identity (Addressing RQ1 & RQ3)

1. **Initial Registration (Genesis/On-chain Minting):** Examines mechanisms for first registration of rights, including oracles, off-chain document anchoring, survey verification, and IPFS hashing, directly informing RQ1 (standardizing heterogeneous rights) and RQ2 (creating authoritative lifecycle entries).
2. **Identity Management (DID, SSI, Verifiable Credentials):** Decentralized identity infrastructure essential for replacing or complementing state verification. Evidence here is crucial for RQ3, revealing if systems can support legitimate, non-repudiable actors.
3. **Token Standards and Metadata Structures:** Token architecture (ERC-721, ERC-1155, dynamic NFTs, metadata schemas) reveals digital representation of property rights, strongly supporting RQ1 and RQ4, as fungibility, composability, and updatability directly affect TDR liquidity and functional behavior.

Phase II: Transaction and Management (Addressing RQ2 & RQ4)

4. **Smart-Contract Transfer Logic:** Identifies models for escrow-less transfers, atomic swaps, timelocks, and verifiable off-chain data, constituting direct evidence for RQ2 and RQ4, determining whether blockchain transfers increase transparency, efficiency, and automation.
5. **Management of Encumbrances:** Examines how blockchains encode burdens, fractional shares, or liens through token binding or nested smart contracts, central to RQ3, assessing if blockchain can replicate complex legal structures beyond simple ownership.
6. **Error Correction and Governance Models:** Analyzes proxies, multi-sig governance, DAO-based validation, and court-ordered oracles, testing whether blockchain can support institutional functions of adjudication and dispute resolution, addressing the Central RQ's core.

Phase III: Systemic Integration and Feasibility (Addressing RQ2 & RQ3)

7. **Interoperability and Legal Integration:** Studies cross-chain messaging, mirrored registries, and legal wrappers for recognizing on-chain titles, directly relevant to RQ2 (cadastre interoperability) and RQ3 (legal constraints).
8. **Cost, Scalability, and Technical Sustainability:** Informs whether blockchain-based land systems can operate at national scale through literature on Layer-2 solutions, gas optimization, and state channels, answering RQ3 (technical constraints) and RQ4 (market efficiency).

Phase IV: Synthesis (Addressing Central RQ)

9. **Case Studies and Implemented Pilots:** Empirical evidence is integrated throughout the thematic analysis (Section 5) to validate theoretical frameworks against real-world implementations in jurisdictions such as Georgia, Sweden, and Ghana.
10. **Gap Analysis Across Studies:** This axis drives the Synthesis (Section 6) and Discussion (Section 7), identifying missing institutional functions to determine whether the current literature supports a complete DLB lifecycle.

4.4. Search Strategy and Protocol

This systematic literature review was conducted following PRISMA guidelines. The protocol minimized selection bias and ensured comprehensive retrieval of studies pertaining to the DLB lifecycle.

4.4.1. Database Selection and Search Strategy

Scopus was selected as the primary source due to extensive interdisciplinary coverage at the intersection of computer science, urban planning, and law. A stratified, two-tiered search strategy was employed: **Tier 1** focused on technological convergence of DLT and TDRs, addressing RQ1; **Tier 2** expanded to broader Land Administration literature, addressing RQ2 and RQ3.

4.4.2. Search String Formulation

An iterative keyword identification process optimized retrieval. The final search string utilized Boolean operators intersecting three core conceptual clusters: (1) Property/Development Rights, (2) DLT/Blockchain Technologies, and (3) Land Administration Domains, executed within "Title, Abstract, and Keywords" fields.

The search was executed within the "Title, Abstract, and Keywords" (TITLE-ABS-KEY) fields using the following syntax:

Search String:("property right*" OR "land right*" OR "real property" OR "property title*" OR "transferable development right*" OR "TDR" OR "air right*" OR "transfer of building coefficient*" OR "building right*" OR "floor area ratio" OR "FAR" OR "floor-to-area ratio") AND ("blockchain" OR "smart contract*" OR "tokenization" OR "DLT") AND ("land administration" OR "land registry" OR "cadastre" OR "land management" OR "real estate")

4.4.3. Eligibility Criteria

To ensure the methodological rigor and relevance of the review, a set of Inclusion Criteria (IC) and Exclusion Criteria (EC) was defined.

The temporal scope was restricted to 2015–2025. The start year of 2015 was selected to coincide with the emergence of second-generation blockchains (e.g., Ethereum), which introduced the smart contract capabilities essential for managing complex rights such as TDRs.

Table 1: Inclusion and Exclusion Criteria

Criterion Type	Description
Inclusion Criteria (IC)	• **Topic:** Studies explicitly examining blockchain/DLT applications in land administration, cadastral systems, or property rights management. • **Timeline:** Published between January 1, 2015, and September, 2025. • **Language:** Full text available in English. • **Source:** Peer-reviewed journal articles and conference proceedings.
Exclusion Criteria (EC)	• Type: Secondary studies (SLRs, meta-analyses), book chapters, and grey literature (tutorials, workshops, keynotes, panels, corrigenda). • Relevance: Studies addressing blockchain in supply chains or finance without a direct link to land/property rights. • Availability: Studies where the full text was inaccessible. • Redundancy: Duplicate records.

4.4.4. Selection Process

The selection process followed a multi-stage workflow:

1. **Identification:** Records were retrieved from Scopus using the defined search string.
2. **Deduplication:** Duplicate entries were identified and removed.
3. **Screening:** Titles and abstracts were screened against the exclusion criteria. Articles clearly falling outside the scope (e.g., cryptocurrency speculation) were rejected.
4. **Eligibility:** The remaining articles underwent a full-text review to verify compliance with the inclusion criteria, specifically regarding technical relevance to the DLB framework.

4.4.5. Methodological Limitations

While the search string underwent iterative refinement, the study remains subject to specific methodological constraints. First, the exclusive reliance on Scopus as the primary bibliographic reservoir inevitably creates a blind spot for relevant scholarship indexed solely in alternative repositories. Similarly, the specific taxonomy of selected keywords imposes lexical boundaries; studies employing adjacent nomenclatures—such as "urban land finance" or "development entitlements" rather than strict TDR terminology—may have evaded retrieval. A risk of semantic filtering bias also persists. By mandating the intersection of legal constructs and technical descriptors, the protocol may have inadvertently filtered out interdisciplinary contributions that emphasize one dimension while leaving the other implicit.

A structural caveat also warrants mention: as a single-author inquiry, this study lacks the inter-rater reliability checks standard in multi-researcher teams. To counterbalance potential selection bias, the research protocol was not merely applied but executed iteratively—incorporating a secondary re-evaluation of selected studies to ensure rigorous consistency. Finally, the deliberate prioritization of land administration domains may have limited the identification of hybrid models that bridge physical land governance with nascent digital property paradigms—experimental architectures that, while peripheral here, could inform the future trajectory of blockchain-based property systems.

5. THEMATIC ANALYSIS OF ARCHITECTURAL FRAMEWORKS

The following analysis is structured according to the first eight analytical axes defined in the methodology, mapping the TDR lifecycle from registration to scalability. Axis 9 (Case Studies) is woven into these sections to provide empirical context, while Axis 10 (Gap Analysis) forms the basis of the subsequent Synthesis and Discussion sections.

The table below summarizes the studies retained in the final stage of the systematic literature review.

Table 2 : studies selected in the final stage

Citation	Thematic Cluster	Research Methodology	Key Contribution	Technology Used
Mohanty et al., 2025	Technical Frameworks	Prototype Implementation / Comparative Analysis	Proposes a new transaction governance framework with a 13% improved block generation time.	Blockchain, pBFT, Smart Contracts
Ullah & Al-Turjman, 2023	Land Administration & Cadastre	Systematic Literature Review & Conceptual Framework	Proposes a 6-layer conceptual framework for adopting smart contracts in smart cities.	Ethereum (EVM)
Kshetri, 2022	Land Administration & Cadastre	Case Study (Andhra Pradesh, India)	Analyzes how blockchain enhances property rights protection in the Global South.	Blockchain (Land Registry)
Singh et al., 2024	Technical Frameworks	Conceptual Framework / Architecture Design	Proposes a 3-tier architecture (Government, Citizens, Banks) for the Indian land registry.	Ethereum, IPFS
Abualhamayl et al., 2024	Technical Frameworks	Prototype Implementation (GREP)	Presents the hybrid "Global Real Estate Platform" for data authenticity and access management.	Hybrid Blockchain
Kasprzak, 2021	Real Estate Tokenization	Conceptual Framework	Examines the role of retail banks as "Oracles" in the real estate tokenization process.	Blockchain, Stablecoins
Khadanga & Jain, 2021	Land Administration & Cadastre	Conceptual Framework / Blueprint	Proposes a blueprint for land registry management in India to resolve disputes.	Hyperledger
Mihna et al., 2025	Metaverse & Virtual Land	Quantitative Analysis (Machine Learning)	Uses ML algorithms (Random Forest) to classify digital contracts (Ownership vs. Lease).	NFTs, Decentraland, Sandbox
Avantaggiato & Gallo, 2019	Technical Frameworks	Prototype Implementation (REchain)	Proposes the REchain platform for direct real estate transactions without intermediaries.	MultiChain
Konashevych, 2020	Legal & Regulatory	Qualitative / Legal & Policy Analysis	Analyzes the technical and legal constraints of DLTs for public registries.	DLT (Permissioned vs Public)
Jebril et al., 2024	Land Administration & Cadastre	Theoretical Analysis	Investigates the impact of blockchain on risk management and sustainability in estate governance.	Blockchain
Konashevych, 2021	Land Administration & Cadastre	Case Study (Afghanistan)	Critical analysis of the LTO Network implementation in Afghanistan's land registry.	LTO Network
Bennett et al., 2021	Land Administration & Cadastre	Comparative Analysis (Case Studies)	Proposes a hybrid approach combining smart contracts with existing land registry roles.	Blockchain, ChromaWay
Tahar et al., 2023	Technical Frameworks	Prototype Implementation	Implements a multisignature system for transparency in land transfer transactions.	Hyperledger Iroha
Podshivalov, 2022	Legal & Regulatory	Legal Modeling & Economic Analysis	Proposes legal measures and the use of Virtual Reality (VR) for real estate registration.	Blockchain, VR/AR
Verma et al., 2024	Land Administration & Cadastre	Review / Conceptual	Assesses blockchain for security and transparency in land transactions.	Ethereum, Smart Contracts
Akhmetbek & Špaček, 2021	Land Administration & Cadastre	Case Study (Kazakhstan)	Identifies legislative gaps and technical complexity as barriers to real estate registration.	Blockchain
Paavo et al., 2025	Land Administration & Cadastre	Design Science / Prototype	Presents a roadmap and system prototype for land registration in Sub-Saharan Africa (Namibia).	MetaMask (Ethereum-based)
Habib et al., 2025	Land Administration & Cadastre	Conceptual Framework	Proposes a framework for cadastral systems in conflict-impacted communities.	Blockchain

Shahaab et al., 2023	Land Administration & Cadastre	Action Design Science / Proof of Concept	Develops a POC for Companies House (UK) to check beneficial owners of overseas entities.	Blockchain
Mottaghi et al., 2024	Real Estate Tokenization	Literature Review & Qualitative Analysis	Analyzes the current state and future of tokenization and fractional ownership.	Blockchain, IoT, AI
Ferreira, 2021	Legal & Regulatory	Legal Analysis	Argues that smart contracts require legal evolution rather than revolution.	Smart Contracts
Subbarayudu & Hemalatha, 2024	Technical Frameworks	Conceptual / Algorithm Proposal	Proposes the "Modified Proof of Authorization" (M-PoA) consensus mechanism for security.	Blockchain, PoA
Siriphen et al., 2024	Real Estate Tokenization	Sentiment Analysis (Social Media)	Analyzes public sentiment regarding digital real estate token investments post-pandemic.	Digital Tokens
Arora & Sarkar, 2023	Land Administration & Cadastre	Auto-ethnography / Critical Analysis	Critiques the "tech hype" surrounding land management in India.	Blockchain (as hype)
Garcia-Teruel & Simón-Moreno, 2021	Legal & Regulatory	Comparative Legal Analysis	Proposes a tokenization model for usufruct rights, comparing 6 jurisdictions.	Asset-backed tokens
Manahov & Li, 2025	Real Estate Tokenization	Quantitative (Volatility Spillover Test)	Examines the effect of hacker attacks on real estate token volatility (e.g., Propy).	Ethereum, Real Estate Tokens
van Erp & Zimmermann, 2022	Legal & Regulatory	Legal / Conceptual Analysis	Examines the digitalization of the EU Succession Certificate via blockchain and e-wallets.	Blockchain, E-wallets
Allam & Jones, 2019	Land Administration & Cadastre	Conceptual Model	Proposes a model for trading "air rights" to curb urban sprawl.	Smart Contracts
Zhang et al., 2024	Technical Frameworks	Prototype / System Design	Time-stamping and registration system for authenticating informal real estate transactions.	Ethereum
Zhang et al., 2025	Real Estate Tokenization	System Design / Conceptual	Tokenized investment platform designed to lower market entry barriers.	Ethereum, Smart Contracts
Daniel & Ifejika Speranza, 2020	Land Administration & Cadastre	Conceptual / Case Discussion	Discusses blockchain for documenting land use rights in the informal rental market.	Blockchain
Baum, 2021	Real Estate Tokenization	Qualitative Analysis / Market Review	Examines mechanisms for creating secondary markets in tokenized assets.	Blockchain
Zhitomirskiy et al., 2023	Technical Frameworks	Prototype / Design Science	Proposes a new token design (ERC-20) for dividend distribution based on holding time.	Ethereum (ERC-20)
Creta & Tenca, 2021	Real Estate Tokenization	Qualitative (Multiple Case Studies)	Exploratory analysis of 12 crowdfunding platforms adopting tokenization.	Blockchain, Tokens
Abualhamayl et al., 2023	Real Estate Tokenization	Prototype Implementation (JOINFT)	Proposes the JOINFT system using fractional NFTs (F-NFTs) for joint ownership.	Fractional NFTs
Veuger, 2018	Land Administration & Cadastre	Interviews / Qualitative Analysis	Investigates the role of trust and disruption in the Dutch real estate market.	Blockchain
Mashatan et al., 2021	Technical Frameworks	Agent-based Modelling / Prototype	Solution to prevent double-ending fraud by real estate agents.	Hyperledger Fabric
Narowski et al., 2025	Metaverse & Virtual Land	Quantitative Analysis	Analyzes 207 Decentraland transactions to test conventional valuation methods.	Decentraland (MANA), NFTs
Leonhard et al., 2025	Metaverse & Virtual Land	Quantitative (Wavelet Coherence Analysis)	Examines the dynamic correlation of returns between virtual land and physical real estate.	Metaverse, Digital Assets

The systematic review of the selected 40 studies reveals seven critical dimensions—or axes—that constitute the architectural framework of a DLB. This analysis moves beyond a

simple enumeration of technologies to examine how distinct technical choices address specific institutional and legal challenges.

5.1. Registration Mechanisms: The "First Mile" Problem

In an application such as the DLB, two fundamental challenges arise. The first concerns the certification and validation of the initial set of property titles introduced into the system. The second relates to the controlled admission of newly created titles, ensuring that any additional digital representations correspond to legally valid and verifiable real-world property rights.

The analysis of registration mechanisms therefore addresses the critical problem of reliable tokenization, namely the process of converting a physical or legal asset into its digital counterpart. This challenge is commonly referred to as the "First Mile Problem", which highlights the difficulty of establishing a trustworthy linkage between off-chain legal reality and on-chain digital records. Given the immutability of distributed ledger technologies, the registration of inaccurate, incomplete, or unauthorized data leads to persistent and irreparable inconsistencies within the system, encapsulated in the dictum that erroneous input data invariably compromises system integrity ("garbage in, garbage out"). Consequently, the design of robust institutional and technical safeguards at the point of initial registration is essential for preserving the integrity and credibility of the DLB as a property governance infrastructure.

The review identifies five distinct approaches to mitigating this risk:

- **The State-Led Approach (Trusted Oracle):** Dominant in the literature, this model posits that blockchain cannot replace legal oversight. A central authority (government agency, notary, or certified inspector) acts as an "oracle" to validate physical ownership before minting the digital record (Mohanty et al., 2025; Abualhamayl et al., 2024; Tahar et al., 2023; Subbarayudu & Hemalatha, 2024; Mashatan et al., 2021; Zhang et al., 2025). The consensus is that technology supplements, rather than supplants, state validation.
- **The Corporate Wrapper Approach (SPV):** Primarily observed in investment contexts, this method utilizes Special Purpose Vehicles (SPVs). The blockchain records shares in the SPV rather than the property title itself, thereby bypassing the need to alter property laws (Baum, 2021; Zhitomirskiy et al., 2023).
- **The Hybrid Digitization Approach:** This strategy bridges legacy systems with DLT. Existing databases remain the primary repository, while cryptographic hashes of documents are stored on-chain to ensure integrity (Konashevych, 2021; Bennett et al., 2019; Zhang et al., 2024; Veuger, 2018).
- **The Virtual-Only Approach (Metaverse):** In virtual environments (e.g., Decentraland), the asset is native to the code. Registration is automatic upon deployment, eliminating the need for physical verification (Mihna et al., 2025; Narowski et al., 2025; Leonhard et al., 2025).
- **Innovative Technical Approaches:** Outlier studies propose novel mechanisms such as DNA encryption for maximum security (Verma et al., 2024) or bottom-up crowdsourcing tools (e.g., STDM) for documenting informal settlements (Daniel & Ifejika Speranza, 2020).

Conclusion: A significant portion of the literature remains theoretical, failing to define the "genesis block" mechanism. However, the prevailing evidence suggests that for physical real estate, no fully decentralized registration process is currently viable; a trusted third party remains essential.

5.2. Identity Management and Verification

Identity management in blockchain real estate systems presents a fundamental paradox: reconciling the native pseudonymity of DLT addresses with the strict identification requirements of land registries.

Five primary strategies were identified:

1. **Integration with National Identity Systems:** Studies from the EU and India advocate leveraging existing infrastructure. Examples include linking wallets to Aadhaar biometrics (Kshetri, 2022; Singh et al., 2024; Khadanga & Jain, 2021) or complying with eIDAS standards (Ferreira, 2021; van Erp & Zimmermann, 2022).
2. **Banking Sector Gatekeeping:** This approach offloads identity verification to financial institutions via KYC/AML protocols. Banks serve as "whitelisting" agents, approving wallet addresses for participation (Kasprzak, 2021; Mottaghi et al., 2024).
3. **On-Chain Identity (Soulbound Tokens):** A technically sophisticated solution involves issuing non-transferable NFTs (Soulbound Tokens) or "Identity Certificates" to a user's wallet. Smart contracts verify the presence of this token before permitting transactions (Verma et al., 2024; Zhitomirskiy et al., 2023).
4. **Web3 Native Anonymity:** Restricted largely to the Metaverse, this model treats the wallet key as the sole identity, disregarding physical legal personhood (Paavo et al., 2025; Narowski et al., 2025; Leonhard et al., 2025).
5. **Role-Based Access Control (RBAC):** Common in permissioned government blockchains, this method utilizes a central administrator to assign specific roles (e.g., Notary, Citizen) to network participants (Abualhamayl et al., 2024; Mashatan et al., 2021).

Implication: A trade-off exists between legal certainty and decentralization. While "whitelisting" preserves some privacy, integration with national ID systems appears inevitable for official land registries.

5.3. Token Architecture and Taxonomy

The choice of token standard is not arbitrary but is determined by the system's functional objective: Title Security versus Liquidity.

Table 3: Comparative Analysis of Token Architectures

Token Type	Standard	Primary Use Case	Representative Studies
Unique Title	NFT (ERC-721)	Property Transfer, Metaverse	(Mihna et al., 2025; Garcia-Teruel & Simón-Moreno, 2021; Narowski et al., 2025; Leonhard et al., 2025)
Investment Share	Fungible (ERC-20)	Crowdfunding, SPVs, Dividends	(Mottaghi et al., 2024; Zhang et al., 2025; Zhitomirskiy et al., 2023)
Hybrid	Fractional NFT (ERC-1155)	Co-ownership of specific assets	(Abualhamayl et al., 2023)
Proof Record	Hash / Struct	Public Administration, Record Integrity	(Khadanga & Jain, 2021; Konashevych, 2021; Paavo et al., 2025; Zhang et al., 2024)
Exotic	Time-Sensitive	TDRs, Air Rights	(Allam & Jones, 2019)

For urban planning, the distinction is vital: government registries prioritize record integrity (hashes), while financial platforms prioritize fractionalization (fungible tokens). Notably, "Time-Sensitive Tokens" (Allam & Jones, 2019) offer specific utility for Transferable Development Rights (TDRs), allowing rights to expire if not exercised, thus preventing speculation.

5.4. Transfer Logic and Automation

Transfer logic defines how smart contracts replace bureaucratic procedures. The literature demonstrates a progression from simple value transfers to complex process orchestration.

- **Atomic Exchange:** The simultaneous swap of title and funds within a single transaction block, eliminating counterparty risk ($msg.value == price \rightarrow transfer$) (Mohanty et al., 2025; Subbarayudu & Hemalatha, 2024; Zhang et al., 2024; Zhang et al., 2025).
- **Conditional Transfer:** The smart contract acts as a compliance gatekeeper, executing transfers only if specific criteria (e.g., whitelist status, no liens) are met (Paavo et al., 2025; Zhitomirskiy et al., 2023).
- **Workflows and Multi-Signature:** Reflecting the reality of multi-party consent, these systems require a quorum of digital signatures (e.g., buyer, seller, bank) to finalize a state change (Avantaggiato & Gallo, 2019; Bennett et al., 2021; Tahar et al., 2023).
- **Transparent Bidding:** Utilizing public ledgers to record bids prevents "double-ending fraud" by agents (Mashatan et al., 2021).
- **Inheritance Mechanisms:**"Dead Man's Switch" contracts automatically transfer titles to heirs upon prolonged inactivity or receipt of a digital death certificate (van Erp & Zimmermann, 2022).

Relevance to TDR: Conditional transfer logic is particularly applicable to TDRs. Smart contracts can verify development feasibility or hold funds in escrow until zoning approval is confirmed, automating the complex compliance checks required by municipal authorities.

5.5. Management of Liens and Encumbrances

A land registry unable to manage mortgages is economically obsolete. The review identifies four levels of maturity in handling encumbrances:

1. **Dynamic Indicator (Status Flag):** A passive metadata field (e.g., isMortgaged: True) that prevents transfer. This mimics traditional paper registries (Kshetri, 2022; Zhang et al., 2024; Zhang et al., 2025).
2. **Smart Pledge (Active Enforcement):** The asset is locked in a smart contract escrow. The system manages permissions and can technically facilitate liquidation or automatic discharge upon loan repayment (Bennett et al., 2021; Akhmetbek & Špaček, 2021; Subbarayudu & Hemalatha, 2024).
3. **Unbundling of Rights:** Tokenization allows for the separation of use rights, ownership rights, and air rights. This allows, for example, a farmer to collateralize a lease without owning the land (Allam & Jones, 2019; Daniel & Ifejika Speranza, 2020).
4. **Fractionalization as Financing:** Instead of traditional debt, owners sell equity tokens to investors, effectively replacing mortgages with crowd-financing (Mottaghi et al., 2024; Baum, 2021; Zhitomirskiy et al., 2023).

Conclusion: For national registries, a combination of Status Flags (for legal certainty) and Smart Pledge workflows (for automation) is the most viable path.

5.6. Governance and Legal Interoperability

The literature indicates a shift away from the "Code is Law" ethos toward "Regulatory Isomorphism"—adapting blockchain to fit existing legal frameworks.

Five strategies bridge the digital-legal divide:

1. **The Legal Wrapper:** Utilizing SPVs to lend legal substance to digital tokens (Baum, 2021; Zhitomirskiy et al., 2023).
2. **Standardization (ISO/LADM):** Aligning data models with ISO 19152 (Land Administration Domain Model) to ensure compatibility with state systems (Habib et al., 2025; van Erp & Zimmermann, 2022).
3. **The Archival Bond (GDPR Compliance):** Storing PII (Personally Identifiable Information) off-chain while keeping only hashes on-chain to satisfy the "Right to be Forgotten" (Shahaab et al., 2023; Mashatan et al., 2021).
4. **The Mirror Registry:** Establishing the state registry as the superior "source of truth," with the blockchain serving merely as a transparent secondary layer (Mohanty et al., 2025; Bennett et al., 2021).
5. **New Legislative Frameworks:** The emergence of specific laws, such as the Swiss DLT Act, that legally recognize ledger-based securities (Ferreira, 2021; Zhitomirskiy et al., 2023).

5.7. Cost, Scalability, and Technical Sustainability

The feasibility of national-scale deployment is ultimately predicated on a delicate balance: technical scalability versus economic viability. Public blockchains, such as the Ethereum Mainnet, often fail this test; they are plagued by volatile transaction fees ("gas fees") and network congestion, rendering routine administrative acts economically lethargic. As (Zhitomirskiy et al., 2023) observe, the unpredictability of operational costs on public chains erects a formidable barrier to entry for both citizens and municipalities. Consequently, to ensure long-term institutional sustainability, a DLB requires a cost structure that is not only low but predictable—decoupled from the wild fluctuations of the cryptocurrency market.

In response to these structural constraints, the scholarly discourse converges on four distinct optimization strategies:

- **Permissioned Blockchains:** Frameworks like Hyperledger Fabric or Corda are favored for their high throughput and the elimination of user-facing transaction fees. In this model, the operational cost burden is shifted from the citizen to the consortium members (e.g., the Municipality). This ensures zero-cost access for the public while maintaining a predictable IT budget (Mohanty et al., 2025; Tahar et al., 2023; Subbarayudu & Hemalatha, 2024; Mashatan et al., 2021).
- **Hybrid Models:** This architecture balances security and cost by utilizing private networks for high-volume data processing, interacting with public networks only to anchor final proofs. This significantly reduces the frequency of expensive on-chain transactions (Konashevych, 2021; Shahaab et al., 2023).
- **Off-Chain Storage (IPFS):** To mitigate the prohibitive cost of on-chain storage, heavy documents—such as deeds and topographical maps—are stored on distributed file systems like IPFS. Only the cryptographic hash, which is lightweight and cheap to store, is recorded on the blockchain (Singh et al., 2024; Verma et al., 2024; Zhang et al., 2024).
- **Layer 2 Solutions:** These protocols (e.g., Polygon, Arbitrum) scale efficiency by bundling thousands of transactions into a single batch, thereby reducing the effective cost

per transaction on public networks to negligible levels (Zhitomirskiy et al., 2023; Leonhard et al., 2025).

6. SYNTHESIS OF ARCHITECTURAL ARCHETYPES

The multi-axis analysis crystallizes four distinct "holistic archetypes," each offering a specialized framework tailored to specific use cases:

- **The Commercial Investment Model:** (Zhitomirskiy et al., 2023) provides a robust blueprint for asset tokenization, featuring on-chain KYC, SPV integration, and complex dividend distribution logic.
- **The Government Registry Model:** (Mashatan et al., 2021) presents the most viable template for state adoption, emphasizing permissioned networks, fraud prevention, and strict GDPR compliance via "Archival Bonds."
- **The Transaction Cycle Model:** (Subbarayudu & Hemalatha, 2024) uniquely integrates the banking sector as a core validator, effectively resolving the "Lien" gap found in other models.
- **The Workflow Management Model:** (Bennett et al., 2019) excels in defining complex administrative workflows, such as mortgage discharge, through hybrid database-blockchain architectures.

Implications for TDR Systems: For urban planning authorities, the evidence suggests that permissioned, hybrid architectures are the only viable solution. Public blockchain fees render small-scale TDR transfers uneconomical, while total decentralization fails to meet administrative requirements. The architectural model proposed by (Mashatan et al., 2021)—utilizing a "Guardian" role for the municipality—offers the most robust template for a DLB focused on development rights.

7. DISCUSSION

This inquiry sought to determine whether blockchain technology could operate not merely as a database, but as a property institution equivalent to traditional legal mechanisms—specifically within the context of Transferable Development Rights (TDRs). Through a systematic analysis of 40 primary studies and the identification of seven critical architectural axes, several key interpretations emerge regarding the transition from analog to digital land governance.

7.1. Institutional Equivalence and the "Oracle Paradox" (Addressing the CRQ)

The Central Research Question interrogated whether blockchain could mimic the legitimacy of traditional institutions. The synthesis suggests that while blockchain possesses functional equivalence, it lacks originating legitimacy. The technology offers superior mechanisms for Exclusivity (via non-fungible tokens) and Transferability (via atomic swaps), yet it cannot independently satisfy the condition of Recognizability without an external source of truth.

This limitation highlights what may be termed the "Oracle Paradox," prevalent in the analyzed studies (e.g., Mohanty et al., 2025; Mashatan et al., 2021). Unlike native cryptocurrencies where the asset is the code, a TDR is a derivative right—it is tethered to physical land. Consequently, the blockchain cannot "know" the state of the physical world (e.g., if a building is historically listed) without a trusted data feed. Thus, the blockchain does not replace the State; rather, it reconfigures the State's role from a manager of records to a

certifier of oracles. The institutional validity of the DLB depends, therefore, not on the decentralization of the ledger, but on the integrity of the "Minting" authority.

7.2. Operationalizing the TDR Lifecycle (Addressing SRQ 1 & 2)

The literature review reveals a sharp architectural divergence between general real estate tokenization and the specific requirements of Transferable Development Rights (TDRs). While standard real estate models prioritize fractional investment strategies (typically utilizing ERC-20 standards), TDRs demand a unique "Lifecycle Architecture" that most current frameworks overlook.

Drawing on findings regarding "Time-Sensitive Tokens" (Allam & Jones, 2019) and "Conditional Transfers" (Paavo et al., 2025), a functional TDR model must implement a strict, linear state-change process consisting of three phases:

1. **Genesis (Minting):** The creation of the asset is triggered exclusively by a planning authority's administrative decree.
2. **Circulation (Trading):** The movement of the asset is governed by smart contracts that strictly enforce zoning compatibility between Sending and Receiving zones.
3. **Extinguishment (Burning):** Unlike standard fee-simple property which is held in perpetuity, a TDR is consumed upon utilization.

To enforce this trajectory, a simple NFT standard (ERC-721) proves insufficient unless paired with a hard-coded "Burn Function." This mechanism ensures the irrevocable destruction of the token upon the issuance of a building permit, effectively preventing the double-spending of density rights—a critical failure point in traditional paper-based systems.

7.3. The Necessity of Hybrid Governance (Addressing SRQ 3)

In addressing transition barriers, the analysis strongly refutes the viability of fully public, permissionless blockchains (e.g., Bitcoin, Ethereum Mainnet) for land administration. The dominant constraints identified—GDPR compliance (Shahaab et al., 2023), gas fee volatility (Zhitomirskiy et al., 2023), and the need for identity reversion (Singh et al., 2024)—point inevitably toward Permissioned or Hybrid Architectures.

A DLB must essentially operate as a Consortium Blockchain. In this model, the public may hold read-access (transparency), but write-access (validation) is restricted to a quorum of trusted nodes (e.g., the Municipality, the Land Registry, the Notariat). This hybrid approach resolves the tension found in Section 5.2 between "Web3 Anonymity" and "State Identification," allowing for the immutable recording of rights while permitting the rectification of errors through multi-signature governance—effectively creating a "digital safety valve" for judicial intervention.

7.4. Market Liquidity vs. Regulatory Control (Addressing SRQ 4)

The review confirms that tokenization significantly enhances market liquidity by reducing transaction friction. However, for TDRs, liquidity is a double-edged sword. Unregulated velocity can lead to speculative bubbles in development rights, making housing unaffordable.

Here, the "Smart Contract as Regulator" concept (Ferreira, 2021) becomes paramount. The discussion suggests that the DLB should not merely facilitate trade but actively regulate it. Smart contracts can be programmed with "Circuit Breakers"—code that limits price volatility or restricts transfers to valid developers only. This finding represents a paradigm shift: the DLB becomes an active policy instrument that enforces urban planning rules ex-ante (before the transaction), rather than relying on ex-post bureaucratic enforcement.

8. CONCLUSIONS

8.1. Summary of Contributions

This study employed a Systematic Literature Review to construct an analytical framework for the implementation of a blockchain-based DLB. By dissecting 40 primary studies through the PICOS framework, this research identified seven critical "architectural axes" necessary for the system's viability. The primary contribution of this work is the conceptual decoupling of Land Title Management (static, perpetual) from Development Rights Management (dynamic, consumable), establishing that TDRs require a distinct tokenomic model characterized by "Mint-and-Burn" mechanics and conditional logic.

8.2. Theoretical Implications

Theoretically, this research challenges the "Code is Law" narrative often associated with blockchain. Instead, it supports a theory of "Regulatory Isomorphism," where blockchain structures must morph to fit existing legal containers to achieve legitimacy. It is concluded that blockchain acts as a techno-institutional layer that does not supplant property rights but "hardens" them—transforming administrative promises (paper certificates) into cryptographic guarantees (digital assets).

8.3. Policy and Practical Recommendations

For policymakers implementing the DLB (e.g., under Greek Law 4759/2020), the following recommendations are drawn from the empirical evidence:

- **Adopt a Permissioned Infrastructure**: Utilize frameworks like Hyperledger Fabric rather than public chains to ensure GDPR compliance and zero-cost transaction fees for citizens.
- **Standardize the "Oracle":** Legislation must explicitly define the digital entry point (the specific administrative act) that triggers the minting of a TDR token to prevent fraudulent creation.
- **Implement "Smart" Zoning:** Encode receiving zone restrictions directly into the TDR token metadata, ensuring that a right can only be transferred to a parcel that legally accepts it.

8.4. Limitations and Future Research

While this study maps the architectural requirements, it is limited by the lack of longitudinal data on TDR-specific blockchain pilots, as most case studies focus on standard land titling. Future research should focus on interoperability standards—specifically bridging the DLB with the National Cadastre—and governance longevity, exploring how immutable ledgers can accommodate changes in urban planning laws over decades.

More broadly, the proposed architecture aligns with ongoing discussions on rule-encoding and automation in planning governance, while raising questions about long-term legal adaptability and accountability.

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AI AND THE DYNAMICS OF CREATIVE DESTRUCTION IN THE GREEN TRANSITION. AS A CASE STUDY THE MUNICIPALITY OF NEA FILADELFIA-NEA CHALKIDONA, ATTICA, GREECE.

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LinearUrbanSystem

AI-driventoCreativeDestruction CaseStudy:MunicipalityofNeaFiladelfeia–Nea Chalkidona(Greece)

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Abstract
Joseph Schumpeter's concept of creative destruction offers a theoretical lens for analyzing processes of structural change through which outdated economic and governance systems are replaced by more innovative and efficient ones. While traditionally associated with industrial innovation, creative destruction has become increasingly relevant in the context of sustainable development and digital transformation. The transition from linear to circular economic models requires not only technological innovation but also the reconfiguration of local governance practices, policy instruments, and citizen participation mechanisms.

Within this framework, artificial intelligence (AI) emerges as a key enabler of circular economy transitions, supporting the optimization of resource flows, predictive management of urban services, and data-driven decision-making. AI-driven systems can enhance transparency, efficiency, and accountability in local governance, while facilitating more inclusive and participatory sustainability initiatives. This article examines how municipalities can leverage AI to implement circular economy principles and promote sustainable green growth, in alignment with the objectives of the European Green Deal.

Using the Municipality of Nea Filadelfeia–Nea Chalkidona as a case study, the article explores AI-supported applications in waste management, bio-waste collection, and citizen engagement. Empirical evidence from existing studies suggests that AI-based waste management systems can increase recycling rates by approximately 20–30% and reduce operational costs by 10–15%, while real-time analytics improve route optimization and service efficiency. At the same time, digital platforms can strengthen citizen participation and social inclusion, contributing to broader environmental and governance goals.

The findings indicate that the convergence of AI technologies, circular economy practices, and participatory local governance can operationalize creative destruction as a catalyst for smart and green urban transitions. While significant opportunities exist, the study

also highlights challenges related to institutional capacity, data governance, and equitable implementation. Overall, the article provides insights for policymakers, practitioners, and researchers seeking to align technological innovation with sustainable development objectives under the European Green Deal.

Keywords: AI, Creative Destruction, Circular Economy, Sustainable Green Development, Smart Green Transition, Governance, European Green Deal.

1. INTRODUCTION

Creative destruction provides a conceptual framework for understanding the transformation of outdated socio-technical systems into more innovative and efficient structures. In the context of green transitions, artificial intelligence is increasingly framed as a catalyst capable of accelerating the shift toward circular economic models by optimizing resource flows, supporting evidence-based policy decisions, and facilitating new forms of citizen engagement. However, such transformations are neither linear nor guaranteed, as they unfold within complex urban systems characterized by institutional fragmentation, competing land-use priorities, and uneven governance capacities (Schumpeter, 1942; Frantzeskaki et al., 2017).

Within this context, the concept of the Green City emerges as a complementary yet contested framework, particularly within European smart city and sustainability agendas. While municipalities are encouraged to leverage digital technologies such as AI to promote circular resource use, environmental sustainability, and improved quality of urban life, critical scholarship highlights a persistent gap between technological potential and effective local implementation (Kitchin, 2014; Bulkeley et al., 2019). This gap is especially pronounced in dense urban areas, where natural assets are limited, spatial pressures are high, and governance arrangements often struggle to integrate environmental objectives into everyday urban planning.

The municipality of Nea Filadelfeia–Nea Chalkidona exemplifies these challenges and opportunities. The presence of the Alsos (urban park) and the Podoniftis river constitutes a significant natural asset that could serve as a core element of a Green City vision, supporting biodiversity, climate adaptation, and citizen well-being. At the same time, these ecosystems are embedded within a highly urbanized environment and are subject to pressures related to pollution, fragmented management responsibilities, and limited data-driven monitoring. This raises critical questions regarding how digital tools and AI-driven governance can be mobilized not merely to enhance efficiency, but to enable integrated, participatory, and ecologically sensitive urban management. Addressing these challenges is central to determining whether Green City strategies can function as instruments of transformative sustainability or remain confined to symbolic and fragmented interventions.

2. Theoretical Framework

2.1.Creative Destruction and Economic Transformation

Joseph Schumpeter (1942) conceptualized **creative destruction** as the dynamic process through which innovation disrupts and replaces obsolete technologies and business models, fostering economic growth and structural transformation. This process operates through several interrelated mechanisms, such as:

- **Technological innovation** drives efficiency and productivity by enabling new technologies to outperform existing systems.

- **Market reconfiguration** emerges as innovative firms reshape production networks and consumer behavior, leading to the decline of outdated enterprises (Schumpeter, 1942; Aghion & Howitt, 1992).
- **Structural transformation** accompanies these changes, requiring adjustments in labor markets, skills, and institutional frameworks (Freeman & Louçã, 2001).
- Finally, **socio-institutional adaptation** ensures that governance structures, policies, and regulations evolve to support emerging technologies and mitigate transitional disruptions (Berkhout et al., 2004).

Collectively, these mechanisms highlight how creative destruction acts as a driver of technological progress, economic renewal, and socio-institutional change.

2.2. Creative Destruction in Sustainable Transitions

Sustainable transitions involve the gradual dismantling of fossil-based and linear production systems while promoting low-carbon, resource-efficient, and socially inclusive models (Geels, 2002; Loorbach, 2010). **Artificial Intelligence (AI)** can accelerate this transformation by optimizing resource use and waste collection, enabling predictive environmental management, supporting evidence-based and transparent policymaking, and reducing operational costs and emissions (Bughin et al., 2018; Dwivedi et al., 2021). Through these mechanisms, AI not only enhances technological innovation but also facilitates the structural and institutional adjustments essential for achieving a sustainable green transition (Schumpeter, 1942; Aghion & Howitt, 1992). By linking the theoretical principles of creative destruction with practical AI applications, municipalities can actively guide sustainable transformations while balancing innovation with environmental stewardship and social responsibility (Berkhout et al., 2004; Geels et al., 2017).

3. AI-Driven Circular Economy in the Municipality of Nea Filadelfeia–Nea Chalkidona

The Municipality of Nea Filadelfeia–Nea Chalkidona exemplifies how Artificial Intelligence (AI) can advance a local circular economy by integrating technology, governance, and citizen participation (Geissdoerfer et al., 2017; Kirchherr et al., 2018).

- **Smart waste management** systems, such as AI-enabled bins that continuously monitor fill levels, weight, and contamination, have been shown to improve recycling rates by 20–30% while reducing unnecessary collection routes (Bertolini et al., 2021; Song et al., 2020). AI-optimized collection routes, leveraging GPS and real-time analytics, contribute to lower CO_2 emissions and enhanced operational efficiency (Li et al., 2021).
- **Bio-waste management** also benefits from AI innovations. Real-time monitoring of moisture, contamination, and decomposition improves compost quality and reduces processing costs (Zhang et al., 2022). Community composting units integrated with AI systems can automatically regulate temperature and oxygen levels, enhancing compost production for urban gardens and supporting local circular loops (Bourlakis & Weightman, 2019).
- **Citizen participation** is strengthened through AI-powered mobile applications, which guide residents in proper waste sorting, enable reporting of overflowing bins or illegal dumping, and implement incentive systems such as "Green Points" to boost engagement (Hossain et al., 2020; Ghezzi et al., 2018).
- **Data-driven governance** is facilitated through AI dashboards that visualize waste generation trends, participation metrics, and cost–benefit analyses. Predictive modeling

forecasts waste production based on population growth, commercial activity, events, and weather, enabling proactive resource allocation. AI-supported material recovery facilities automate sorting processes, increasing the recovery of plastics, paper, aluminum, and organic materials, transforming waste into marketable resources and reinforcing the local circular economy (Korhonen et al., 2018; Lieder & Rashid, 2016).

By integrating AI across waste management, bio-waste treatment, citizen engagement, and policy planning, the Municipality of Nea Filadelfeia–Nea Chalkidona can implement a smart and sustainable circular economy, generating measurable environmental, economic, and social benefits (Geels et al., 2017; Bocken et al., 2016).

4. Current Limitations and Future Needs

The Municipality of Nea Filadelfeia–Nea Chalkidona currently lacks essential AI- enabled infrastructure necessary for a fully operational circular economy. Specifically, smart waste bins, predictive collection routing systems, bio-waste monitoring, automated composting, and AI-supported material recovery facilities have not yet been implemented. Furthermore, no publicly available data exist to demonstrate measurable improvements in recycling rates, operational efficiency, or cost reductions from prior digital initiatives (Bertolini et al., 2021; Hossain et al., 2020).

To achieve a fully AI-driven circular economy, the municipality must invest in several key areas. Firstly, the deployment of IoT-enabled waste infrastructure would allow real- time monitoring of fill levels, contamination, and bio-waste conditions, thereby enabling more efficient collection and resource allocation (Song et al., 2020; Li et al., 2021). Secondly, digital platforms for citizen engagement are critical to guide proper waste sorting, facilitate reporting of overflowing bins or illegal dumping, and promote participation through incentive mechanisms such as gamification and "Green Points" systems (Ghezzi et al., 2018; Zhang et al., 2022). Thirdly, AI dashboards for evidence- based decision-making would allow municipal authorities to visualize waste trends, participation metrics, and cost–benefit analyses, supporting proactive policy planning (Geissdoerfer et al., 2017). Finally, pilot projects are necessary to demonstrate measurable environmental, economic, and social benefits, providing empirical evidence for scaling AI-assisted circular economy initiatives (Bocken et al., 2016; Korhonen et al., 2018).

Despite these limitations, the municipality possesses significant advantages that can facilitate the gradual integration of AI technologies. The presence of the **Alsos park** offers a valuable green infrastructure that can be leveraged for bio-waste recycling, urban gardens, and community engagement initiatives, aligning with the Green City concept of integrating environmental performance, urban livability, and technological innovation (Geels et al., 2017; Kirchherr et al., 2018). Additionally, the municipal Innovation Hub provides a strategic platform for collaboration with universities, technology partners, and funding agencies, which can accelerate capacity building, knowledge transfer, and sustainable urban development (Bourlakis & Weightman, 2019).

By combining these natural and institutional assets with targeted investments in AI infrastructure and citizen-centered digital platforms, Nea Filadelfeia–Nea Chalkidona can transform its ambitious sustainability plans into tangible outcomes, enhancing both environmental performance and social inclusivity in line with circular economy principles (Korhonen et al., 2018; Lieder & Rashid, 2016).

5. CONCLUTIONS

The integration of Artificial Intelligence (AI) into local governance illustrates that creative destruction can function as a deliberate and managed process within sustainable urban transitions (Schumpeter, 1942; Geels et al., 2017). By aligning AI- driven innovation with circular economy principles, municipalities can enhance administrative capacity, operational efficiency, and strategic decision-making, enabling more resilient and adaptive governance structures (Korhonen et al., 2018; Lieder & Rashid, 2016).

In the Municipality of Nea Filadelfeia–Nea Chalkidona, AI-based tools have the potential to significantly improve environmental performance and municipal management by facilitating more effective allocation of resources, real-time monitoring of waste flows, and proactive policy interventions (Bertolini et al., 2021; Li et al., 2021). However, the municipality currently faces **limitations in managing sustainability initiatives**, including the absence of AI-enabled infrastructure such as smart bins, predictive routing, bio-waste monitoring, and automated composting, as well as a lack of experience in data-driven decision-making. These gaps hinder the municipality's ability to fully implement circular economy practices and to achieve the objectives of a Green City (Geissdoerfer et al., 2017; Hossain et al., 2020).

Despite these challenges, there are **significant opportunities**. With targeted investments, pilot projects, and collaboration with academic and technological partners, AI can enhance municipal governance, foster citizen participation, and deliver measurable environmental, economic, and social benefits (Bocken et al., 2016; Kirchherr et al., 2018). The municipality also possesses valuable assets, including the **Alsos urban park**, which provides natural infrastructure for bio-waste recycling, urban gardening, and community engagement initiatives. Leveraging such resources through AI-driven management systems can transform sustainability plans into **practical Green City strategies**, integrating environmental performance, participatory governance, and citizen engagement into a coherent urban development model (Geels et al., 2017; Bourlakis & Weightman, 2019).

Ultimately, while current limitations highlight the municipality's challenges in managing sustainability initiatives, AI-driven circular economy initiatives, combined with natural assets and strategic planning, can enable Nea Filadelfeia–Nea Chalkidona to emerge as a **smart, sustainable, and socially inclusive Green City**. This demonstrates that creative destruction, when guided by public policy and supported by AI, can position municipalities as central actors in the green transition, aligning technological innovation with ecological stewardship and community well-being (Korhonen et al., 2018; Lieder & Rashid, 2016).

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ESPORTS AND SOCIAL STABILITY: MORAL VALUES AND LEARNING OPPORTUNITIES IN VIRTUAL CITIES

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Abstract
eSports, a rapidly growing cultural phenomenon, extend beyond mere entertainment to foster vibrant "virtual communities" and promote social values. This study explores the integration of eSports in educational environments and their potential contribution to social sustainability through the cultivation of moral values and innovative pedagogical approaches. The research underscores that eSports can instill virtues critical for life beyond the digital space. Participation in eSports enhances teamwork and cooperation, enabling players/students to communicate effectively, build trust, and leverage their teammates' strengths toward achieving common objectives. It also nurtures critical thinking and problem-solving abilities, as participants analyze strategies and make swift decisions while navigating complex challenges.

Furthermore, eSports serve as a significant tool in developing digital identity and responsibility. Engaging within online communities that prioritize sportsmanship, respect, and inclusion, players can address vital issues such as diversity and mental health. The educational application of eSports creates interactive learning experiences that enhance student engagement. By leveraging data analytics, educators can assess student performance and engagement levels, facilitating the design of personalized learning paths that enhance collaboration.

Aligned with the goals of the IEP (Institute of Educational Policy), which emphasizes the cultivation of 21st-century skills such as critical thinking, communication, collaboration, and creativity, this research highlights the theoretical and practical significance of eSports. Ultimately, it posits that eSports are an influential medium for fostering social cooperation, active participation, and the emergence of new community forms, preparing citizens for the challenges of the modern digital landscape.

Keywords: eSports, social sustainability, educational environments, teamwork, digital identity, 21st-century skills.

SESSION

"Energy and Sustainable Development"

Chaired by **Prof Kabassi Katerina** and
Kremlis George

UNIVERSITY-LED SOLAR ENERGYINITIATIVES IN SUPPORTOFSDG7 AND SDG13: A LITERATURE REVIEW (2015–2025)

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Abstract
This paper presents a thematic and descriptive literature review examining how universities contribute to the achievement of Sustainable Development Goal 7 (Affordable and Clean Energy) and Sustainable Development Goal 13 (Climate Action) through solar energy initiatives. A structured search using the Scopus database was conducted for the period 2015–2025, filtered by open-access journal papers in English, specifically targeting the keyword "Solar Energy" in the context of higher education institutions. A total of 25 relevant articles were identified and analyzed. The review combines both descriptive and thematic approaches. Descriptive analysis revealed a growing academic interest in solar-related sustainability actions across European universities, particularly in operational and technological domains. Thematic synthesis highlighted four dominant areas: (1) solar photovoltaic system implementation on campuses, (2) energy efficiency strategies linked to institutional sustainability plans, (3) integration of solar energy topics into research and curricula, and (4) use of monitoring and assessment frameworks for carbon and energy performance.

In addition to thematic grouping, the 25 articles were further categorized according to five analytical lenses: (1) level of engagement, (2) SDG specificity, (3) methodological approach, (4) geographic and institutional profile, and (5) outcome orientation. These categorizations aim to enhance the interpretative depth of the review and identify gaps in current research practices, such as the limited explicit alignment with SDG 13 and the lack of robust evaluation of long-term outcomes.

The findings underline the emerging role of higher education institutions not only as consumers but also as laboratories and advocates of clean energy transitions, encouraging the dissemination of clean energy technologies implementation via their example. Future research should explore more integrated institutional strategies that address both energy and climate objectives, supported by measurable impact assessments and broader stakeholder engagement.

Keywords: Energy Efficiency in Higher Education, Climate Action, Institutional Sustainability Strategies, Carbon Performance Monitoring, Clean Energy Dissemination, SDG Integration in Academia

TOWARD SUSTAINABLE AND SOCIALLY EQUITABLE CITIES: A LOCAL CLIMATE ZONE APPROACH FOR PHOTOVOLTAIC DEPLOYMENT IN EUROPEAN CITIES

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Abstract
Accelerating climate change represents an urgent and complex challenge with elevating global and local temperatures, extreme weather events, and unsustainable patterns of energy generation and consumption, calling for immediate action. Renewable energy sources, particularly solar energy and photovoltaic (PV) systems, constitute a viable pathway to mitigate greenhouse gas (GHG) emissions and enable cities' transitions toward a more sustainable energy future.

However, the local microclimate of urban landscapes strongly influences the suitability, efficiency, and applicability of large-scale PV deployments. In view of the above, the Local Climate Zone (LCZ) classification offers a systematic methodological framework to classify and evaluate the microclimate of urban and peri-urban regions. As cities struggle to develop climate-resilient urban planning and sustainable infrastructure, the integration of the LCZ classification with solar energy strategies becomes increasingly important. Using Ioannina in Greece and Brussels in Belgium as case studies, this work investigates how LCZ-based urban climate analyses can guide the deployment of PV technologies, demonstrating their valuable contribution in the development of evidence-based strategies for urban energy transitions and cities' decarbonization. By coupling LCZ-driven insights with thoughtful renewable energy management, both scientists and urban policymakers can assess solar PV potential and optimal PV installation sites in full alignment with performance variation attributed to urban morphology, land cover type, building density, and thermal patterns. This approach reveals the complex interplay between energy systems, climatic conditions, and urban morphology, while laying the foundation for climate-sensitive urban design.

Furthermore, an additional dimension of the LCZ approach is associated with social equity since the LCZ morphology often reveals underlying social and economic patterns. As communities worldwide are searching for appropriate mechanisms to undertake urban initiatives without external support, the need for targeted supportive actions, tailored to the socio-economic profile of the residents, is prioritized. Combining the LCZ classification with the spatial distribution of socio-economic key performance indicators provides a holistic approach in which renewable energy solutions and climate resilience are inclusive, equitable, and practically feasible.

Key words: Urban environments, Energy transition, Photovoltaics, Local Climate Zones (LCZs), Solar PV potential, Socio-economic equity

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SUPPORTING THE ENERGY TRANSITION: HOW REGULATIONS AND MARKET-BASED INSTRUMENTS SHAPE THE CHANGING ENERGY LANDSCAPE IN GREECE AND THE EU-27

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Abstract
This paper provides a comprehensive review of energy transition dynamics within the EU27, with a particular focus on Greece's long-term sustainability strategy and the phase-out of its lignite-dependent energy system. The study analyzes shifts in the composition and structure of the energy mix in Greece and the EU27 and conducts a comparative analysis of electricity generation over the past two decades. It also evaluates national and regional emissions mitigation objectives anchored in decarbonization targets set by the Greek National Energy and Climate Plan (NECP) and the Just Transition Development Plan.

The paper argues that achieving these climate targets requires a coordinated approach combining direct regulatory measures, mandated phase-outs, and energy plans, alongside market-based instruments such as carbon pricing. Based on a critical review of the literature and current regulatory frameworks, the study provides an analytical discussion of the distinct and complementary roles of these mitigating mechanisms, focusing on carbon taxation and cap-and-trade schemes. Current global data on emissions trading systems and carbon tax revenues are incorporated to assess their effectiveness in reducing emissions and achieving decarbonization objectives.

Keywords: energy transition, power generation, market-based tools, RES, decarbonization, cap-and-trade, carbon taxation.

1. INTRODUCTION

Fossil fuel combustion has profound and far-reaching impacts on the environment. The release of carbon dioxide (CO_2) is the primary driver of global climate change, while other harmful emissions, including sulfur dioxide, nitrogen oxides, and particulate matter, significantly affect public health worldwide (World Health Organization, 2021).

Among fossil fuels, coal has particularly severe environmental consequences. Coal-fired power plants and coal mining activities cause extensive local environmental degradation, including habitat destruction, soil erosion, water and air pollution, acidification, and resource depletion (Papavasiliou, Roumpos, & Michalakopoulos, 2016; Finkelman, Wolfe, & Hendryx, 2021). Lignite combustion is therefore a major source of greenhouse gas emissions, releasing roughly twice as much CO_2 per unit of energy as natural gas, along with higher levels of harmful air pollutants (Soeder, 2021).

Despite its considerable environmental and health impacts, coal continues to play a major role in the global energy system. In 2024, coal accounted for 28% of global energy supply, following oil (34%) and ahead of natural gas (25%) (Energy Institute, 2025). In

electricity generation, coal reached an all-time high of 35% in 2023 and declined slightly to 34% in 2024, followed by renewables (32%), natural gas (22%), nuclear (9%), and oil (2%). China remains the largest coal consumer, responsible for 56% of global demand, while India surpassed the combined consumption of Europe and North America for the first time in 2024. Global coal use rose to 8.77 billion tonnes in 2024—another record high—and is expected to remain at these levels until at least 2027, depending largely on developments in China (IEA, 2024).

Limiting global warming to 1.5–2°C and achieving net-zero CO_2 emissions requires a profound transformation of national and global energy systems. According to the IPCC (2023), this objective demands a 25% reduction in CO_2 emissions by 2030 and their near-complete elimination by 2070. Aligned with the objectives of the 2015 UN Paris Agreement, most European and OECD countries have committed to phasing out coal-fired power generation by 2030. In Europe, 23 countries have announced coal phase-out plans. Sweden (2020), the UK (2024), Portugal (2021), Belgium (2016), and Austria (2020) have already eliminated coal from their electricity mix (Beyond Fossil Fuels, n.d.). Cyprus, Switzerland, Albania, Norway, Estonia, Latvia, and Lithuania never incorporated coal into their power generation systems.

Other European nations have adopted later phase-out targets: Slovakia, Ireland, and Spain (2025); France and Hungary (2027); Denmark, Italy, and Greece (2028); Finland and the Netherlands (2029); North Macedonia (2030); Romania (2032); Slovenia, Czechia, and Croatia (2033); Montenegro (2035); Germany (2038); and Bulgaria (2040)[45].

Greece, once heavily dependent on lignite for electricity generation, is actively participating in this energy transition. As one of Europe's largest lignite producers, Greece historically relied on this domestic resource to support its energy needs (Heinrich Böll Stiftung, 2015). The country originally announced a coal phase-out target of 2026, later revised to 2028 in line with broader European climate objectives (Beyond Fossil Fuels, n.d.).

The growing share of renewable energy sources (RES) in the EU-27 electricity mix, combined with the sharp decline in solid fossil fuel use, has led to substantial reductions in greenhouse gas emissions across Europe (European Environment Agency, 2024). Electricity generation represents only one dimension of the required mitigation effort. Achieving climate neutrality requires rapid and sustained emissions reductions across all major sectors: energy, industry, land use, transport, and infrastructure.

Reducing greenhouse gas emissions relies on both direct and indirect policy interventions affecting fossil fuel use. Climate and energy policies have been central to the delignification process, with carbon pricing mechanisms playing a particularly critical role. In this context, the European Green Deal (European Commission, 2019) established a strategic roadmap to achieve a climate-neutral EU economy by 2050, with main objectives being energy decarbonization, transition to RES, energy efficiency, achievement of net-zero greenhouse gas emissions (carbon neutrality), and air, water, and soil pollution elimination.

2. EVOLUTION OF THE ENERGY LANDSCAPE IN GREECE AND THE EU27

The impact of delignification and broader decarbonization efforts in Europe is clearly reflected in the evolution of domestic greenhouse gas emissions, which have declined substantially over the past twenty years. In the EU27, total net domestic greenhouse gas emissions reached 2,827,024 Gg CO_2-equivalent in 2024, representing a 33% reduction compared to 2004. Greece achieved an even sharper decrease: its net greenhouse gas

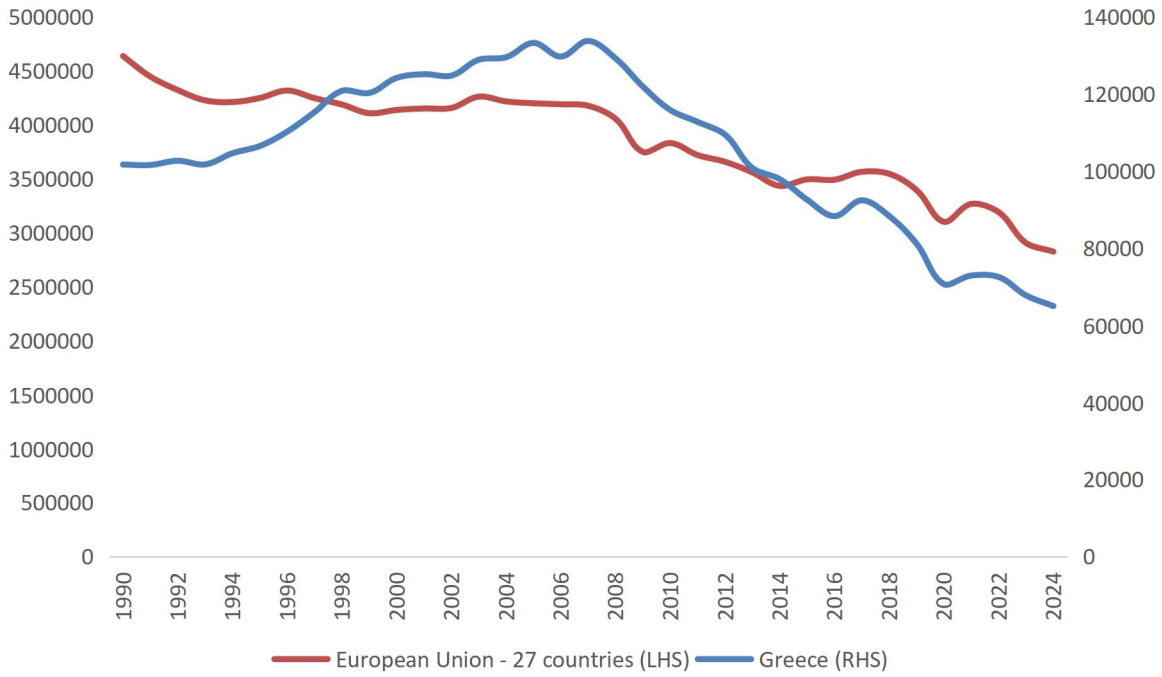
[45] In Serbia, coal phase-out is under discussion, while no official timelines exist for Bosnia-Herzegovina, Kosovo, Turkey, or Poland.

emissions fell to 65,070 Gg CO_2-equivalent in 2024, corresponding to a 50% reduction since 2004, which is the second-largest decline among EU27 member states after Denmark (eea.europa.eu).

Fossil fuels use reduction is the primary cause of this emissions mitigation. Fossil fuels dominated primary energy production in both Greece and the EU27 for decades. In recent years, renewable energy sources (RES) and natural gas have significantly increased their shares in the energy mix, leading to substantial changes in the structure of energy systems. Distinct shifts in the fuel mix are observable across different stages of the energy flows, reflecting broader trends in decarbonization and diversification.

Over the past twenty years, the energy profiles of both the EU27 and Greece have changed markedly in terms of overall quantities and the composition of fuels. A clear transition away from lignite has taken place in both cases, accompanied by a steady rise in RES and natural gas.

Figure 1: Domestic net greenhouse gas emissions in Gg CO_2-equivalent.



Source: processed data of European Environment Agency (eea.europa.eu)

To capture these developments more systematically, we employ the Standard International Energy Product Classification (SIEC), which provides a detailed categorization of energy products by type of energy flow. This classification includes solid and liquid fossil fuels, non-fossil fuels such as renewables and biofuels, electricity, non-renewable waste, heat, and nuclear heat. In the following sections, we combine the SIEC framework with Eurostat's Complete Energy Balance Sheets to enable consistent comparisons across time and regions, as well as a more granular analysis of energy transitions.

Primary Production

In Greece, primary energy production, defined as the extraction or capture of energy from natural resources within a country's territory, declined substantially over the period examined, mirroring a broader EU27 trend. Greece's domestic production fell from 115,988 GWh in 2003 to 61,610 GWh in 2023, a 47% reduction. In 2023, primary energy production in Greece

was driven mainly by RES and biofuels, which together accounted for nearly 75% of total production. The remaining 25% consisted entirely of solid fossil fuels, specifically lignite. In 2003, lignite comprised 82% of domestic production. Between 2003 and 2023, lignite production fell by 84%, while RES output increased by 144%.

In the EU27, total primary energy production decreased by 20% between 2003 and 2023. Solid fossil fuels made up 14% of primary production in 2023, down by 59% compared to 2003. RES accounted for 46% of primary production, representing a cumulative increase of 140% since 2003. Nuclear heat, which is not part of Greece's energy mix, contributed 29% of EU27 production in 2023, though this represents a decline of 33% compared with 2003. Other EU27 sources included natural gas (5%) and crude oil (3%), both of which declined sharply (by 73% and 60%, respectively).

Energy Trade

Energy trade refers to the import and export of energy products across national borders and it can include both indigenous production and energy products that have been transformed, such as electricity or refined petroleum.

Unlike domestic production, Greece's energy imports increased by 26% from 2003 to 2023, reaching 419,674 GWh in 2023—nearly seven times higher than domestic production. Energy exports also rose sharply, tripling to 217,822 GWh in 2023, resulting in a net import balance of 201,853 GWh. Greece's imports consisted mainly of oil and petroleum products (86% of the total, primarily crude oil) and natural gas (11%). Natural gas imports rose by 105% between 2003 and 2023, while oil imports increased by 21%. Electricity imports were relatively small at 8,151 GWh in 2023, though this represented a 96% increase since 2003. Export growth was driven by a 200% increase in oil product exports (primarily refined petroleum), a 117% rise in lignite exports, and a 56% increase in electricity exports.

In the EU27, energy imports declined slightly (by 3%) over the same period, totaling 14,140,780 GWh in 2023. Imports were roughly twice the level of primary production. Energy exports rose by 32% to 5,051,956 GWh. The EU27 import structure was dominated by oil and petroleum products (65%), followed by natural gas (25%), solid fossil fuels (5.4%), electricity (3%), and RES/biofuels (2%). EU27 energy exports consisted mainly of oil and petroleum products (73%), natural gas (12%), electricity (8%), solid fossil fuels (3%), and RES/biofuels (3%).

Final Energy Consumption

Final energy consumption corresponds to the energy that is actually used by end-users, after transformation and losses, and it includes the gross inland consumption (net imports and primary production) as well as the net transformation output minus any distribution losses and the energy's sector own use (SIEC). In Greece, available energy for final consumption reached 176,850 GWh in 2023, falling by 25% since 2003. The sectoral structure of energy demand shifted over time, with industry's share declining and transport's share increasing.

In 2023, final energy consumption consisted of 54% oil and petroleum products (down from 68% in 2003), 12% natural gas (up from 5%), 26% electricity, and 12% RES (up from 5%). Sectorally, industry relied on oil (30%), natural gas (23%), RES (6%), and especially electricity (40%). Transport remained overwhelmingly fossil-fuel-dependent, using 99% oil and only 0.3% electricity. The commercial and public services sector, along with agriculture and forestry, primarily used electricity (68% and 65%, respectively). Household consumption consisted of 10% natural gas, 24% oil, and 31% RES, including 9% solar thermal, 3% ambient heat (heat pumps), and 19% solid biofuels.

Table 1: Energy mix per fuel in 2023 in the EU-27 (GWh)]

Type of fuel	Primary production	Imports	Exports	Total energy supply	Final consumption - energy use
Greece (GWh) - 2023					
Solid fossil fuels	15,251	381	1,684	13,713	704
	24.8%	***0.1%***	***0.8%***	***6.0%***	***0.4%***
Natural gas	30	47,720	2,619	46,208	12,493
	0.0%	***11.4%***	***1.2%***	***20.1%***	***7.1%***
Oil and petroleum products (excluding biofuel portion)	586	362,717	210,238	118,669	94,780
	1.0%	***86.4%***	***96.5%***	***51.6%***	***54.2%***
Renewables and biofuels	45,641	706	43	46,438	20,778
	74.1%	***0.2%***	***0.0%***	***20.2%***	***11.9%***
Non-renewable waste	102	-	-	102	-
	0.2%			***0.0%***	
Electricity	-	8,151	3,238	4,913	45,817
		1.9%	***1.5%***	***2.1%***	***26.2%***
Heat	-	-	-	-	297
					0.2%
Total	61,610	419,674	217,822	230,043	174,869
	100%	***100%***	***100%***	***100%***	***100%***
EU27 (GWh) - 2023					
Solid fossil fuels	878,492	761,247	165,409	1,460,510	169,641
	13.7%	***5.4%***	***3.3%***	***10.0%***	***1.7%***
Manufactured gases	-	-	-	-	49,367
					0.5%
Peat and peat products	5,836	334	104	10,866	2,941
	0.1%	***0.0%***	***0.0%***	***0.1%***	***0.0%***
Oil shale and oil sands	30,762	-	-	27,417	-
	0.5%			***0.2%***	
Natural gas	341,442	3,480,762	623,841	3,170,374	2,000,442
	5.3%	***24.6%***	***12.3%***	***21.6%***	***19.7%***
Oil and petroleum products (excluding biofuel portion)	219,148	9,248,224	3,690,966	4,965,583	3,797,897
	3.4%	***65.4%***	***73.1%***	***33.8%***	***37.4%***
Renewables and biofuels	2,957,489	235,967	164,094	3,030,573	1,284,930
	46.0%	***1.7%***	***3.2%***	***20.7%***	***12.6%***
Non-renewable waste	154,990	7,344	251	162,143	56,046
	2.4%	***0.1%***	***0.0%***	***1.1%***	***0.6%***
Nuclear heat	1,836,966	-	-	1,836,966	-
	28.6%			***12.5%***	
Electricity	-	406,836	407,281	-445	2,329,109
		2.9%	***8.1%***	***0.0%***	***22.9%***
Heat	8,398	65	11	8,452	467,345
	0.1%	***0.0%***	***0.0%***	***0.1%***	***4.6%***
Total	6,433,522	14,140,780	5,051,956	14,672,438	10,157,719
	100%	***100%***	***100%***	***100%***	***100%***

Source: processed data of Eurostat's Complete Energy Balance Database (ec.europa.eu/eurostat/)

In the EU27, available energy for final consumption reached 10,958,177 GWh in 2023, a 10% decline since 2003. Final energy use in industry fell by 22% over this period, maintaining a 25% share in 2023. Households accounted for 26% of final consumption in 2023 (down from 28% in 2003), with household energy demand falling by 14% over the

period. Other sectors held a combined 17% share, with commercial and public services being the most energy-intensive components.

By fuel type, EU27 final consumption consisted of 37% oil, 20% natural gas, 13% RES, 23% electricity, 5% heat, and 1% non-renewable waste. The transport sector remained oil-dependent but less so than in Greece, with oil accounting for 90% of transport final use and RES for 6%. RES use was notably higher in the EU27's "other sectors" (40%), whereas in Greece these sectors used 99% oil and almost no RES.

In Greece, available energy for final consumption has consistently remained lower than net imports. In contrast, in the EU27 it has remained higher. These patterns reflect differing levels of energy dependency: the EU27 maintains a significantly higher share of domestic primary production. In Greece, the ratio of primary production to available energy fell from 64% in 1990 to just 35% in 2023. In the EU27, the corresponding ratio decreased more moderately, from 74% to 59%, highlighting the region's comparatively lower dependency on imports.

Electricity Generation Mix During the Energy Transition Era

The carbon intensity of electricity generation in Europe, measured in grams of CO2 per kilowatt-hour (gCO2/kWh), decreased from 500.6 gCO2/kWh in 1990 to 334.7 gCO2/kWh in 2010, and further to 207.1 gCO2/kWh in 2023. This downward trend was temporarily interrupted in 2021 and 2022, when GHG emissions rose due to the post-COVID economic rebound and the energy market disruptions triggered by the war in Ukraine.

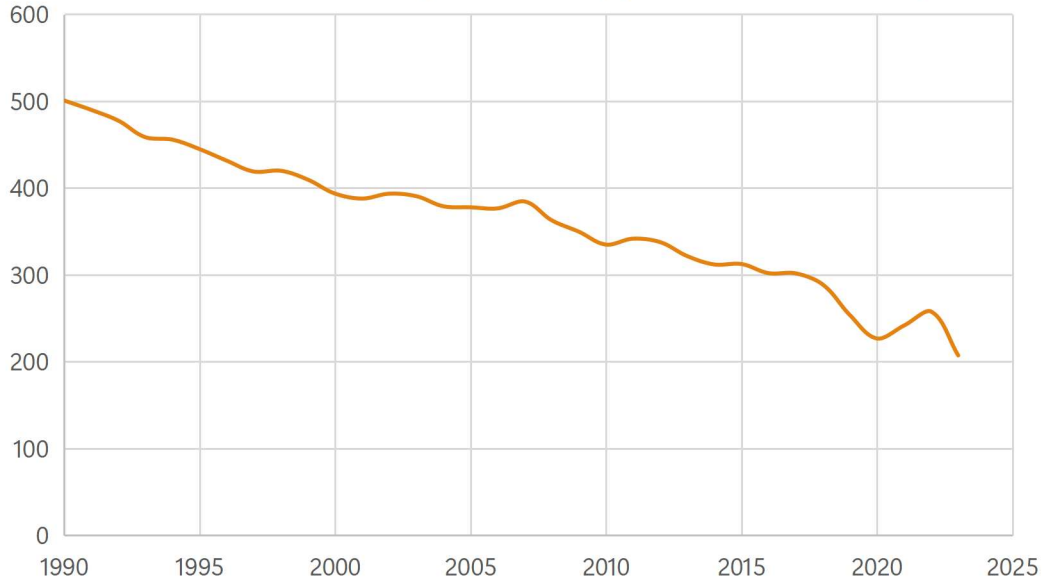
Electricity generation (excluding heat production) from all producers and autoproducers in Greece amounted to 49,917 GWh in 2023. Historical data reveal a peak in 2008, just before the onset of the Greek economic crisis, reaching 63,750 GWh. Over the last two decades (2003–2023), electricity generation has declined by 15%, accompanied by a significant transformation in the country's energy mix.

In the 1990s, electricity production in Greece was dominated by fossil fuels. In 1993, 72% of electricity generated originated from lignite and 20% from oil, resulting in fossil fuels comprising 90% of the mix. Natural gas accounted for only 0.2%, while RES, primarily hydropower, contributed about 6% of total electricity generation.

This composition began to shift in the early 2000s, with natural gas gaining ground. By 2003, the share of natural gas in Greece's electricity production had risen to 14%, while lignite had fallen to 60% and oil to 9%. Renewable sources and biofuels increased their share to 10%. Among RES used for electricity generation in 2003, hydropower was the main source, accounting for 81%. Wind power began to emerge, representing 17% of RES, while biofuels made up the remaining 2%.

By 2013, the electricity mix had shifted further, although lignite still accounted for a substantial 46% of electricity generation. RES and biofuels expanded their share to 25%, while natural gas reached 19%. Oil use declined further to 9%. The 2010s marked a turning point in the penetration of other RES, particularly wind and solar power. By 2013, wind comprised 29% of total RES-based generation, solar 25%, while hydropower's share had fallen to 44%.

Figure 2: GHG emission intensity of electricity generation, EU level (gCO2/kWh).



Source: processed data of European Environment Agency (eea.europa.eu)

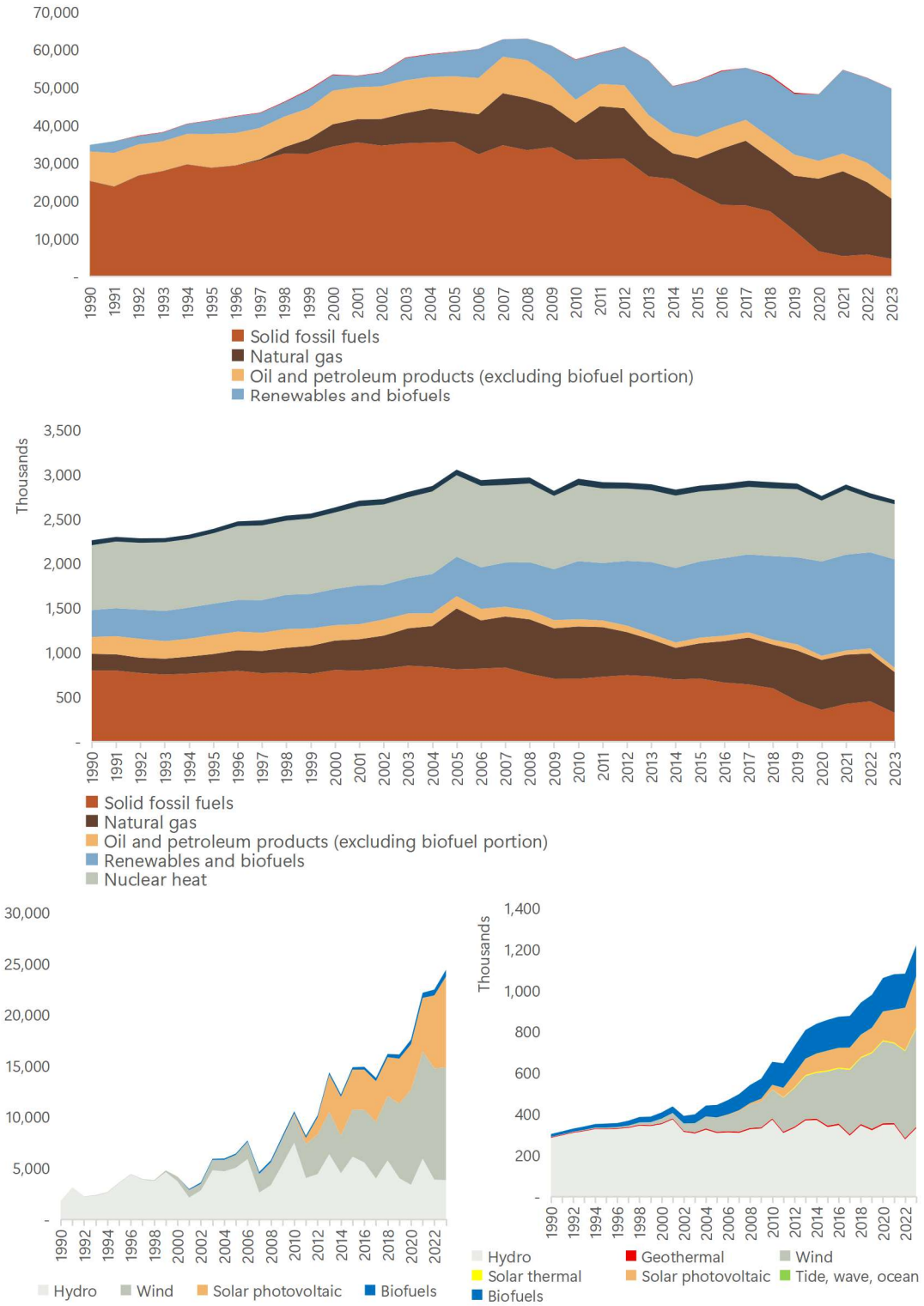
By 2023, the share of electricity produced from RES and biofuels had quadrupled since 2003, reaching 24,386 GWh and accounting for 44% of total power generation. Wind and solar photovoltaic emerged as the dominant RES technologies, contributing 45% and 36% of RES-based generation, respectively. Hydropower declined to 16%, while biofuels increased to 3%, marking a sixfold rise since 2003. The 2023 electricity mix also shows a doubling of natural gas use since 2003, reaching 32% of total generation. Over the same period, oil use declined by 46%, representing a 9% share in 2023, equal to that of lignite.

In the EU27, electricity generation (excluding heat production) increased steadily until 2003 and remained relatively stable thereafter, reaching 2,748,558 GWh in 2023. RES dominate the European mix, contributing 44% of total power generation, having more than tripled their share since 2003, when they accounted for 14%. As of 2023, several countries display notably high RES penetration: Denmark (87%), Austria (80%), Latvia (78%), Lithuania (74%), as well as Portugal, Croatia, and Sweden (all close to 70%).

Lignite accounted for 12% of EU27 power generation in 2023, a decline of 62% since 2003. Among EU countries still generating electricity from lignite, Poland leads with 59% of its total power generation, followed by Czechia (39%), Bulgaria (29%), Germany (24%), Slovenia (20%), and Romania (14%). Member states producing less than 10% of their electricity from lignite include Croatia, Denmark, the Netherlands, Hungary, Italy, Slovakia, Ireland, Finland, and Spain. Outside the EU, several European countries - such as Kosovo (87%), Serbia (59%), Bosnia and Herzegovina (56%), North Macedonia (40%), Montenegro (39%), and Turkey (35%) - continue to heavily rely on lignite for power generation.

Among other fossil fuels, natural gas accounted for 17% of the EU27 electricity mix in 2023, a modest increase of 9% since 2003, in contrast to Greece, where the share of natural gas doubled over the same period. Oil accounted for 2% in 2023, having dropped by 71% since 2003, while other sources (such as peat, heat, oil shale, manufactured gases, and non-renewable waste) contributed 2% of EU electricity generation.

Figure 3: Gross electricity production fuel mix in Greece (top) and the EU27 (middle), and variation in RES mix in Greece (bottom left) and the EU27 (bottom right) (in GWh)



Source: processed data of Eurostat's Complete energy balance database (ec.europa.eu/eurostat/)

The EU's electricity mix is more diversified than that of Greece, notably due to the significant contribution of nuclear heat, which accounts for 23% of EU electricity production, with 13 member states operating nuclear facilities. France leads, deriving 64% of its electricity from nuclear power, followed by Slovakia (61%), Hungary (45%), Finland (42%), Bulgaria (40%), Czechia and Belgium (both 39%), Slovenia (35%), and Sweden (29%). Other contributors include Spain (20%), Romania (19%), the Netherlands (3%), and Germany (1%). Although nuclear heat remains a key source, its use has declined by 32% between 2003 and 2023.

Table 2: RES in electricity generation per country in the EU27

Country	RES as a share of total electricity		Share of renewable energy sources by type in total RES, per country, 2023			
	2003	2023	Hydro	Wind	Solar photovoltaic	Other types (mainly geothermal and solar thermal)
Denmark	17%	87%	0%	66%	12%	22%
Austria	59%	80%	68%	13%	11%	8%
Latvia	59%	78%	76%	5%	5%	13%
Lithuania	2%	74%	10%	57%	16%	17%
Portugal	38%	70%	35%	38%	15%	12%
Croatia	41%	70%	67%	21%	3%	9%
Sweden	43%	69%	57%	30%	3%	10%
Germany	8%	53%	7%	52%	24%	17%
Finland	23%	52%	36%	36%	2%	27%
Spain	21%	50%	17%	45%	30%	8%
Luxembourg	4%	49%	7%	40%	24%	29%
Romania	24%	49%	64%	27%	8%	2%
Greece	10%	49%	16%	45%	36%	3%
Estonia	0%	49%	1%	24%	26%	49%
Netherlands	4%	47%	0%	52%	34%	13%
Ireland	5%	45%	7%	83%	5%	6%
EU27	14%	44%	27%	39%	20%	13%
Italy	16%	44%	35%	20%	26%	19%
Slovenia	22%	40%	80%	0%	16%	5%
Belgium	1%	33%	1%	56%	28%	14%
Poland	1%	27%	5%	53%	24%	18%
France	11%	27%	41%	36%	16%	8%
Hungary	1%	26%	2%	7%	74%	17%
Bulgaria	7%	25%	31%	16%	35%	19%
Slovakia	11%	22%	70%	0%	9%	21%
Cyprus	0%	21%	0%	19%	76%	5%
Czechia	2%	14%	21%	6%	26%	47%
Malta	0%	14%	0%	0%	97%	3%

Source: processed data of Eurostat's Complete energy balance database https://ec.europa.eu/eurostat/

Regarding the use of renewable energy sources (RES) and biofuels by fuel type in the EU-27, a clear shift in composition is observed. In 2003, hydroelectric power was the dominant renewable, as in Greece, accounting for 77% of total RES-based electricity generation. Since then, it has been gradually overtaken by other renewables, primarily wind and solar photovoltaics. By 2023, wind and solar accounted for 39% and 20%, respectively, of total RES-based electricity generation in the EU, marking a substantial increase since 2003.

Among all RES technologies, wind power has recorded the most significant growth, now contributing the largest share to RES electricity generation. Wind power constitutes the largest share of the RES mix in most countries, followed by solar photovoltaics. In countries

such as Ireland (where wind accounts for 83% of total RES), Denmark (66%), and Lithuania (57%), wind is the dominant RES for electricity generation. This is achieved through both onshore and offshore wind turbine installations, with offshore wind gaining increasing ground, particularly in Denmark, the Netherlands, Germany, and France (Wind Europe, 2024).

Beyond the EU-27, countries such as Iceland, Norway, and Albania have achieved near-total reliance on RES and biofuels for electricity generation, with shares approaching 100% in both 2003 and 2023. Specifically, in Iceland in 2023, 70% of electricity was generated from hydropower and 30% from geothermal energy. In Norway, approximately 90% of electricity production continues to be generated from hydroelectric power plants.

3. REGULATORY FRAMEWORKS DRIVING GREECE'S TRANSITION AWAY FROM LIGNITE

Challenges of the Transition in Lignite-dependent Areas

For countries such as Greece, the economic and social costs of transitioning away from lignite mining present significant challenges, particularly in lignite-dependent regions. Several studies have examined the multifaceted difficulties associated with this transition. Initial estimates indicated that, without mitigating interventions, the closure of lignite plants in Western Macedonia alone would directly result in more than 6,000 job losses and over €1 billion in local value-added losses. When broader multiplicative effects are included, these losses could reach approximately 13,000 jobs and nearly €2.5 billion in local value added (WWF 2016). These losses could be offset through strategic development plans focused on sustainable practices, the expansion of RES infrastructure, industrial tourism, ecotourism, and the establishment of research centers (WWF 2016).

A demographic survey assessing the socioeconomic implications of delignification in Kozani, Florina, Amyntaio, Megalopolis, and Tripolis found that while most respondents (92%) were aware of the impending phase-out, roughly half reported that their income depended, to varying degrees, on local lignite-fired plants (Dianeosis, 2020). Social concerns were pronounced: 71% expressed negative or somewhat negative views regarding plant closures. At the same time, respondents acknowledged both environmental benefits and economic challenges, with majorities anticipating improvements in air quality (72%), public health (68%), and quality of life (67%), but also expecting adverse effects on regional economic growth (87%), household income (42%), and employment levels (86%).

Further quantification of economic and social impacts in the regions of Kozani, Florina, and Arcadia concluded that, without intervention measures, phasing out lignite-fired power plants by 2028 would generate substantial regional economic damage. Impacts differed across regions, with Florina potentially being the most severely affected, facing projected losses of up to 28% of local GDP, 15% of employment, and 28% of income from work (IOBE 2020).

Ziouzios et al. (2021) highlighted that transitioning high-carbon-intensive economies requires comprehensive strategies tailored to regional conditions rather than one-size-fits-all approaches. Their recommendations included productive diversification, rehabilitation of depleted lignite mines, strategic spatial planning, creation of local energy communities, development of major infrastructure projects, and reskilling of the workforce.

Other research examined the role of circular economy principles following surface coal mine closures. Pavloudakis et al. (2024) argued that post-mining transition should exceed minimum legal and environmental permit requirements by maximizing material recovery and preparing land for new productive uses. This approach, they suggested, would better support

sustainable development while mitigating socio-economic impacts on affected communities - a critical factor in Greece's broader energy transition.

The National Energy and Climate Plan

Greece is adapting to the energy transition by also considering the regions most affected by lignite phase-out. It has developed a regulatory framework, including the National Energy and Climate Plan (2024) and the National and Territorial Just Transition Plan (2020), to support a fair and effective transition. These regulations aim both to promote direct measures for reducing carbon emissions through the gradual elimination of lignite use and to mitigate the associated socioeconomic impacts.

The Greek National Energy and Climate Plan (NECP 2024) outlines the country's strategy for transitioning to a sustainable energy system while addressing climate change. In alignment with the European Green Deal, the plan sets ambitious carbon neutrality objectives, targeting a 58% reduction in greenhouse gas emissions (GHG) by 2030 compared to 1990, and an 80% reduction by 2040, with almost full carbon neutrality by 2050.

The NECP aligns with European targets such as those in the Fit for 55 package, introducing comprehensive measures for energy efficiency. The plan prioritizes cost-effective investments in solar, wind, and hydroelectric power, emphasizing the development of energy storage and smart grid infrastructure. It promotes the complete shutdown of all lignite-fired power plants by 2028 and aims to increase the RES share to 75% by 2030 and 95.6% by 2035. Key pillars include investments in biogas, hydrogen, and energy-saving initiatives. The primary repurposing strategy for lignite mines is their transformation into RES hubs, particularly large-scale solar and wind installations (NECP 2024).

Although the NECP has become the cornerstone of Greece's energy and climate policy, it has also faced some criticism. Earlier versions were assessed as lacking transparency in fossil fuel subsidy phase-out strategies and insufficiently addressing climate vulnerabilities that could jeopardize target achievement (European Commission, 2023). Zervas et al. (2021) argued that the initial Plan followed a linear, single-scenario approach and failed to consider key uncertainties in the energy sector, including geopolitical instability, rapid technological progress, volatile fossil fuel prices, and extreme natural events. They also emphasized challenges associated with replacing lignite with natural gas, noting that increased reliance on imported gas could threaten energy security and that methane leakages along the supply chain could offset the emissions benefits of switching from lignite.

The 2024 NECP proposes a more advanced framework, incorporating detailed risk assessments for energy production, consumption, and sustainability, and ensuring greater preparedness across multiple potential scenarios.

The Just Transition Development Plan

The Just Transition Development Plan was designed to mitigate the negative socioeconomic effects of lignite phase-out in alignment with NECP targets. Its primary objective is to support lignite-dependent regions by preserving employment, promoting workforce reskilling, and ensuring an equitable transition that integrates environmental, economic, and social priorities. The Plan emphasizes investments in RES, innovation-driven industrial clusters, and key development pillars such as clean energy, industry, smart agriculture, sustainable tourism, technology, and education (Just Transition Plan 2020).

Financially, Greece's Just Transition Development Plan foresees approximately €5 billion in investments, supported through public subsidies, state-backed loans, commercial

lending, and private equity. Supporting measures include tax incentives, expedited permitting, wage subsidies, relocation grants, and targeted credit lines to stimulate private investment.

By 2028, the Plan projects the creation of roughly 8,000 jobs and extensive reskilling programs for affected workers. Key initiatives include a 2 GW photovoltaic rollout, voluntary early retirement schemes, mine-site restoration, natural gas district heating networks, spatial planning fast-tracks, circular economy pilot projects, and support for energy communities.

For the former lignite regions, proposals include photovoltaic parks, agri-tech and eco-tourism development, and major public infrastructure upgrades. Innovative initiatives include high-efficiency Combined Heat and Power (CHP) and gas-fired units, biomass co-firing, and green hydrogen hubs. The latter are also supported by the Greek White Dragon initiative, aimed at converting lignite-fired plant infrastructure for green hydrogen production by adapting natural gas pipelines for hydrogen storage and transport (Polychroniou, 2022). Studies indicate that these targeted actions and funding mechanisms can effectively counteract the negative economic impacts of lignite phase-out, potentially transforming affected regions into dynamic growth centers (IOBE 2020).

Recent announcements by the Public Power Corporation (PPC) also demonstrate progress toward NECP and Just Transition Plan objectives. PPC has presented a strategic transformation plan for Western Macedonia, positioning the region as an emerging energy and technology hub. Key initiatives include converting Ptolemaida V to a natural gas unit by 2027, with plans for future hydrogen integration. The Corporation's RES strategy involves large-scale projects such as 1.2 GW of solar farms, 300 MW of battery storage, and expanded hydroelectric capacity. Former lignite mines in Ptolemaida are being repurposed for RES installations, leveraging the existing high-voltage distribution network. Capitalizing on its energy infrastructure, available land, skilled workforce, and streamlined permitting, Western Macedonia is also positioned to become a significant data center hub, with initial plans for a 300 MW data center and potential expansion to 1,000 MW.

4. THE ROLE OF MARKET-BASED TOOLS IN DECARBONIZATION

While climate change mitigation objectives are global, their implementation varies across countries. The gradual delignification of energy production through regulatory initiatives represents a direct approach to reducing GHG emissions by lowering reliance on fossil fuels. Complementing these regulatory measures, market tools such as carbon pricing have been shown to effectively curb emissions. These pricing mechanisms are gaining momentum worldwide and are increasingly recognized as fundamental instruments for controlling carbon use and limiting emissions (World Bank 2023, 2024).

Carbon pricing is adaptable to various economic, political, and environmental frameworks, acting as a Pigouvian tool that discourages excessive carbon use and reduces GHG emissions (EPRS 2020). These instruments are not fixed or uniform across regions, jurisdictions, or sectors, and they often incorporate exemptions and different design features. They also differ substantially in their operational structure, operating either "upstream" - targeting producers and fuel distributors or "downstream"- directly affecting end users (EPRS 2020). Their scope varies as well, ranging from taxes on fossil fuels to levies on electricity generation, and they may cover only CO2 or a broader set of GHGs, either at national or sub-national level.

Carbon pricing provides a clear signal to emitters by internalizing the negative externality of greenhouse gas emissions — namely their social and environmental costs. Faced with a carbon price, firms can either pay for their emissions, adopt cleaner alternatives,

or pass the additional cost on to consumers (EPRS 2020). Although politically challenging to implement, well-designed carbon pricing policies can facilitate the shift to cleaner energy sources, generate public revenue, and deliver significant environmental benefits (EPRS 2020).

Among market-based mechanisms, carbon taxation and emissions trading systems (ETSs), commonly known as cap-and-trade schemes, are the two most prominent. A carbon tax sets a direct price on carbon by taxing the carbon content of fossil fuels per ton of emitted CO2, thus controlling the price but not the quantity of emissions. In contrast, an ETS directly controls the quantity of emissions by introducing a cap on total allowable emissions or emission intensity (i.e., emissions per unit of GDP), while letting the market determine the carbon price.

Cap-and-trade systems reduce aggregate emissions by establishing a cap and issuing a limited number of tradable allowances that correspond to this cap (Aldy and Stavins 2012, Goulder and Schein 2013). Allowances may be allocated for free or auctioned in the primary market, and firms can subsequently trade them in secondary markets. Firms with low abatement costs can sell unused allowances, whereas firms with higher abatement costs can buy them (Narassimhan et al. 2018). At the end of each compliance period, companies must surrender allowances equal to their verified emissions, facing penalties if they exceed their permitted limits.

Although ETSs have expanded more rapidly than carbon taxation, hybrid systems have emerged by combining elements of both approaches. These systems typically integrate carbon taxes with tradable permits under a cap-and-trade structure (Goulder and Schein 2013). By incorporating price floors or "safety valves," hybrid systems aim to reduce price volatility and improve predictability. Such mechanisms provide both stability and flexibility in carbon pricing, balancing the certainty of a price signal with the efficiency of market-based trading (Baranzini et al. 2017, Haites 2018, Emeka-Okoli 2024).

Other, less widely used market-based instruments for reducing GHG emissions include clean energy standards with specific technology targets in the electricity sector, fossil fuel subsidy phase-outs, and emission reduction credits (Aldy and Stavins 2012). Carbon crediting, typically voluntary and project-based, allows developers to earn credits for mitigating emissions through activities such as forest protection or renewable energy deployment. While carbon pricing imposes direct costs on emissions, carbon crediting provides offsets that allow entities to compensate for emissions rather than reduce them directly. However, critics argue that many credits do not correspond to genuine emission reductions, highlighting the need for stricter standards and reforms (Probst et al. 2024). In a similar way, Internal Carbon Pricing (ICP) has gained reputation as a corporate tool for driving emissions reductions. Despite its increasing adoption, ICP remains in an early stage of development and requires further refinement in both practice and empirical research (Sinclair-Desgagné et al. 2024).

Comparative Overview of Carbon Taxes and ETSs Worldwide

Based on World Bank data for compliance instruments, emissions coverage, prices, and revenues, a total of 142 carbon pricing mechanisms in the form of ETSs or carbon taxes have been recorded globally since 1990. As of 2024, 111 instruments were active across various jurisdictions. Of these, 36 (32%) were ETSs and 76 (68%) were carbon taxes, implemented in 68 national or subnational jurisdictions. Several countries apply multiple carbon tax rates for different fuel types or products. For example, Argentina and Mexico have 10 and 11 distinct tax rate labels respectively, covering gasoline, kerosene, diesel, gas oil, coal, solvents, and more. Notably, in 2004 no ETS existed, but only 12 carbon taxes were operational in seven European countries, namely Norway, Denmark, Slovenia, Finland, Latvia, and Poland.

As of 2024, Europe and Central Asia recorded the highest number of carbon pricing schemes (46), consisting of 39 carbon taxes and 7 ETSs. Latin America and the Caribbean followed with 30 instruments, East Asia and the Pacific with 18, and North America with 16. Sub-Saharan Africa had only one carbon pricing mechanism, namely a carbon tax in South Africa. In Latin America and the Caribbean and in Sub-Saharan Africa, no ETSs operate, whereas in North America and in East Asia and the Pacific, ETSs outnumber carbon taxes. In terms of income classification, 60% of all instruments are implemented in high-income countries, 39% in upper-middle-income countries, and just 1% in lower-middle-income countries.

Despite the rapid expansion of carbon pricing, fewer than 5% of global GHG emissions are currently priced at levels compatible with 2030 climate targets, and only around 1% are priced above the recommended range (World Bank 2024). In 2024, the average price across all carbon taxes and ETS allowance prices was 34.9 US$/tCO2e, recording an increase of 78% compared to 2004. The average carbon tax rate reached 37 US$/tCO2e, while the average ETS allowance price stood at 30.3 US$/tCO2e. Uruguay recorded the world's highest carbon tax rate at 167 US$/tCO2e, while the highest ETS price was observed in the EU ETS at 61.3 US$/tCO2e. On average, allowance and tax prices in upper-middle-income countries reached only 6.6 US$/tCO2e in 2024, compared with an average of 53.6 US$/tCO2e in high-income countries.

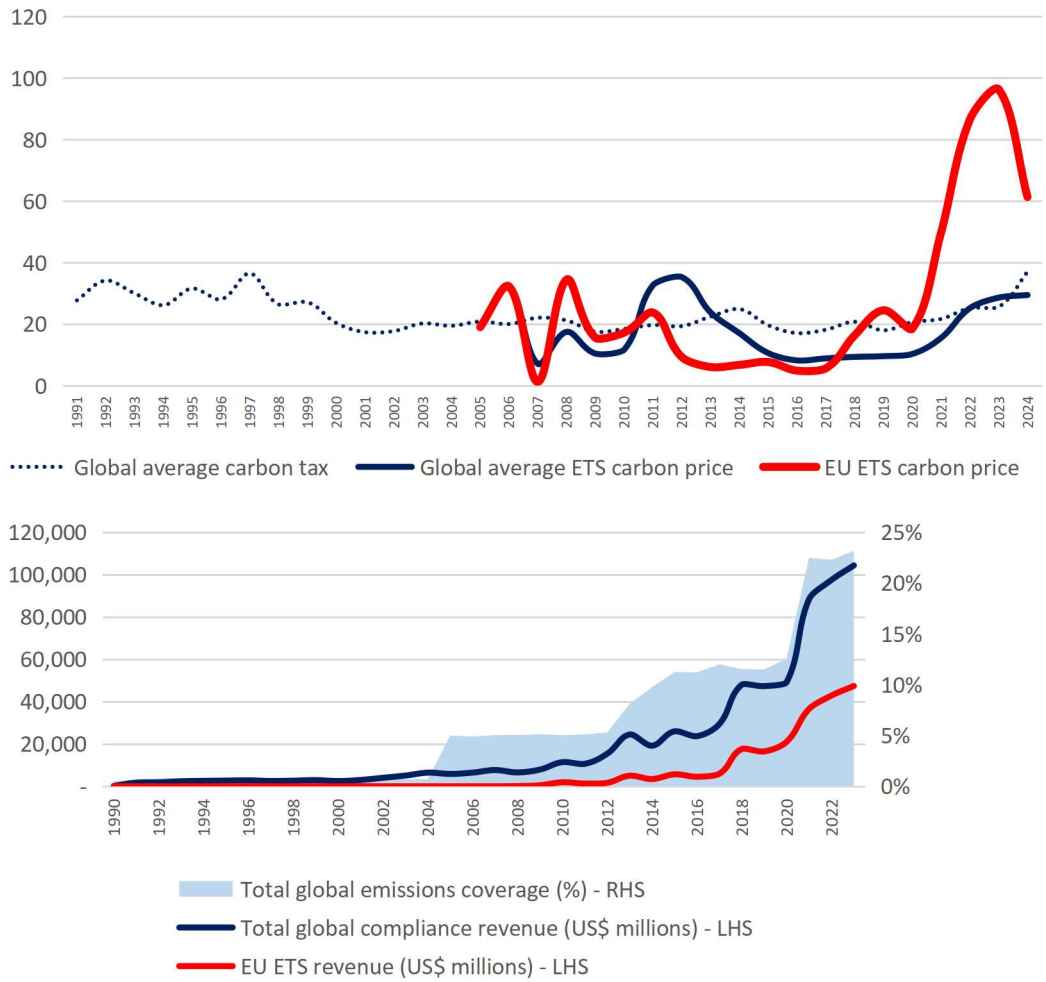
Global revenue from carbon pricing has risen substantially in parallel with the expansion of these mechanisms. Revenues reached 104.3 billion US$ in 2023, of which 75 billion US$ (72%) originated from ETS and 29.3 billion US$ (28%) from carbon taxes. By comparison, global revenues amounted to only 24.4 billion US$ in 2013 and 5.4 billion US$ in 2003. Until 2020, with the exception of 2013, ETS revenues remained consistently below those from carbon taxes. However, after 2021 - when ETS allowance prices increased sharply - ETS revenues surpassed carbon tax revenues. Between 2005 and 2020, carbon taxes generated on average 64% of global carbon pricing revenue, compared with 36% from ETSs. By 2023, this pattern had reversed, with ETSs accounting for 72% of worldwide revenues and carbon taxes for only 28%.

Collectively, the 111 carbon pricing mechanisms covered almost one quarter of global GHG emissions in 2024 - equivalent to 12.8 Gt of CO2 - with ETSs accounting for 19% and carbon taxes for roughly 5% of the total. For comparison, in 2014, 36 instruments covered approximately 10% of global emissions, while in 2004 only 1% of global emissions were subject solely to carbon taxation. In 2024, China's national ETS, operational since 2021, alone accounted for 9.3% of the emissions coverage, while the EU ETS accounted for 2.6%.

The European Union Emissions Trading System (EU ETS)

The European Union (EU) ETS, established in 2005, is the oldest and one of the largest cap-and-trade systems globally. Since then, it has undergone four trading phases. The first phase (2005–2007) operated as a pilot to test system functionality ahead of the first Kyoto Protocol commitment period. Due to limited baseline data, an overallocation of allowances led to a collapse in carbon prices by 2007 (EU ETS Handbook 2015). The second phase (2008–2013), aligned with the first Kyoto commitment period, strengthened monitoring, reporting, and verification requirements and introduced links to global markets through international credits. The third phase (2013–2020) broadened sectoral coverage, tightened rules, and made auctioning the default allocation method. In 2019, the Market Stability Reserve (MSR) was introduced to address allowance surpluses and improve price stability.

Figure 4: Average carbon tax (since 1991), average ETS carbon price (since 2005) and EU ETS carbon price.



Source: processed data of World Bank (carbonpricingdashboard.worldbank.org)

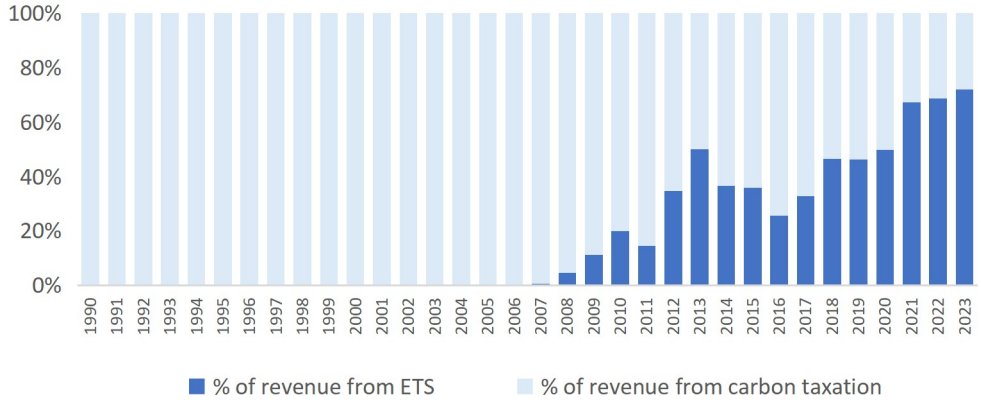
The fourth trading phase (2021–2030) is currently underway. Under the broader ETS reform, a new, separate system - EU ETS2 - was established in 2023 to cover buildings, road transport, and selected small industries. ETS 2 is set to become operational in 2027 (or 2028 under persistently high energy prices). Since 2021, the annual cap under the existing EU ETS has been decreasing at a rate of 2.2%, up from 1.74% previously.

Allowances in the EU ETS are distributed primarily via auctioning, though free allocation remains available for sectors at risk of carbon leakage. The system regulates emissions from coal, diesel, gasoline, kerosene, jet fuel, natural gas, and other oil products, as well as selected industrial process emissions. Sectoral coverage includes electricity generation, manufacturing, heavy industry, intra-EU aviation, and more recently maritime transport (World Bank Carbon Pricing Dashboard). Some European countries, such as Germany and the United Kingdom, operate national ETSs in parallel with (or previously within) the EU ETS. Greece, which does not have a separate carbon tax, has been a participant in the EU ETS since 2005, initially covering CO2 emissions from power and heat generation and from energy-intensive industries.

EU ETS allowance prices increased sharply over the last years, from 49.8 US$/tCO2e in 2021 to 86.5 US$/tCO2e in 2022 and 96.3 US$/tCO2e in 2023, before declining to 61.3

US$/tCO2e in 2024. This volatility largely reflects the post-COVID economic recovery, the energy market disruptions triggered by Russia's war in Ukraine, and the effects of tighter EU climate policies.

Figure 5: Shares of global revenue from carbon taxation and ETS carbon pricing.



Source: processed data of World Bank (carbonpricingdashboard.worldbank.org)

Effectiveness of Carbon Pricing Instruments

The effectiveness of carbon pricing mechanisms in curbing GHG emissions has been stated in an extensive body of literature. Although carbon pricing contributes to reductions in CO$_2$ emissions, total GHG emissions remain high, implying limited overall effectiveness in achieving climate neutrality (OECD 2022; IPCC 2023). Aldy and Stavins (2012) explored the effectiveness of carbon pricing mechanisms, drawing from the experience of developed countries. They argued that conventional environmental policies are not sufficient to address the ubiquity and diversity of GHG and claimed that well-designed carbon pricing policies could promote cost-effective abatement, provide incentives for innovation, and help alleviate government fiscal problems. The authors also highlighted the importance of international cooperation and careful policy design to address challenges such as competitiveness impacts and emissions leakage.

Goulder and Schein (2013) compared the relative merits of carbon taxes, cap-and-trade systems, and hybrid approaches and found that these approaches can be equivalent in many ways and yield similar incentives to emissions abatement, but also differ significantly in important dimensions. Carbon taxing or hybrid systems with exogenous emissions pricing offer several advantages over pure cap-and-trade, including the limitation of price volatility, the minimization of policy errors and interactions with other climate policies, and the prevention of large wealth transfers among countries.

Narassimhan et al. (2017) distinguished between carbon taxes and emissions trading systems (ETSs), noting that both instruments should be embedded within a broader climate policy framework. Their effectiveness in reducing emissions depends on factors such as the carbon price level, sectoral and geographic coverage, and the presence of complementary policies. The authors suggest that countries considering an ETS might first adopt a carbon tax, which entails lower administrative costs, although it does not guarantee emissions reductions. If a country adopts both carbon pricing instruments, they must ensure they are effectively coordinated and not applied to the same emissions base within the same sectors, as this could lead to unfair distributional effects and economically inefficient abatement costs. They also emphasize that while carbon pricing has generally not hindered economic growth, its impacts can be more pronounced in specific sectors, particularly in energy-intensive industries.

Moreover, Narassimhan et al. (2018) also assessed the implementation of ETS systems across various jurisdictions, including the EU. Based on certain criteria such as environmental effectiveness, economic efficiency, market management, revenue management, and stakeholder engagement, the authors concluded that even modest carbon prices can amplify the effectiveness of ETSs, leading to significant emissions reductions if the cap tightens over time and auction revenues are reinvested in other emissions-reduction activities, such as investments in clean energy and innovation. Implementing minimum and maximum price thresholds, banking and borrowing allowances, and maintaining reserve allowances can enhance market predictability and stability. They also stress the need for better understanding of how ETSs interact with other climate policies to optimize emissions reductions while minimizing administrative costs.

Baranzini et al. (2017) highlighted the cost-effectiveness of carbon pricing for reducing emissions when combined with other technology and innovation policies, enhancing overall effectiveness in climate policy. Köppl and Schratzenstaller (2022) provide a thorough review of the empirical effects of carbon taxation across several key dimensions. Carbon taxes were shown to be effective in reducing CO$_2$ emissions or slowing their growth and do not negatively affect economic growth, competitiveness, or employment. The authors show that countries with higher carbon tax rates exhibit greater reduction in carbon emissions, although their impact depends on the type and height of the tax rate, the exemptions, and the broader environmental policies.

Haites (2018) argues that both carbon taxes and carbon trading have reduced emissions, but from a ``business as usual'' perspective. Achieving reductions in actual emissions is often influenced by other mitigation policies or external factors, such as changes in fossil fuel prices and economic conditions. ETS allowance prices are generally lower than carbon tax rates, and many carbon tax rates are falling short of the necessary levels to achieve climate goals. The author claims that few jurisdictions regularly adjust their tax rates or ETS caps and implement measures in case of allowance surpluses, such as annual reductions in emissions caps.

Studies have also commented on the presence of speculative trends within emissions trading systems, suggesting that entities other than compliance firms who actually emit, such as investment firms, brokers, and banks, hold shares of carbon allowances and enter the carbon market primarily for profit. This can have a distortionary effect on price signals, which are primarily intended to incentivize emissions reductions (Isah et al., 2025). Speculation is a strong predictor of carbon prices, rendering the ETS an attractive investment opportunity for non-emitters and consequently, ignoring speculative behavior can lead to misjudgments regarding the effectiveness of carbon pricing and therefore contribute to increased long-term carbon price volatility (Isah et al., 2024). However, the investigation of the dramatic surge in European Emissions Allowance prices between 2018 and 2022 concluded that although speculation exists and to some extent can amplify price movements, these surges reflected primarily factors such as energy demand and supply, or gas-coal switching, rather than purely speculative impacts (ECB, 2022).

Carbon taxes can also have distributional implications, as their impact on income groups varies depending on how revenues are used. For instance, lump-sum transfers tend to benefit lower-income households (Köppl and Schratzenstaller 2022). To mitigate the distributional effects and enhance public acceptance, recycling carbon tax revenues, such as through reductions in social security contributions or labor taxes, but also channeling a portion into environmental projects, can lead to a ``double dividend,'' with economic and environmental benefits (Köppl and Schratzenstaller 2022). As argued by Hepburn et al. (2020), carbon pricing is just one, although very crucial, part of a broader structural transformation strategy

for reducing GHG emissions and meeting climate targets. Necessary to achieve net-zero emissions is also the encouragement of positive motivation through direct regulation and public investment in clean technologies.

5. CONCLUSIONS

Restructuring the energy system towards cleaner alternatives remains a multifaceted challenge. The scheduled lignite phase-out in Greece by 2028 represents an ambitious structural reform, requiring a comprehensive transformation that balances economic requirements, environmental imperatives, and social considerations, particularly in regions where fossil fuels have historically served as economic pillars.

In this regard, both Greece and the EU-27 have achieved substantial emission reductions through delignification and a fundamental energy mix transformation. This is especially evident in electricity generation, where Renewable Energy Sources (RES) now dominate the landscape, signaling a decisive shift away from solid fuels. The National Energy and Climate Plan (NECP) and the Just Transition Program (JTP) have provided the essential framework and necessary social safeguards for Greece, utilizing a robustly funded mechanism to manage the transition fairly, while repurposing former lignite regions into new RES and technology hubs.

However, it is crucial to recognize that while regulatory measures constitute the structural backbone of decarbonization—establishing targets and mandates—they are often insufficient on their own to ensure cost-effectiveness or to stimulate continuous abatement across all sectors. Consequently, the policy framework increasingly relies on complementary market-based instruments. Tools such as the EU ETS reinforce national regulatory efforts by providing clear financial signals that optimize abatement costs and accelerate the transition to cleaner alternatives.

Ultimately, neither regulation nor carbon pricing is sufficient in isolation; a synergistic approach is required. While regulations establish the foundational architecture and binding targets, market tools provide the incentives and flexibility to ensure economic efficiency. Furthermore, the transition demands large-scale investments in RES technologies alongside energy efficiency solutions, such as smart grids and advanced carbon capture, to supplement the existing regulatory and pricing mechanisms.

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STUDENTS' PERCEPTIONS OF GLOBAL WARMING CAUSES AND THEIR ENERGY FOOTPRINT TOWARDS SUSTAINABILITY

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Abstract
Global warming has intensified in the last fifty years with a significant impact on the environmental balance, causing negative consequences for life on the planet and consequently affecting the human species in a series of factors related to security, well-being and economy (Amicarelli et al., 2021; Scheffran & Battaglini, 2021; Tang, 2021; Zgheib et al., 2023; Zhang, 2023). Energy and its consumption play a key role in this evolutionary climate change process, especially since per capita energy consumption is an indicator of a nation's well-being (Bose, 2010). Carbon dioxide emissions from energy consumption are a key factor in global warming and the creation of urban microclimates (Cadeira & Kasting, 1993; Luqman et al., 2023; Vasenev et al., 2023; Yamasaki, 2003). As a consequence, in recent decades there has been a focus on environmental education with an emphasis on issues such as global warming, carbon dioxide emissions and "clean" forms of energy (Çavdar, 2023; Handayani & Trivanto, 2022; Yazdanparast et al., 2013). This research examines the views of more than 6000 lower secondary school students attending schools in Attica, an area particularly affected by air pollution and greenhouse gases. Statistical results confirm that less than half of students know that carbon dioxide is responsible for rising atmospheric temperatures, while a significant percentage chooses rising sea levels as the cause of global warming. This fact can lead to new, targeted educational practices that will lead students to internalize knowledge and adopting sustainable behaviors. At the same time, it will shed light on the energy topic, which is not a classic body of knowledge in content but a complex field of learning, giving educational designers the necessary elements to structure appropriate educational practices.

Key words: Sustainability, global warming, carbon dioxide, education.

SESSION

"Climate Change and Sustainable Development"

Chaired by **Prof Ntalos Georgios** and **Karytsas Spyridon**

ANIMALS' LEGAL PERSONHOOD IN MUNICIPAL (CLIMATE) ADAPTATION PLANS IN POLAND

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Abstract
Climate change adaptation in urban environments may be conceptualized as a complex of policy measures and regulatory instruments directed towards urban inhabitants and users of the city. Its dual objective consists, on the one hand, in enhancing socio-ecological resilience, and on the other, in fostering civic awareness concerning the phenomenon of climate change and the risks associated with the absence of adequate adaptive responses. These risks encompass not only anthropocentric vulnerabilities but also extend to the preservation of urban biodiversity and ecological resources, including green infrastructure, stormwater, and meltwater retention systems. Climate change causes not only natural catastrophes or changes in the structure of crops but also impacts other aspects of human life, such as health[46], especially that of children[47] and the elderly[48]. However, it is not just human health that is affected – animal wellbeing[49] is also threatened by climate change: both wildlife, including urban wild animals found in cities, and pets, from cats and dogs to rabbits, birds, turtles and all the other domesticated animals we share our lives with. Heat stress caused by high temperatures, depending on its intensity and duration, may negatively affect pets' health by causing metabolic alterations, oxidative stress, immune suppression and even death[50]. Current literature clearly demonstrates that climate change is expected to exert the same overwhelming negative effect on livestock health and the welfare of pets[51] as it will do on human beings. Humans, however, can avoid at least some of the negative effects of Urban Heat Islands (UHI), while pets have no choice in accompanying people outside in all weather conditions, and, like their human carers, have special needs (e.g. walking) that are impossible to satisfy inside.

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Thus scholarly attention ought to be directed towards the necessity of undertaking adaptive measures on behalf of *pets* that cohabit with humans in urban contexts. Contemporary socio-demographic transformations, exemplified by the shift from the nuclear family model towards childless households in which companion animals frequently assume quasi-filial roles, amplify the relevance of this issue[52]. Parallel cultural discourses increasingly advocate for the recognition of legal subjectivity beyond the human species, with corresponding entitlements related to the protection of their ontological status and integrity[53].

Within this analytical framework, animals' legal personhood may be understood as a conceptual category encompassing domesticated animals regarded as recipients of human emotions, care, and affection.[54] The growing prevalence of "pet-friendly" urban spaces exemplifies the informal recognition of pets as quasi-subjects of rights requiring protection, and increasingly considered in urban governance practices. In this respect, climate change adaptation may legitimately be extended to encompass the specific needs of companion animals, such as shaded recreational areas and access to drinking fountains or mitigation of hazards arising from overheated pavements during summer heatwaves.

This raises the question of the extent to which formal legal regulation—thus far only marginally responsive to societal demands for the juridical recognition of animals as subjects of law—intersects with the practical, policy-oriented approaches to ensuring the well-being of pets within urban adaptation strategies.

The proposed study will examine Polish regulatory frameworks and policy instruments in this domain. In Poland, in the years 2019-2020, forty-five climate change adaptation plans were prepared for the largest cities, yet only one of these incorporated measures explicitly directed towards the protection of pets[55]. Since January 2025, the process of preparing adaptation plans has been extended to cities with populations exceeding 20,000 inhabitants.

The objective of this research is to assess whether, and to what extent, these new adaptation plans incorporate the needs of non-personal entities (*pets*) as addressees of adaptive measures, and to formulate normative and policy-oriented conclusions in this regard. The envisaged substantial inclusion of local regulations dedicated to the protection of non-personal entities within adaptation plans may also serve as an indicator for the legislator, pointing towards the consideration of introducing appropriate legal provisions of animals' legal personhood in the future.

Key-words: Animals' legal personhood, Municipal Adaptation Plan

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ENHANCING THE SUSTAINABILITY OF THE SHIPPING INDUSTRY THROUGH THE REDUCTION OF GREENHOUSE GAS EMISSIONS: LITERATURE REVIEW

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Abstract
The decarbonisation of maritime transport has emerged as a central challenge for global sustainability, driven by escalating climate commitments, regulatory pressure, and market expectations. Although shipping has traditionally been regarded as an energy-efficient transport mode, its growing contribution to greenhouse gas (GHG) emissions necessitates a fundamental transformation of propulsion technologies, operational practices, and investment strategies.

This paper presents a comprehensive literature review of regulatory developments, clean propulsion technologies, and economic implications associated with the reduction of GHG emissions in maritime transport, with particular emphasis on the Greek shipping industry. The analysis examines the evolving regulatory framework at both global and European levels, including key instruments introduced by the International Maritime Organization and the European Union, and evaluates their impact on shipowners' strategic decision-making.

Furthermore, the study reviews a broad range of technological decarbonisation pathways, encompassing transitional fuels such as liquefied natural gas and biofuels, as well as emerging zero-carbon options including hydrogen, ammonia, and renewable methanol. Economic and operational considerations—such as capital expenditure, operating costs, access to finance, and charter market dynamics—are analysed to assess their role in shaping technology adoption.

The Greek shipping industry is examined as a case study, highlighting a pragmatic, flexibility-oriented approach to decarbonisation based on fuel-ready vessels, operational optimisation, and participation in research and innovation initiatives. The findings indicate that no single technological solution currently dominates, underscoring the need for a portfolio-based strategy supported by regulatory alignment, infrastructure development, and coordinated action among stakeholders. The paper concludes that Greek shipping is well positioned to contribute to global maritime decarbonisation while maintaining long-term competitiveness under conditions of technological and regulatory uncertainty.

Keywords: Maritime decarbonisation; Greenhouse gas emissions; Clean propulsion technologies; Regulatory framework; Greek shipping; Sustainability; Alternative marine fuels

1. INTRODUCTION

Maritime transport constitutes the backbone of global trade, facilitating nearly 90% of international cargo movements. Despite its historical reputation as an energy-efficient transport mode, the sector's continued expansion and persistent reliance on fossil fuels have led to a growing contribution to global greenhouse gas (GHG) emissions. According to recent international assessments, maritime transport currently accounts for approximately 3% of global anthropogenic emissions, a figure projected to increase substantially by mid-century in the absence of effective mitigation measures.

In response to mounting climate concerns, the shipping industry is undergoing its most profound transformation since the transition from sail to steam. Regulatory pressure, technological innovation, and market-driven environmental expectations collectively shape a new operational paradigm focused on decarbonisation. The International Maritime Organization (IMO), alongside regional actors such as the European Union, has introduced increasingly stringent frameworks aimed at reducing carbon intensity and accelerating the adoption of cleaner propulsion technologies.

Within this evolving landscape, the Greek shipping industry occupies a pivotal position. As the world's leading commercial fleet owner, Greek shipowners exert significant influence over global investment trends, technology diffusion, and compliance strategies. Their decisions are driven not only by regulatory obligations but also by competitiveness, access to finance, and long-term risk management in an uncertain fuel transition environment.

This paper provides a structured literature review of regulatory developments, clean propulsion technologies, and economic implications related to the reduction of GHG emissions in shipping, with a particular focus on the Greek fleet. By synthesizing existing research, the study highlights the drivers and barriers of maritime decarbonisation and assesses the strategic role of Greek shipping in the global transition toward sustainability.

2. REGULATORY FRAMEWORK GOVERNING MARITIME DECARBONISATION

The international regulatory framework for maritime decarbonisation has evolved rapidly, transforming environmental compliance into a central determinant of strategic and investment decisions within the shipping industry. What was once a primarily voluntary or technical consideration has now become a binding operational and financial constraint, shaping vessel design, fuel selection, and day-to-day operations.

At the global level, the International Maritime Organization (IMO) provides the core regulatory architecture for greenhouse gas (GHG) mitigation, while regional actors—most

notably the European Union—have adopted more ambitious and economically binding mechanisms. The interaction between these regulatory layers creates both compliance challenges and strategic opportunities for shipowners.

2.1 Evolution of the IMO's GHG Strategy

The IMO's environmental governance framework is anchored in MARPOL Annex VI, which regulates air pollution from ships. A major milestone was the adoption of the Initial IMO GHG Strategy in 2018, which established quantitative targets for reducing the carbon intensity of international shipping by at least 40% by 2030 and total GHG emissions by at least 50% by 2050, relative to 2008 levels.

Subsequent revisions of the strategy have increased ambition, with the IMO moving toward a commitment to net-zero emissions "around 2050." A key conceptual shift within the revised strategy is the adoption of lifecycle-based emissions assessment, commonly referred to as the well-to-wake approach. This transition significantly affects the perceived sustainability of alternative fuels, placing greater emphasis on upstream production pathways rather than solely on onboard emissions.

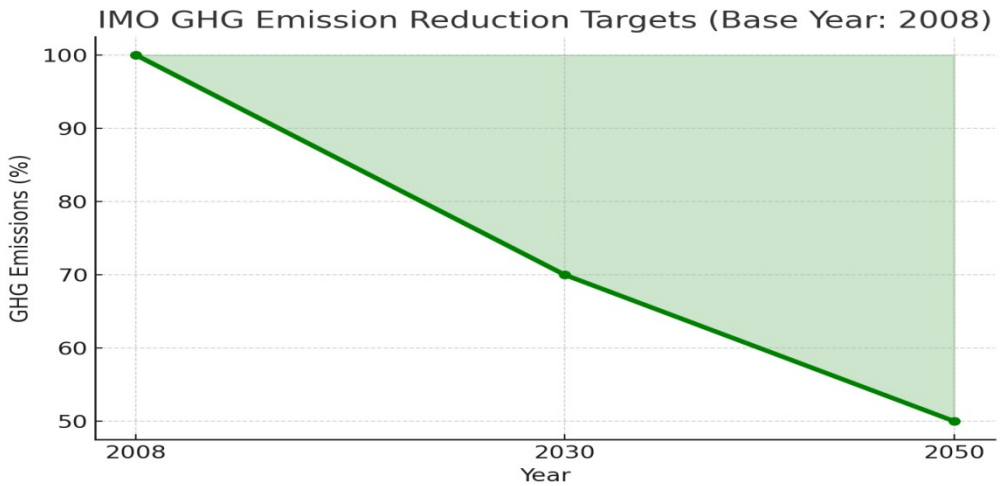

Figure 1: IMO greenhouse gas emission reduction targets relative to 2008 levels.
Source: IMO (2023).

2.2 MARPOL Annex VI: From Design to Operational Control

MARPOL Annex VI has progressively expanded beyond sulphur and nitrogen oxide control to encompass comprehensive energy efficiency and emissions monitoring mechanisms. Instruments such as the Energy Efficiency Design Index (EEDI) for newbuildings and the Ship Energy Efficiency Management Plan (SEEMP) have institutionalised energy efficiency as a regulatory requirement rather than a voluntary practice.

The introduction of the Fuel Oil Data Collection System (DCS) further enhanced transparency by mandating systematic reporting of fuel consumption and emissions. Collectively, these measures have laid the groundwork for performance benchmarking and data-driven regulatory enforcement, enabling a gradual shift from prescriptive design standards toward outcome-based regulation.

2.3 EEXI and CII: A Dual Compliance Regime

A significant regulatory development was the introduction of the Energy Efficiency Existing Ship Index (EEXI) and the Carbon Intensity Indicator (CII), which together form a dual

compliance regime applicable to the existing fleet. EEXI establishes a minimum technical efficiency threshold, often requiring interventions such as engine power limitation or the installation of energy-saving devices.

In contrast, CII evaluates actual operational performance, categorising vessels annually from A to E based on emissions per cargo mile. This operational focus directly links regulatory compliance to voyage planning, speed management, and fuel consumption strategies. For shipowners, maintaining favourable CII ratings has become essential not only for compliance but also for commercial attractiveness and asset valuation.

2.4 European Union Climate Policies Affecting Shipping

While IMO regulations apply globally, the European Union has adopted a more stringent and economically binding approach to maritime decarbonisation. The inclusion of shipping in the EU Emissions Trading System (ETS) from 2024 introduces explicit carbon pricing, requiring shipowners to purchase emission allowances for voyages involving EU ports.

In parallel, the FuelEU Maritime regulation—effective from 2025—sets progressively tightening limits on the greenhouse gas intensity of marine fuels. These measures are embedded within the broader "Fit for 55" policy package, which aims to achieve climate neutrality across the European economy. For shipowners operating extensively within European trades, EU regulations significantly accelerate the economic rationale for cleaner propulsion technologies.

2.5 National and Regional Dimensions: The Greek Context

At the national and regional level, Greece has initiated measures to support maritime decarbonisation through port electrification projects, alternative fuel bunkering initiatives, and participation in EU-funded research programmes. Strategic ports such as Piraeus and Igoumenitsa are gradually enhancing infrastructure readiness for LNG, shore power, and future alternative fuels.

For Greek shipowners, the regulatory landscape is particularly complex due to simultaneous exposure to global IMO rules and advanced EU climate policies. Compliance therefore necessitates a forward-looking approach that integrates regulatory forecasting, technological flexibility, and long-term investment planning. The literature consistently identifies regulatory alignment as a key driver of green investment decisions within the Greek fleet.

3. CLEAN PROPULSION TECHNOLOGIES: CURRENT STATUS AND FUTURE OUTLOOK

The decarbonisation of maritime transport is fundamentally a technological challenge, yet one characterised by high uncertainty and fragmentation. Given the diversity of vessel types, operational profiles, and trade routes, no single propulsion technology or fuel can currently serve as a universal solution. Instead, the literature increasingly converges on a portfolio-based approach, combining transitional fuels, zero-carbon alternatives, and energy efficiency measures to achieve both short-term compliance and long-term climate neutrality *as summarized in table 1.*

Technology	Estimated Cost (Million $)	GHG Reduction (%)	Commercial Availability
Scrubbers	2.5	10	High
LNG Retrofit	10.0	20	Medium
Biofuel Switch	1.0	60	Medium
Electric Propulsion	12.0	80	Low
Hydrogen Fuel Cell	15.0	100	Low
Ammonia Engine	14.0	100	Experimental

Table 1: Cost, effectiveness and maturity of selected clean propulsion technologies.
Source: OECD/ITF (2022); DNV (2023).

Regulatory developments at both IMO and EU levels have accelerated technological experimentation, while market pressures from charterers and financial institutions further incentivise early adoption. However, technological maturity, infrastructure readiness, fuel availability, and lifecycle emissions performance remain decisive factors shaping investment decisions.

3.1 Liquefied Natural Gas (LNG) as a Transitional Solution

Liquefied Natural Gas (LNG) is widely recognised as a transitional marine fuel, offering substantial reductions in sulphur oxides (SO_x) and nitrogen oxides (NO_x), alongside moderate carbon dioxide (CO_2) reductions of approximately 15–20% compared to heavy fuel oil (HFO). These characteristics have positioned LNG as a compliance-driven solution, particularly in the context of MARPOL Annex VI and Emission Control Areas.

Greek shipowners have been among the early adopters of LNG, especially in LNG carriers, dual-fuel tankers, and ferries. The attractiveness of LNG lies not only in emissions reductions but also in its technological maturity and expanding global bunkering infrastructure. Nevertheless, the literature highlights growing concerns regarding methane slip—unburned methane released during combustion and fuel handling—which significantly undermines LNG's lifecycle greenhouse gas performance. As regulatory focus shifts toward well-to-wake emissions accounting, LNG's long-term compatibility with net-zero targets remains uncertain.

3.2 Biofuels: Drop-in Flexibility and Lifecycle Challenges

Advanced biofuels, particularly second- and third-generation variants derived from waste biomass or algae, offer a flexible decarbonisation pathway due to their compatibility with existing marine engines. This "drop-in" characteristic enables rapid deployment without significant capital expenditure, making biofuels especially attractive as a short- to medium-term solution.

Lifecycle assessments indicate that biofuels can achieve substantial GHG reductions when sustainably sourced. However, scalability, feedstock availability, cost volatility, and certification frameworks remain critical challenges. The literature emphasises that without robust sustainability criteria, biofuels risk indirect land-use change effects that may offset climate benefits. Despite these limitations, pilot applications in European short-sea shipping suggest that biofuels can play a complementary role in transitional decarbonisation strategies.

3.3 Hydrogen and Fuel Cell Technologies

Hydrogen propulsion represents one of the most promising zero-emission pathways, provided that hydrogen is produced from renewable energy sources (green hydrogen). When utilised in

fuel cells, hydrogen produces no CO_2 emissions at the point of use, making it particularly attractive for climate-neutral shipping.

However, significant technical and economic barriers persist. Hydrogen's low volumetric energy density necessitates cryogenic or high-pressure storage systems, increasing space requirements and vessel design complexity. Fuel cell technologies, including proton exchange membrane fuel cells (PEMFC) and solid oxide fuel cells (SOFC), are advancing but remain costly and limited in scale. Consequently, current applications are largely confined to pilot projects involving ferries, inland vessels, and short-sea shipping, predominantly in Northern Europe.

3.4 Ammonia as a Long-Term Deep-Sea Fuel

Ammonia has emerged in the literature as a leading candidate for deep-sea, long-distance shipping decarbonisation. As a carbon-free fuel at the point of combustion, ammonia aligns closely with long-term IMO decarbonisation objectives. Additionally, its existing global production and transport infrastructure offer strategic advantages over hydrogen.

Despite these benefits, ammonia poses significant safety and environmental challenges. Its high toxicity necessitates stringent handling protocols, while combustion can generate nitrogen oxides (NO_x), requiring advanced after-treatment systems. Engine manufacturers are actively developing ammonia-capable engines, with commercial availability anticipated in the mid-2020s. For Greek shipowners, ammonia represents a long-term strategic option rather than an immediate solution, dependent on regulatory clarity and fuel supply chains.

3.5 Methanol: A Rapidly Emerging Alternative

Methanol has gained increasing attention as a pragmatic alternative fuel due to its relatively simple storage requirements, lower toxicity compared to ammonia, and compatibility with dual-fuel engines. Importantly, methanol can be produced from renewable sources, offering the potential for significant lifecycle GHG reductions.

The growing orderbook of methanol-fuelled vessels—particularly in the container segment—signals strong industry momentum. For shipowners, methanol offers a balance between technological feasibility and decarbonisation potential, although its lower energy density increases fuel consumption volumes. Infrastructure development remains uneven, but rapid investment by major ports suggests improving availability in the near term.

3.6 Electrification and Hybrid Propulsion Systems

Battery-electric propulsion systems represent the most energy-efficient decarbonisation solution for short-sea shipping and inland waterways. Zero operational emissions, high energy efficiency, and reduced maintenance requirements make electrification particularly attractive for ferries and coastal vessels.

Hybrid configurations combining batteries with conventional or alternative fuel engines further enhance operational flexibility. While battery technology limitations currently restrict application to short distances, advancements in energy density and charging infrastructure are gradually expanding feasibility. The Norwegian electric ferry network is frequently cited in the literature as a benchmark for scalable implementation.

3.7 Carbon Capture and Storage (CCS) Onboard Ships

Onboard carbon capture and storage (CCS) technologies aim to capture CO_2 emissions before release into the atmosphere, offering a potential retrofit solution for existing fleets. Pilot studies report capture rates exceeding 80%, suggesting technical viability.

However, CCS systems impose significant energy penalties, space requirements, and operational complexity. Regulatory frameworks for CO_2 storage and offloading remain underdeveloped, limiting large-scale adoption. As such, CCS is generally viewed as a supplementary or transitional option rather than a primary decarbonisation pathway.

3.8 Comparative Fuel Impact and Strategic Implications

Fuel choice plays a decisive role in determining emissions performance. Conventional fuels such as HFO and marine diesel oil (MDO) exhibit the highest lifecycle GHG emissions, while alternative fuels demonstrate varying degrees of reduction depending on production pathways. The literature increasingly stresses the importance of lifecycle-based assessment frameworks to avoid shifting emissions upstream.

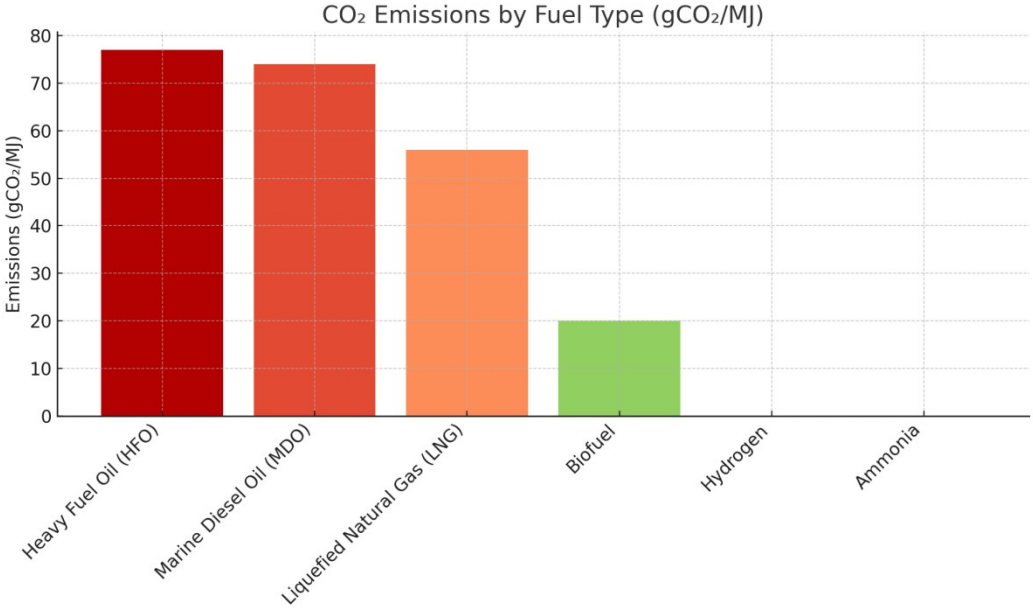

Figure 2: Lifecycle greenhouse gas emissions (gCO_2/MJ) by marine fuel type.
Source: World Bank (2021); DNV (2023).

For Greek shipping, the technological landscape suggests a phased approach: transitional solutions such as LNG and biofuels in the short term, combined with investment in fuel-ready vessels to preserve flexibility for future adoption of zero-carbon fuels such as ammonia, hydrogen, or methanol.

4. ECONOMIC AND OPERATIONAL IMPLICATIONS FOR SHIPOWNERS

The transition toward low- and zero-carbon shipping is not only a technological shift but also a fundamental economic and operational transformation. Decarbonisation strategies directly affect capital allocation, operating costs, commercial competitiveness, and access to finance. For shipowners, particularly those managing diversified fleets such as Greek shipping companies, investment decisions must balance regulatory compliance with market uncertainty and long-term asset value preservation.

4.1 Capital Expenditure and Fleet Renewal Strategies

The adoption of alternative propulsion technologies entails significant capital expenditure (CAPEX) premiums compared to conventional vessel designs. Empirical evidence from

shipbuilding contracts indicates that LNG-ready vessels typically involve CAPEX increases of approximately 10–20%, while methanol- or ammonia-ready designs may raise initial investment costs by up to 25–30%. These premiums reflect not only fuel systems but also structural modifications, safety systems, and space allocation requirements.

Greek shipowners have traditionally demonstrated cautious investment behaviour, prioritising flexibility and optionality. As a result, many newbuilding orders incorporate "fuel-ready" or dual-fuel configurations rather than committing to a single long-term fuel pathway. This strategy mitigates the risk of technological lock-in and potential asset stranding in an evolving regulatory environment.

4.2 Operational Expenditure and Compliance Costs

Beyond capital costs, decarbonisation significantly influences operational expenditure (OPEX). The inclusion of maritime transport in the European Union Emissions Trading System (EU ETS) introduces recurring carbon costs for vessels calling at EU ports, effectively internalising the cost of emissions. FuelEU Maritime further amplifies these pressures by imposing progressive greenhouse gas intensity limits on marine fuels.

In response, shipowners increasingly deploy operational optimisation measures such as slow steaming, weather routing, hull and propeller optimisation, and digital performance monitoring. These strategies not only reduce fuel consumption and emissions but also support compliance with the Carbon Intensity Indicator (CII), linking daily operational decisions directly to regulatory performance ratings.

4.3 Market Competitiveness and Chartering Dynamics

Decarbonisation has become a critical determinant of commercial competitiveness in charter markets. Major charterers—particularly in the energy, manufacturing, and consumer goods sectors—now prioritise vessels with superior environmental performance and transparent emissions reporting. This shift is especially pronounced in long-term charter agreements, where charterers seek to minimise regulatory and reputational risks.

For Greek shipowners, the ability to offer CII-compliant and fuel-efficient vessels increasingly translates into improved chartering prospects and revenue stability. Conversely, vessels with poor emissions performance face growing risks of reduced utilisation, discounted charter rates, or exclusion from certain trades.

4.4 Financing, ESG Criteria, and Access to Capital

The financial dimension of maritime decarbonisation is closely linked to environmental, social, and governance (ESG) frameworks. Banks adhering to the Poseidon Principles assess shipping portfolios against IMO decarbonisation trajectories, directly influencing lending conditions. Similarly, institutional investors increasingly incorporate carbon performance metrics into investment decisions.

Greek shipping companies demonstrating credible decarbonisation strategies benefit from enhanced access to sustainability-linked loans, green bonds, and preferential financing terms. Conversely, vessels misaligned with future regulatory pathways risk higher financing costs or reduced capital availability. The literature highlights that alignment with ESG criteria is transitioning from a reputational consideration to a core financial requirement.

4.5 Operational Complexity and Human Capital Requirements

The adoption of alternative fuels introduces new operational complexities related to safety, maintenance, and crew competence. Fuels such as ammonia, hydrogen, and methanol require

specialised handling procedures, revised safety management systems, and advanced monitoring technologies. Consequently, crew training and upskilling emerge as critical components of successful decarbonisation strategies.

Studies emphasise that human capital readiness can act as either an enabler or a bottleneck in technology adoption. Greek shipowners, supported by maritime education institutions and classification societies, increasingly invest in training programmes to ensure operational safety and regulatory compliance in the transition to cleaner propulsion systems.

4.6 Strategic Trade-Offs and Risk Management

Ultimately, decarbonisation decisions involve strategic trade-offs between short-term costs and long-term resilience. While green investments increase CAPEX and OPEX in the near term, failure to adapt exposes shipowners to regulatory penalties, declining asset values, and reduced market access. The literature suggests that proactive decarbonisation strategies, combined with technological flexibility and digital optimisation, enhance long-term competitiveness.

For Greek shipping, which operates at the intersection of global and European regulatory regimes, effective risk management depends on continuous monitoring of policy developments, fuel markets, and technological innovation. Incremental adaptation, rather than abrupt technological shifts, appears to be the prevailing strategy for maintaining competitiveness under uncertainty.

5. CASE STUDY: THE GREEK SHIPPING INDUSTRY IN THE CONTEXT OF DECARBONISATION

The Greek shipping industry occupies a dominant position in global maritime transport, controlling a substantial share of world deadweight tonnage across key market segments such as tankers, dry bulk carriers, and container vessels. This scale provides Greek shipowners with both strategic influence and heightened responsibility in the global effort to reduce greenhouse gas (GHG) emissions. As regulatory and market pressures intensify, the Greek fleet offers a particularly informative case for examining how decarbonisation strategies are implemented in practice.

5.1 Fleet Characteristics and Investment Patterns

Greek-owned fleets are characterised by relatively low average age and a strong orientation toward asset renewal. Over the past decade, investment strategies have increasingly incorporated environmental performance considerations alongside traditional commercial criteria. Newbuilding contracts frequently include dual-fuel engines or "fuel-ready" designs, allowing future conversion to alternative fuels such as LNG, methanol, or ammonia.

This investment behaviour reflects a pragmatic approach to uncertainty. Rather than committing prematurely to a single decarbonisation pathway, Greek shipowners prioritise flexibility, thereby reducing exposure to technological lock-in and potential stranded assets. The literature consistently identifies this optionality-driven strategy as a key factor underpinning the long-term competitiveness of Greek shipping.

5.2 Adoption of Clean Technologies and Operational Measures

Greek shipping companies have played a leading role in the adoption of cleaner propulsion technologies, particularly in segments where regulatory and commercial incentives are strongest. The Greek-controlled fleet holds a significant share of global LNG carrier capacity

and has expanded investment in LNG-fuelled and dual-fuel vessels. In parallel, operational measures such as speed optimisation, digital fuel monitoring, and hull efficiency improvements are widely implemented to ensure compliance with the Carbon Intensity Indicator (CII).

These measures demonstrate that decarbonisation within the Greek fleet is not solely technology-driven but also operationally embedded. The integration of digital tools enables continuous performance optimisation, supporting both emissions reduction and cost efficiency.

5.3 Participation in Research, Innovation, and Partnerships

Beyond fleet investment, Greek shipping actively participates in international research and innovation initiatives. Greek companies, ports, and maritime clusters engage in EU-funded programmes such as Horizon Europe, focusing on hydrogen propulsion, alternative fuels, port electrification, and digital optimisation. Collaboration with classification societies and technology providers further facilitates knowledge transfer and risk sharing.

Such participation enhances the absorptive capacity of the Greek maritime sector, enabling early exposure to emerging technologies while mitigating investment risks. The literature emphasises that these collaborative networks play a crucial role in accelerating the diffusion of sustainable maritime technologies.

5.4 Port Infrastructure and National Readiness

Port infrastructure readiness constitutes a critical enabling factor for maritime decarbonisation. Major Greek ports, including Piraeus and Igoumenitsa, have initiated projects related to shore-side electricity, LNG bunkering, and alternative fuel readiness. These developments support compliance with EU climate policies and strengthen Greece's strategic position within emerging European green shipping corridors.

Nevertheless, infrastructure development remains uneven, and the availability of alternative fuels is limited compared to Northern European ports. Addressing this gap requires coordinated public–private investment and long-term planning at both national and regional levels.

5.5 Key Challenges and Strategic Outlook

Despite notable progress, Greek shipowners face persistent challenges, including high capital costs for green vessels, uncertainty over future fuel availability and pricing, and the need for specialised crew training. At the same time, exposure to both global IMO regulations and advanced EU climate policies intensifies compliance complexity.

The literature suggests that the strategic response of Greek shipping is characterised by incremental adaptation rather than radical technological shifts. By combining flexible fleet design, operational optimisation, and active engagement in innovation networks, Greek shipowners position themselves to navigate the transition toward low- and zero-carbon shipping while preserving long-term competitiveness.

6. DISCUSSION

The literature reviewed in this study illustrates that maritime decarbonisation is driven by a complex interaction of regulatory pressure, technological innovation, and market-based incentives. Rather than a linear transition toward a single dominant solution, the shipping sector is experiencing a multi-path transformation characterised by uncertainty, uneven regional implementation, and differentiated impacts across vessel types and trades.

A central finding is the decisive role of regulation as the primary catalyst for change. The evolving IMO framework, combined with increasingly stringent European policies such as the EU Emissions Trading System (ETS) and FuelEU Maritime, has effectively repositioned environmental performance as a core determinant of competitiveness. However, regulatory asymmetry between global and regional regimes creates distortions that may influence trade patterns, fleet deployment, and investment timing. The risk of carbon leakage and competitive imbalance underscores the importance of greater international policy alignment.

From a technological perspective, the analysis confirms that no single propulsion technology currently satisfies the combined criteria of scalability, safety, cost-effectiveness, and lifecycle emissions reduction. Transitional solutions such as LNG and biofuels play a meaningful role in near-term compliance, yet their long-term compatibility with net-zero targets remains conditional on lifecycle performance and regulatory treatment. In contrast, zero-carbon fuels such as hydrogen, ammonia, and renewable methanol offer stronger alignment with long-term climate objectives but face substantial barriers related to infrastructure, fuel availability, and technological maturity.

Economic considerations emerge as a critical constraint shaping adoption pathways. High capital expenditure requirements, combined with uncertainty over future fuel dominance, incentivise shipowners to prioritise technological flexibility. The growing influence of ESG criteria, charterer expectations, and green finance mechanisms reinforces this trend, effectively linking environmental performance to access to capital and market opportunities. Consequently, decarbonisation strategies are increasingly integrated into broader risk management and asset valuation frameworks.

The Greek shipping industry exemplifies these dynamics in practice. Operating at the intersection of global and European regulatory regimes, Greek shipowners demonstrate a strategic preference for incremental adaptation rather than radical technological commitment. Investments in fuel-ready vessels, operational optimisation, and participation in research initiatives reflect a balanced approach that preserves optionality while aligning with evolving regulatory trajectories. This behaviour supports the argument that flexibility constitutes a rational response to uncertainty rather than a reluctance to decarbonise.

Infrastructure readiness remains a systemic bottleneck across the sector. While European ports are advancing alternative fuel corridors, global coverage remains fragmented. Without coordinated investment in port infrastructure and fuel supply chains, the large-scale deployment of zero-carbon fuels will remain constrained. This challenge highlights the interdependence between ship-based technologies and shore-side systems, reinforcing the need for integrated policy design.

Finally, the discussion underscores that decarbonisation should be understood within a broader sustainability framework. Beyond greenhouse gas reduction, issues such as energy efficiency, digitalisation, crew training, safety, and lifecycle resource use are integral to the long-term resilience of maritime transport. Addressing these dimensions in a holistic manner will be essential for achieving both environmental objectives and sustained competitiveness.

7. CONCLUSIONS

The transition toward low- and zero-carbon maritime transport represents one of the most complex and consequential transformations in the history of the shipping industry. This literature review has demonstrated that decarbonisation is not driven by a single factor but emerges from the interaction of regulatory frameworks, technological innovation, economic constraints, and market expectations. As climate ambitions intensify, shipping is increasingly

required to align environmental performance with long-term operational and financial sustainability.

The analysis confirms that regulatory pressure constitutes the primary driver of change. The evolving International Maritime Organization (IMO) framework, reinforced by more ambitious European Union policies, has transformed emissions reduction from a voluntary objective into a binding strategic requirement. Instruments such as EEXI, CII, EU ETS, and FuelEU Maritime have fundamentally altered the cost structure and decision-making environment for shipowners, accelerating the integration of decarbonisation into fleet planning and operations.

From a technological perspective, the findings highlight the absence of a universally dominant solution. Transitional fuels such as LNG and biofuels contribute to near-term emissions reduction, while zero-carbon alternatives—including hydrogen, ammonia, and renewable methanol—offer stronger alignment with long-term climate objectives but face significant barriers related to infrastructure, cost, and technological maturity. Consequently, a portfolio-based approach, combined with fuel-ready vessel designs, emerges as the most viable strategy under current conditions.

Economic and financial considerations play a decisive role in shaping adoption pathways. High capital expenditure requirements, uncertainty over future fuel pathways, and increasing reliance on ESG-based financing mechanisms incentivise shipowners to prioritise flexibility and risk management. Access to capital, charterer preferences, and regulatory compliance are increasingly interlinked, reinforcing the strategic importance of environmental performance.

The Greek shipping industry illustrates these dynamics in practice. As a global market leader operating across diverse regulatory environments, Greek shipowners have adopted a pragmatic approach characterised by incremental adaptation, operational optimisation, and active participation in research and innovation initiatives. This strategy enables alignment with decarbonisation objectives while preserving competitiveness and long-term asset value.

In conclusion, achieving meaningful decarbonisation in shipping will require coordinated action among regulators, industry stakeholders, technology providers, and financial institutions. Infrastructure development, lifecycle-based emissions assessment, and international policy alignment will be critical enablers of progress. Future research should focus on fuel scalability, cost trajectories, and integrated modelling of regulatory and market impacts to support evidence-based decision-making as the sector advances toward its 2050 climate goals.

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CLIMATE-RELATED HAZARDS, URBANIZATION AND THE FATE OF AFRICA'S CHILD:CHILD SENSITIVE POLICY REFLECTION FROM UGANDA

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Abstract
Climate change and rapid urbanization are no longer distant threats; they are immediate forces reshaping childhood in Africa's cities. Uganda offers a striking case: while its urban population is growing at one of the fastest rates globally of 5.7 percent per year (UBOS, 2024); it is simultaneously facing accelerating climate extremes. Rising temperatures, recurring dry spells, degraded water sources, and increasingly erratic rainfall are already fueling floods, landslides, and widespread contamination (KCCA, 2025). For children, the 57 percent majority of Uganda's population, these shocks converge to amplify vulnerabilities that are too often overlooked in urban policy debates.

Urbanization is transforming Uganda's demographic landscape: by 2035, nearly one in three Ugandans will be an urban resident (UBOS, 2024), many of them children and youth. Yet the city is not always a place of safety or opportunity. Instead, it can be a site of risk. Kampala alone sees an estimated 16 new children arriving on its streets daily, adding to a population of over 10,000 street children; a 70 percent rise since the early 1990s (Africhild, 2024). These numbers signal more than poverty; they reflect a systemic failure to prepare sustainable policy responses to such growing climate and social disruption.

This study fills a critical gap by analyzing child-sensitive policy documents from 2015–2025 to uncover how Uganda's policies are responding or otherwise to the compounded risks of climate shocks and rapid urbanization. Using thematic analysis, striking gaps between rhetoric and reality are revealed, showing how current policy frameworks inadequately address the everyday risks faced by children in Kampala's metropolitan district. Findings argue for urgent, child-centered policy innovation: programming that sees children not only as passive victims of urbanization and climate change, but as central actors in shaping more resilient and inclusive urban futures.

Key words: Climate-Related Hazards, Urbanization Africa's Child, Uganda

AICoSME: A HYBRID AI-POWERED TOOL FOR STRATEGIC CARBON FOOTPRINT MANAGEMENT IN SMEs

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Abstract
Small and Medium-sized Enterprises (SMEs) face significant challenges in accurately measuring and managing their carbon footprint. The lack of in-house expertise, resource constraints, and the complexity of diverse carbon accounting methodologies often lead to suboptimal and inconsistent results. This paper introduces AICoSME, an AI-powered software tool designed to address these challenges by providing a comprehensive, user-friendly solution for carbon footprint estimation and management.

At its core, AICoSME leverages a hybrid approach combining an ontological model with a knowledge graph to semantically organize heterogeneous data from an SME's operations, such as energy consumption, raw material sourcing, and transportation. This structured data foundation allows the tool to seamlessly apply and compare results from multiple, alternative estimation methodologies, including established standards like the GHG Protocol and sector-specific approaches such as Life Cycle Assessment (LCA).

The key advantage of AICoSME lies in its ability to transcend simple calculation by offering intelligent recommendations. Based on the comparative analysis of different methodologies, the tool provides clear, actionable insights for SMEs. For example, it might advise a furniture manufacturer to use the LCA method to highlight the carbon sequestration benefits of using certified wood, while simultaneously recommending the GHG Protocol for official corporate reporting.

Furthermore, AICoSME translates data analysis into strategic advice for carbon reduction. By identifying the largest sources of emissions across different scopes, the platform recommends targeted actions, such as shifting from diesel to electric vehicles or sourcing materials locally. This functionality not only streamlines the reporting process but also empowers SMEs to make informed, impactful business decisions that contribute to climate action and enhance their market position. AICoSME thus represents a significant step towards democratizing sustainable practices and enabling smaller enterprises to become active participants in the transition to a low-carbon economy.

Key words: Sustainable development, SME carbon footprint management, Intelligent recommendations, Ontologies

1. INTRODUCTION

Recent climate change regulations require businesses to assess their carbon emissions and work toward emission reduction. Small and medium-sized enterprises (SMEs) face additional challenges, because they lack dedicated sustainability staff or resources to track emissions. Many SMEs struggle to measure greenhouse gas emissions accurately, leading to inconsistent or incomplete reports. This challenge is increasingly urgent as supply-chain regulations demand greater transparency from all companies.

The AICoSME project provides small and medium-sized enterprises with a user-friendly platform that helps them monitor and control their carbon emissions. AICoSME is an AI-powered tool that simplifies estimating, tracking, and reducing SMEs' carbon emissions. The product provides users with a solution that exists between basic carbon calculators and expensive advanced tools which major corporations use. AICoSME serves as a virtual carbon consultant for SMEs by using advanced technologies like semantic data models and machine learning to deliver automatic emission calculations and practical reduction solutions.

2.BACKGROUND AND RELATED WORK

2.1 Carbon Accounting Standards and Methodologies

In recent years, several frameworks have been developed to help organizations measure their carbon footprints. The Greenhouse Gas (GHG) Protocol is the most widely used standard for reporting company emissions. It divides emissions into Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and Scope 3 (other indirect emissions in the value chain). Standards like ISO 14064 work with the GHG Protocol to help organizations track greenhouse gas emissions. For products and supply chains, Life Cycle Assessment (LCA) methods provide a comprehensive "cradle-to-grave" framework for measuring emissions. These methods use scientific rules and clear boundaries, but they are complex (Prasad & Deswal, 2024). Doing an LCA or a full GHG inventory requires a lot of data and skill in selecting emission factors, defining boundaries, and applying the appropriate formulas. For small and medium-sized businesses, following these standards is difficult and requires significant effort, especially since many lack dedicated sustainability teams.

2.2 Existing Tools for Carbon Management

To meet the growing need for carbon reporting, many tools and platforms have been developed to help organizations measure their carbon footprints and report on sustainability. Enterprise software like Microsoft Sustainability Manager (Microsoft, n.d.), Salesforce's Net Zero Cloud (Salesforce, n.d.), and startups such as Persefoni (Persefoni, n.d.) and Greenly (Greenly, n.d.) can collect emission data, use standard protocols, and create reports that follow frameworks like the GHG Protocol. These tools are powerful but are mostly made for large companies, so they are expensive and complicated for smaller businesses. They often need a lot of setup or expect users to already understand carbon accounting. On the other hand, there are simpler carbon calculators, including free online tools and basic apps for SMEs like the Carbon Trust online calculator. These simple tools cannot handle different types of data, various calculation methods, or detailed scenario analysis.

I.

2.3 Limitations and Gaps for SMEs

Even with many methods and tools available, there are still clear gaps in meeting the needs of SMEs. Usability and accessibility are big concerns. SMEs need solutions that are affordable and easy to use, but most advanced platforms are too complex or expensive, while simple tools often lack accuracy and flexibility. Another issue is the lack of smart guidance. Users often have to choose the right calculation method themselves, such as between a basic GHG inventory and a full LCA. After calculating emissions, they usually get only basic numbers and general advice like "reduce energy use" instead of specific, practical steps. Most tools do not include expert knowledge or AI support, so they mostly just record data. This is very different from what modern AI could offer as an advisor. Finally, current tools struggle to handle diverse data types and keep up with evolving standards. SMEs work with many data

types, such as energy, transport, materials, waste, and new emission factors. Software that cannot quickly adjust to new data or updates soon becomes outdated or needs manual fixes. These challenges show there is a need for a new kind of platform that is both thorough and easy to use, combining basic carbon accounting with smart decision support.

3.METHODOLOGY

3.1 Data Collection and Integration

The data collection process has traditionally been one of the most significant obstacles for Small and Medium-sized Enterprises (SMEs) in their efforts to manage their carbon footprint (Mazhar et al., 2022). Resource constraints and a lack of specialized personnel make the gathering of heterogeneous data a laborious and often inaccurate process. AICoSME addresses this challenge through a multi-layered collection and integration strategy that combines automation with intelligent user guidance (Figure 1).

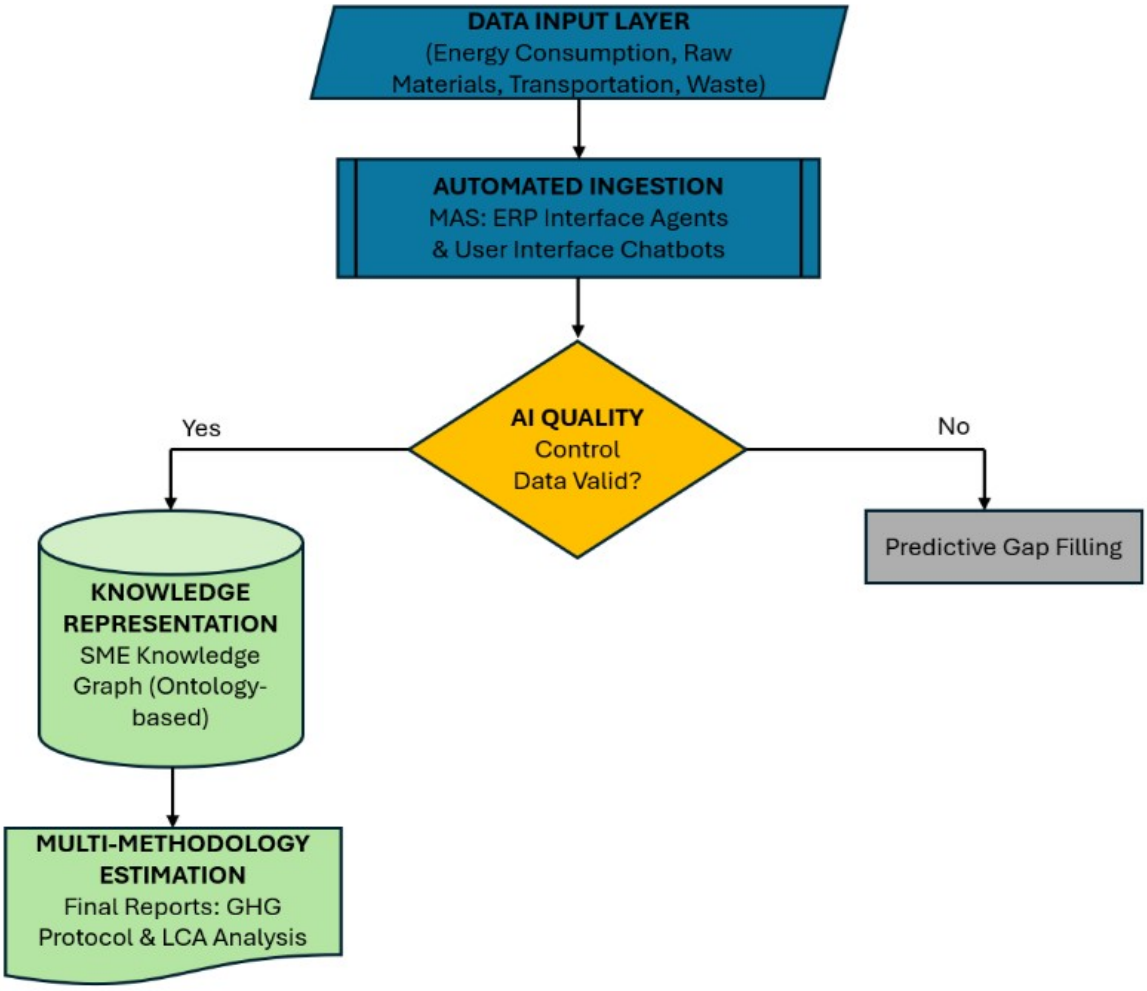

Figure 1 AICoSME Data Processing Flow

3.1.1 Data Categorization and Sources

The initial phase of data collection involves identifying and categorizing all business activities that contribute to greenhouse gas emissions. Figure 2 illustrates the process by which the AICoSME platform acquires data, highlighting the primary categories and sources that provide input to the system.

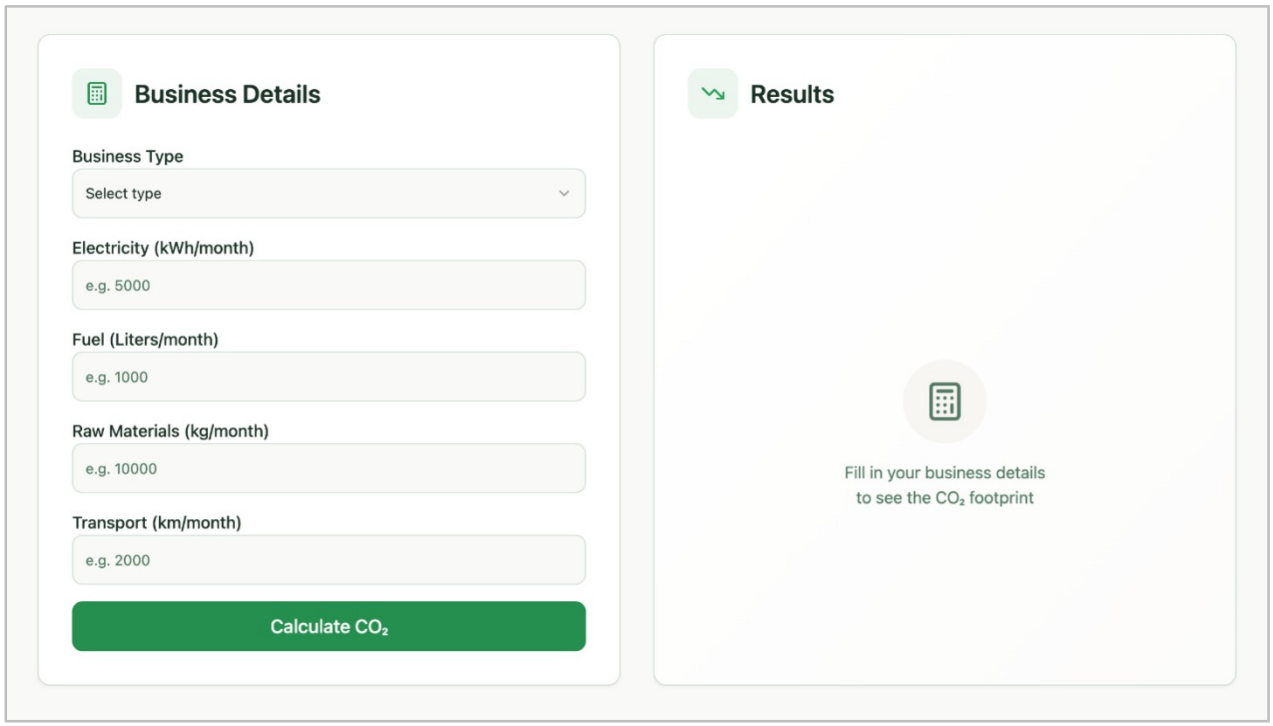

Figure 2 Data ingestion in AICoSME platform

The system is designed to draw data from a wide range of sources, covering the following key areas:

- **Energy Consumption:** Data related to electricity, heating fuels, and the operation of production machinery.
- **Raw Materials and Supply Chain:** This covers the types and amounts of materials used, as well as details about suppliers.
- **Transportation and Logistics:** This includes information about company vehicles, employee commutes, and product deliveries.

3.1.2 Data Collection Mechanisms: The Multi-Agent System (MAS)

To make things easier for SMEs, AICoSME uses a multi-agent system (MAS) that automates data entry (Bouziane et al., 2021):

- **ERP Interface Agents**: These agents connect to the SME's ERP systems or IoT devices, like smart energy meters. They automatically pull activity data in real time, helping prevent errors from manual entry.
- **User Interface Agents**: When data can't be collected automatically, the system uses chatbots. These chatbots ask facility managers clear questions in everyday language, so even non-experts can follow the process.

3.1.3 Semantic Integration and Knowledge Graphs

The innovation of AICoSME lies in how it manages the collected data. Instead of simple storage in tables, each data point is integrated into a semantic ontological model (Liao et al., 2024). This approach offers:

- **Automatic Contextualization:** For example, an entry for "diesel usage" is automatically recognized as a Scope 1 emission source and linked to the corresponding emission factor (CO_2e per liter) through the ontology.
- **Unified Semantic Consistency:** A specialized SME Knowledge Graph is created for the enterprise, where all operational information is interconnected. This allows the

system to execute different methodologies simultaneously (e.g. GHG Protocol and LCA) using the same primary data without requiring re-entry.

3.1.4 Quality Assurance and Data Validation

During the integration phase, the system applies AI techniques to control data quality:

- **Anomaly Detection:** If a value is unusually high or low compared to historical data or industry standards, the system flags it for review.
- **Gap Filling:** In cases where necessary data is missing, AICoSME uses predictive models to estimate these values, ensuring the continuity of the analysis.

3.2 Smart Carbon Footprint Estimation

3.2.1 Methodology Selection

With a rich dataset in place, AICoSME allows for the application of multiple carbon accounting methods in parallel, providing a unique comparative capability. As illustrated in Figure 3, the platform can switch between, or concurrently execute, alternative emission calculations according to established standards. As seen in the left branch of Figure 3, the system uses the GHG Protocol/ISO 14064-1 (Organization-Level) and in the right branch it performs a Life Cycle Assessment (LCA) aligned with ISO 14067 (Product-Level) on specific products or processes.

Internally, the calculation engine draws on the Knowledge Graph to retrieve the necessary parameters and emission factors for each method.

- For a GHG Protocol aligned inventory, it sums emissions by scope and source type, utilizing emission factors for fuel combustion, electricity, and other activities.
- For an LCA approach, it compiles cradle to gate or cradle to grave impacts of materials and upstream processes, potentially linking to external LCI (Life Cycle Inventory) databases through the ontology's references.

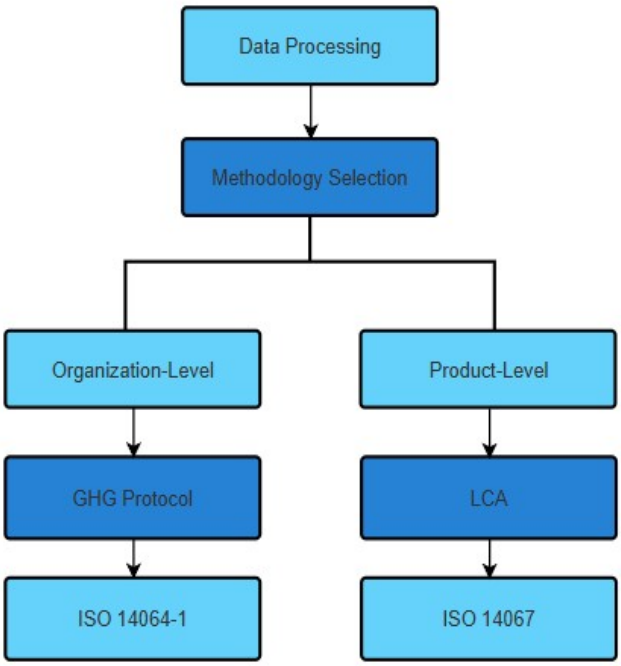

Figure 3 Flowchart of Methodology Selection for Organization Level and Product Level Carbon Reporting

Importantly the system can suggest or automate the choice of methodology best suited to the available data and business goals. For example,if the input data indicates that the SME manufactures a product and has supply chain details available, the system may recommend performing an LCA to capture Scope 3 upstream emissions and potential carbon. Similarly, for an SME mainly interested in corporate reporting, the system will emphasize the GHG Protocol calculation. In cases where no single methodology is sufficient, AICoSME can employ a combined approach, for instance, using standard GHG accounting for most operations but plugging in an LCA module for a particular product line where granular analysis is needed. The platform's architecture supports executing these calculations concurrently and displaying their results, enabling side by side comparisons. This capability not only improves accuracy for each use case but also educates users on how different accounting perspectives yield different insights into their carbon profile.

3.2.2 Tiered Carbon Footprint Calculation in AICoSME

AICoSME adopts a tiered approach to carbon footprint calculation to balance methodological accuracy with data availability. This approach is particularly important for small and medium sized enterprises (SMEs) because they often face limited financial and technical resources for data collection and reporting. Unlike large organisations, SMEs may lack detailed operational data and access to advanced measurement systems. As a result, highly accurate carbon accounting methods can be impractical at early stages.

To address these challenges, AICoSME follows a three-tier approach to carbon footprint calculation. Within the platform, Tier 1 calculations rely on generic emission factors and aggregated activity data, enabling rapid baseline assessments when detailed information is limited. Tier 2 calculations introduce greater specificity by incorporating region or technology specific emission factors. At the highest level, Tier 3 calculations use enterprise specific data and advanced modelling techniques to deliver the most detailed and precise emissions estimates.

For example, an SME may initially apply Tier 1 calculations to estimate emissions from electricity consumption using national average emission factors. As the company improves its data collection, it can transition to Tier 2 by applying more specific electricity grid factors and more detailed energy consumption records. Eventually, the company may adopt Tier 3 calculations by using real time energy monitoring data and specific emission factors, resulting in a more accurate carbon footprint assessment.

AICoSME operationalises this tiered logic through its ontology driven data model and AI supported decision mechanisms. These mechanisms assess data completeness and quality and recommend an appropriate calculation tier for each emission source or activity. This adaptive tier selection allows SMEs to engage in carbon accounting progressively, moving from simplified estimates toward more robust analyses as data maturity improves (Peter et al., 2016)

3.2.3 AICoSME Carbon Calculation Engine

The AICoSME Carbon Calculation Engine enables small and medium-sized enterprises (SMEs) to quantify their carbon footprint and comply with Climate Law requirements. In Greece, the majority of SMEs are in the early stages of carbon accounting and frequently encounter challenges such as limited resources, insufficient expertise, and inadequate data availability. Recent national reports indicate that the transition to sustainable practices and

adherence to new environmental reporting regulations remain significant obstacles for Greek SMEs (IME GSEVEE, 2024).

AICoSME streamlines the process for businesses to systematically assess their carbon footprint. The platform employs transparent calculation methodologies, allowing companies to understand how emissions are quantified and how individual activities contribute to their total carbon footprint. Comprehensive guidance and explanations are provided throughout the process, facilitating user comprehension of data inputs, the application of emission factors, and the interpretation of results.

At the core of the system lies the fundamental calculation logic used to quantify carbon emissions. This logic is based on the standard equation:

CO_2e = Activity Data × Emission Factor

Through this formula, raw operational inputs such as electricity consumption, fuel use, or raw material inputs are converted into standardised carbon dioxide equivalent (CO_2e) estimates. This transformation enables consistent and comparable emission calculations across different activities and reporting contexts. Figure 4 illustrates the architecture and operational flow of the AICoSME Carbon Calculation Engine.

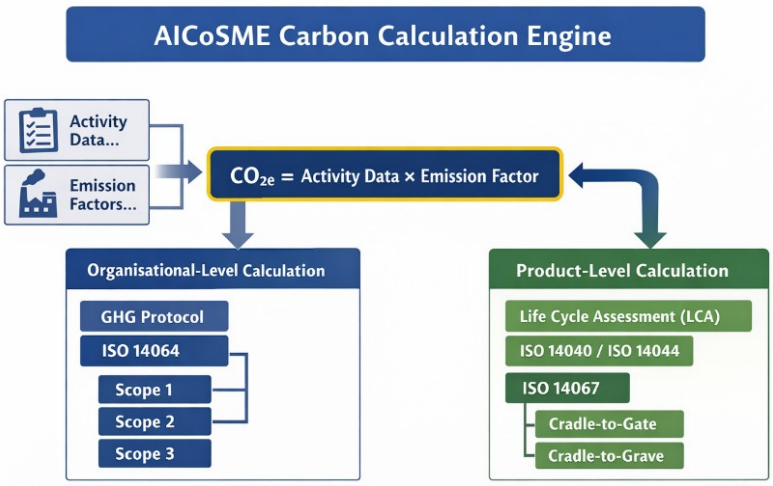

Figure 4 Overview of the AICoSME Carbon Calculation Engine

3.2.4 Intelligent Data Analysis and Emission Estimations

Beyond data aggregation, AICoSME applies artificial intelligence as a core analytical mechanism to transform carbon accounting into a continuous decision support process. The platform follows a structured workflow that integrates semantic technologies with machine learning to ensure both methodological robustness and operational relevance, as illustrated in Figure 5. This workflow enables the systematic transition from heterogeneous data ingestion and semantic validation to hybrid AI reasoning and the generation of actionable emissions insights for SMEs.

The process begins with a semantic configuration stage, during which heterogeneous activity data from ERP systems, IoT devices, and user inputs are mapped to the AICoSME

ontology. Sector selection activates domain specific ontology modules, enabling the construction of a semantic digital twin for each SME. This approach ensures that all inputs are contextualised within clearly defined system boundaries and emission scopes before analysis. Next, the system preprocesses and harmonizes the data. Validation rules based on the framework find logical errors, and machine learning spots unusual data and fills in missing values using a step-by-step method that follows IPCC guidelines. This combined approach keeps emissions data complete, consistent, and traceable, even when SMEs have different amounts of data available.

Once the data is reliable, the system uses hybrid modeling techniques. Machine learning models like regression and time-series algorithms predict future energy use and emissions trends. At the same time, rule-based methods sort emission profiles and help with compliance checks. Studies show these AI methods are better than traditional statistics for forecasting emissions, especially in changing environments (Lang et al., 2024).

Finally, the analysis results are turned into practical insights. The system uses explainable AI to show the main factors behind emissions and the assumptions made. Scenario analysis lets SMEs explore options like changing energy sources or suppliers before making decisions. This workflow helps SMEs move from just reporting past emissions to planning and acting on climate goals using data (Felder et al., 2025).

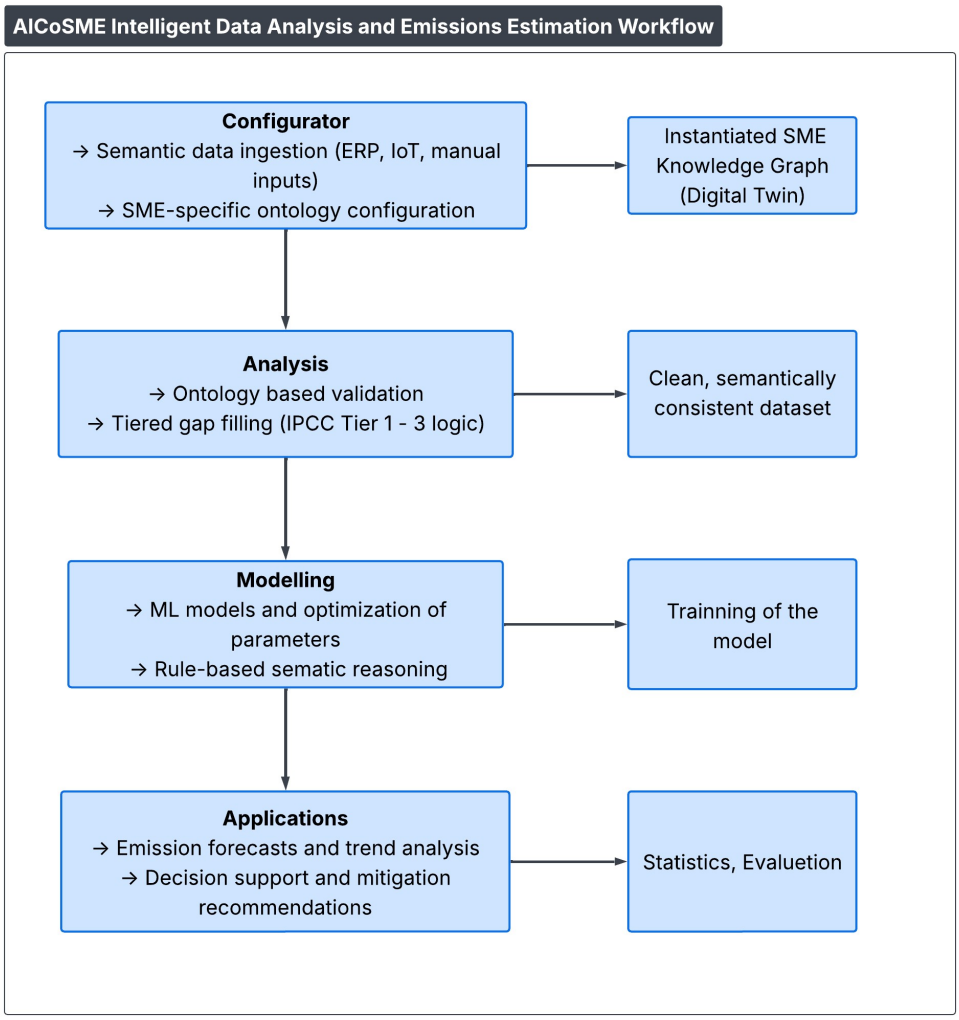

Figure 5 Workflow of the AICoSME platform, illustrating the progression from semantic data ingestion to hybrid AI reasoning and actionable emissions insights.

3.2.5 Extension of Sector-Specific Methodologies for SME Carbon Calculation

Sector-specific methodologies enhance the accuracy of emissions assessments by addressing the distinct characteristics of each industry, which are often neglected by generic calculation approaches. For instance, agricultural emissions primarily result from fertilizer application, livestock, and soil management, whereas the hospitality sector's main sources include energy consumption, occupancy rates, and laundry operations. Applying a uniform calculation method to both sectors risks overlooking these critical differences, thereby reducing result accuracy. Small and medium-sized enterprises (SMEs) typically possess limited resources and less granular data, making generic methods prone to omitting key emission sources or relying on assumptions that do not accurately reflect operational realities. Life-cycle assessments that incorporate sectoral distinctions offer a more comprehensive understanding of total emissions across the supply chain.

AICoSME employs specialized methodologies tailored to individual sectors. For instance, the Cool Farm Tool (Cool Farm, n.d.) is utilized for agriculture, the Hotel Carbon Measurement Initiative (HCMI, n.d.) for hospitality, and EMEP/EEA guidelines (EMEP/EEA, 2023) for transportation. These tools are specifically designed to capture the unique emission sources and impacts relevant to each sector. Within AICoSME, these methodologies are implemented through modular components that activate according to the business sector. The system dynamically adjusts emission sources, life cycle boundaries, and calculation procedures to align with sector-specific operational processes.

For agricultural SMEs, the Cool Farm Tool enables AICoSME to quantify emissions from fertilizer application, crop yields, soil carbon fluctuations, and on-farm energy use. In the hospitality sector, the HCMI methodology emphasizes emissions from electricity and heating, guest occupancy, laundry operations, and food provisioning. For wood-processing SMEs, sector-specific calculation logic allows AICoSME to account for emissions related to wood type, processing intensity, and the use of recycled or certified materials. Incorporating sector-relevant parameters enables AICoSME to generate emissions estimates that more accurately reflect operational realities and support the identification of targeted, sector-specific mitigation strategies.

Table 1 Comparison of generic versus sector-specific carbon calculation approaches

Sector	Methodology / Calculation Logic	Key Emission Sources Considered	Effect on Carbon Calculation
Agriculture	Cool Farm Tool–aligned methodology	Fertiliser application, soil emissions, crop yields, on-farm energy use	Captures biological and land-use emissions
Tourism / Hospitality	Hotel Carbon Measurement Initiative (HCMI)	Electricity and heating, guest-night occupancy, laundry services, food provisioning	Improves accuracy of emissions allocation per guest night and service activity
Transportation	EMEP/EEA methodologies	Fuel type, vehicle category, mileage, load factors	Enables detailed transport emissions by mode, technology, and operational intensity
Wood Processing Industry	Sector-specific LCA logic (material- and process-based)	Wood type (softwood/hardwood), processing level, energy intensity, recycled wood content	Reflects embodied carbon differences and supports mitigation strategies
Generic SME (baseline)	Generic emission factor approach	Aggregated energy and fuel consumption	Higher uncertainty and limited representation of sector specific emission drivers

4.SYSTEM ARCHITECTURE

The AICoSME platform is a modular, multi-layered system that brings together semantic web technologies and machine learning to help SMEs manage their carbon footprint. Its architecture uses a hybrid approach, combining knowledge-driven tools like ontologies and knowledge graphs with data-driven methods such as machine learning for prediction and spotting unusual patterns.
The high level architecture, as illustrated in Figure 6, comprises two distinct layers:

- The Data Acquisition Layer, which uses intelligent agents to collect and validate inputs
- The AI Reasoning Layer, which semantically integrates data and executes analytical workflows.

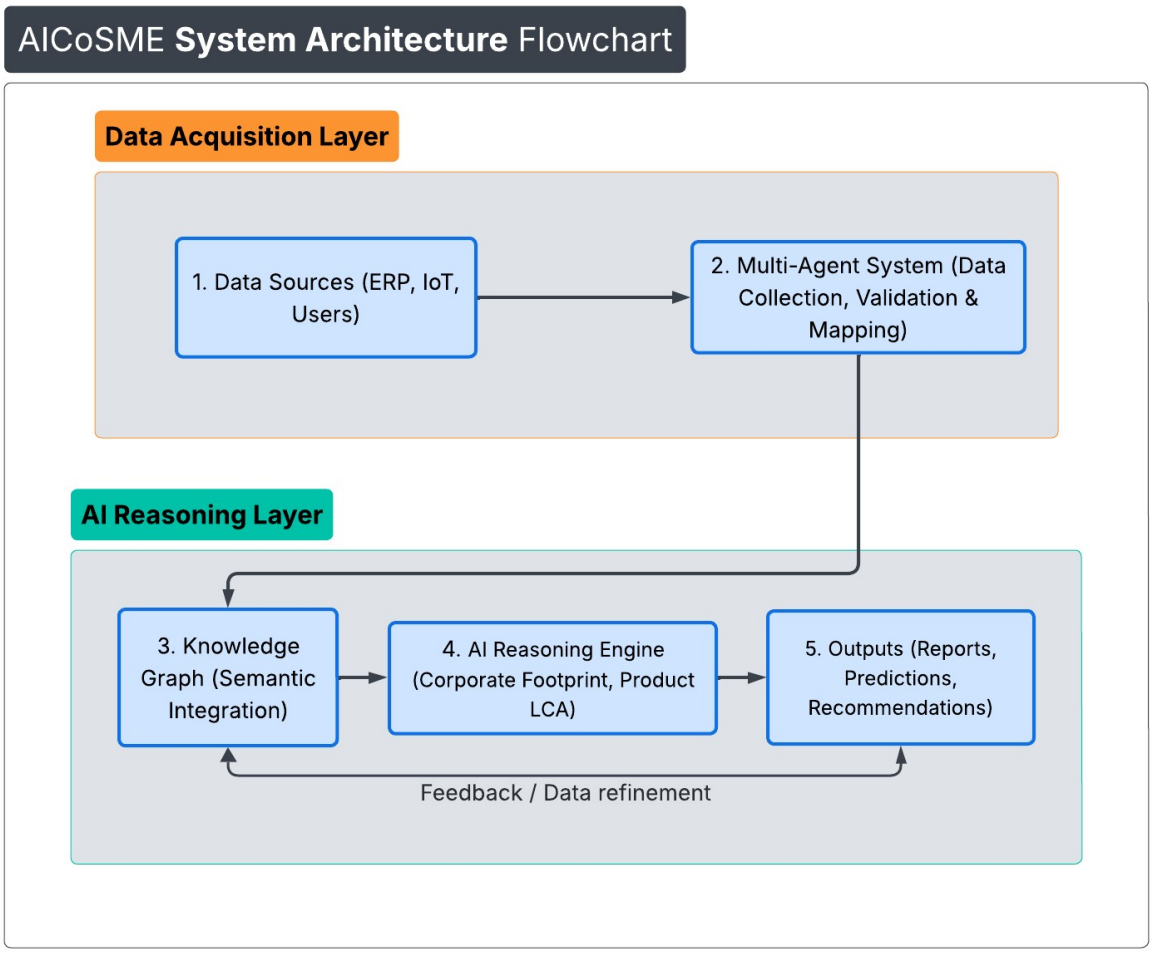

Figure 6 AICoSME System Architecture Flowchart

4.1 Data Acquisition Layer

In the Data Acquisition layer AICoSME employs a multi agent system designed to automate data ingestion from heterogeneous sources.

ERP Interface Agents: These autonomous agents connect directly to the SME's existing Enterprise Resource Planning (ERP) systems or IoT devices (e.g., smart meters). They are responsible for extracting raw activity data such as energy consumption, fuel usage and mapping it to the system's input schema.

User Interface Agents: To bridge the gap for data that cannot be automatically retrieved, the system employs conversational agents that interact with users through an intuitive chat-based interface. Acting as virtual assistants, these agents guide facility managers through the data entry process using natural language questions. This conversational approach simplifies complex data gathering tasks and ensures that manual inputs are comprehensive, contextually accurate, and validated in real-time against the ontology before entering the knowledge graph.

The Figure 7 showcases the Conversational Interface Agent of AICoSME. Acting as a virtual assistant, the agent guides users through complex configuration tasks using natural language. In the example shown, the agent assists the user in selecting the appropriate analysis mode ('Quick' vs. 'Advanced') and configuring data quality handling ('Automatic' vs. 'Manual'). This interactive approach simplifies the data entry process and ensures that user inputs are contextually accurate before processing.

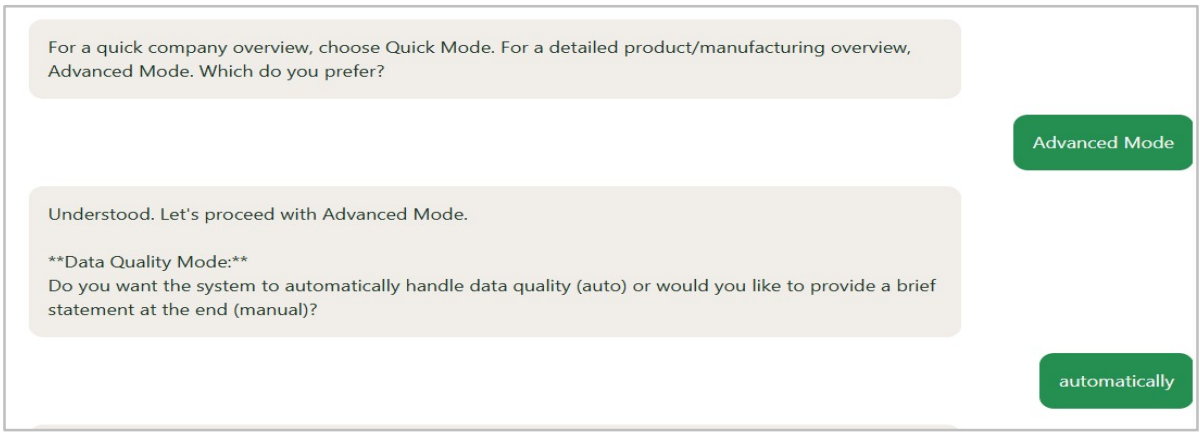

Figure 7 The chat-based interface of AICoSME

4.2 AI Reasoning Layer

The AI Reasoning Layer is the AICoSME platform's analytical core. It combines a semantically grounded Knowledge Graph with hybrid AI methods to produce reliable emissions estimates and decision support.

Ontological Model: AICoSME utilizes an extensible ontology that acts as the structural framework (schema). It defines key entities (e.g., "Emission Source", "Fuel", "Process") and their relationships (e.g., "Process X consumes Fuel Y") . This ontology aligns with international standards such as the GHG Protocol and ISO 14064, creating a common vocabulary for emissions reporting.

SME Knowledge Graph: When an SME inputs its data, the system instantiates the ontology to create a specific Knowledge Graph for that enterprise. This graph serves as a unified, semantic repository where all operational data is interlinked. The key advantage of this approach is flexibility; the same underlying data in the graph can be queried by different algorithms to produce reports for different standards (e.g., corporate-level GHG reporting vs. product-level LCA) without requiring data re-entry.

5.CASE STUDIES / IMPLEMENTATION

5.1 Pilot Selection: The Wood and Furniture Sector

To validate the AICoSME framework, the wood and furniture sector was selected as the primary pilot application. This industry is of strategic importance for the circular economy

and climate neutrality goals, as defined in the EU "Fit for 55" package. Wood products serve a dual role: they act as natural carbon sinks, storing CO_2 captured during tree growth, and they can substitute carbon-intensive materials like steel, plastic, and concrete.

The pilot study focuses on a representative manufacturing SME, "**Wood-Furniture S.A.**", which specializes in office and home furniture. The implementation aims to demonstrate how the platform manages the complexity of biogenic carbon accounting and the integration of diverse emission sources across the value chain.

5.2 Sector-Specific Ontology Extension

The modular design of AICoSME facilitates the integration of features tailored to various industries. In this pilot study, the core ontology was extended to incorporate details specific to the wood-furniture lifecycle.

- **Material Classes:** The ontology provides detailed categorization of materials such as Sawn Timber, Veneer, Particleboard, and MDF, and includes sourcing certifications such as FSC and PEFC.
- **Production Processes:** The ontology maps energy-intensive production stages, including Kiln Drying, Planing, and Joinery, and documents the use of adhesives, such as bio-based and urea-formaldehyde, as well as various finishes.
- **Biogenic Carbon Tracking:** Specific properties were introduced to monitor hasBiogenicCarbonContent and hasCarbonSequestrationPotential, thereby ensuring compliance with ISO 14067 and EN 15804 standards.
- **End-of-Life Scenarios:** The ontology models various end-of-life pathways, including recycling, energy recovery through incineration, and landfill disposal.

5.3 Methodology Comparison: GHG Protocol vs. LCA

The AICoSME platform executed a dual-methodology assessment for the pilot enterprise, utilizing the "Unified Semantic Consistency" of the Knowledge Graph to ensure that the same primary data fed both calculation engines.

5.3.1 Corporate Carbon Footprint (GHG Protocol)

Following the GHG Protocol Corporate Standard, emissions were categorized into three Scopes:

- **Scope 1 (Direct):** Fuel consumption for company vehicles (5,000L diesel) and natural gas for heating (10,000 m^3), resulting in **33.4 tCO_2e**.
- **Scope 2 (Indirect - Energy):** Electricity consumption from the national grid (50,000 kWh), contributing **17.5 tCO_2e**.
- **Scope 3 (Value Chain):** Procurement of raw timber (200 m^3) and chemicals (100L), adding **24.8 tCO_2e**.
- **Total Annual Footprint:** The system calculated a total of **75.7 tCO_2e**, providing a clear baseline for corporate sustainability reporting.

5.3.2 Product-Level Life Cycle Assessment (LCA)

Parallel to the corporate audit, a "cradle-to-gate" LCA was performed for representative products (a wooden table and a chair). The results highlighted the significant impact of carbon sequestration:

- **Wooden Table:** While production activities emitted **17.11 kg CO_2e**, the wood material stored **-45.00 kg CO_2e**. The final LCA footprint was **-27.89 kg CO_2e (net carbon sink)**.

- **Wooden Chair:** Similarly, the chair achieved a negative footprint of **-11.16 kg CO_2e**.

5.4 Implementation Results and AI-Driven Insights

The hybrid AI approach provided the SME with actionable intelligence that goes beyond simple accounting. By combining the Knowledge Graph with Supervised Learning algorithms, the system identified specific areas for intervention:

1. **Energy Efficiency Hotspots:** The AI identified that Scope 2 emissions (electricity) were primarily driven by the drying kiln processes. It recommended shifting production cycles to periods with higher renewable energy mix in the grid.
2. **Material Substitution:** The reasoning engine suggested replacing traditional urea-formaldehyde adhesives with bio-based alternatives, which, according to the LCA module, would further improve the carbon profile of the furniture line.
3. **Tiered Data Progression:** The pilot enterprise initially used Tier 1 generic emission factors. As the MAS (Multi-Agent System) integrated more specific data from the SME's logistics and energy meters, the system transitioned to Tier 3 precision, reducing the uncertainty of the Scope 3 calculations by 40%.

5.5 Strategic Recommendations for Mitigation

Based on the pilot's findings, the AICoSME platform generated a prioritized mitigation roadmap:

- **Renewable Energy Integration:** Installation of on-site solar PVs to address the significant Scope 2 emissions identified in the GHG inventory.
- **Circular Waste Management:** Utilizing wood offcuts and sawdust for on-site thermal energy production, thereby reducing both waste management costs and Scope 1 natural gas reliance.
- **Sustainable Sourcing:** Increasing the ratio of FSC/PEFC certified wood to enhance the biogenic carbon claims and improve the enterprise's "Sustainability Score" within the platform.

The pilot implementation confirms that the combination of semantic modeling (Ontologies) and AI techniques provides the necessary balance between scientific rigor and practical applicability for SMEs. The automated data ingestion and dual-methodology approach allow even small enterprises to gain a comprehensive understanding of their environmental impact and take strategic action toward climate neutrality.

6. RESULTS AND DISCUSSION

6.1 Carbon footprint estimation outcomes

The AICoSME pilot produced both corporate-level GHG inventories and product-level LCA results, demonstrating the platform's dual methodology capability. Following GHG Protocol logic, the pilot SME's corporate inventory amounted to **75.7 tCO_2e annually**, partitioned into Scope 1 (33.4 tCO_2e), Scope 2 (17.5 tCO_2e) and Scope 3 (24.8 tCO_2e) (Table 2).

Table 2 Corporate Carbon Footprint Analysis

Emission Category (Scope)	Emission Source	Quantity/Unit	Emissions (tCO2 e)	% of Total
Scope 1 (Direct)	Diesel &Natural Gas	5,000 L/10,000 m^3	33.4	44.1%
Scope 2 (Indirect - Energy)	Grid Electricity	50,000 kWh	17.5	23.1%
Scope 3 (Value Chain)	Raw Materials (Timber/Chemicals)	200 m^3/100 L	24.8	32.8%
Total			**75.7**	100%

Parallel cradle-to-gate LCA calculations for representative products revealed substantial biogenic carbon effects: the wooden table and chair exhibited net negative footprints (−27.89 kg CO_2e and −11.16 kg CO_2e respectively), reflecting carbon storage in wood materials and the influence of material choice on product footprints (Table 3). These outcomes show that AICoSME can produce coherent, comparable results across methodological perspectives using the same underlying dataset.

Table 3 : Product Life Cycle Assessment and Biogenic Carbon Impact

Product	Production Emissions ($kgCO_2e$)	Carbon Sequestration ($kgCO_2e$)	Net Carbon Footprint ($kgCO_2e$)
Wooden Table	+17.11	-45.00	**-27.89**
Wooden Chair	+6.84	-18.00	**-11.16**

6.2 Advantages over traditional methods

AICoSME brings several practical and technical benefits over standard methods. Its knowledge graph keeps data consistent, so the same main inputs work for both greenhouse gas and life cycle assessments without extra data entry. The AI tools spot errors and fill in missing data, saving time and making the information more complete. The system's tiered calculations allow for step-by-step improvements. For example, in a pilot, **Scope-3 uncertainty dropped by 40%** when the system moved from Tier 1 to Tier 3 data by adding the Multi-Agent System and metering. The platform also provides useful suggestions, such as how to schedule kilns, swap materials, or use energy more efficiently on-site, rather than just showing totals. This helps turn measurement into action. Together, these features make the system more reliable, reduce user workload, and help people make better decisions.

6.3 Strategic recommendations impact

The platform's reasoning engine converted analytical outputs into a prioritized mitigation roadmap tailored to the SME's operations. For the wood-furniture pilot, recommended actions included shifting high-consumption processes to periods with higher grid renewable share, substituting adhesives with lower-impact alternatives, installing on-site solar PV and valorising process residues for thermal energy. Scenario analysis within AICoSME allows SMEs to compare the relative effectiveness of interventions before investment. In the pilot, these recommendations provided clear operational levers (energy scheduling, material choice, circular waste reuse) that address the largest emission drivers identified by the AI and LCA modules. While exact percentage reductions depend on site-specific implementation, the platform's scenario module supports evidence-based prioritisation and business case development for mitigation measures.

7. CONCLUSION AND FUTURE WORK

AICoSME advances SME carbon management by integrating semantic data modelling and modular sectoral methodologies into a single platform. The pilot demonstrates three central contributions:

1. The ability to produce consistent corporate (GHG Protocol) and product (LCA) footprints from a shared knowledge base.
2. Reduced uncertainty and data burden through automated data ingestion, anomaly detection and tiered calculation logic.
3. Transformation of accounting outputs into targeted, operational recommendations that support mitigation planning and strategic decision making. Pilot outcomes — including a total corporate footprint of 75.7 tCO_2e and product LCAs showing net biogenic sinks — illustrate both the technical viability and the practical value of the approach.

For SMEs and policymakers, AICoSME's principal implication is the feasibility of democratizing robust carbon accounting: smaller firms can attain credible, standards-aligned footprints and prioritise cost effective mitigation without prohibitive technical overhead. This capability supports compliance readiness and strengthens SMEs' participation in decarbonisation efforts.

Future work will focus on:

a) Expanding sectoral modules and official methodology mappings.
b) Integrating external LCI databases and third-party verification workflows.
c) Enhancing user facing explainability and training materials.
d) Conducting longitudinal field trials to quantify realized emission reductions after implementation of recommended measures.

These developments will further improve accuracy, interoperability with national reporting systems, and the platform's ability to drive measured climate action in the SME sector.

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SOCIETAL PERCEPTION OF CARBON CAPTURE, TRANSPORT AND STORAGE: OPPORTUNITIES AND RISKS, INSIGHTS FROM FOCUS GROUP MEETINGS

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Abstract
Carbon Capture, Transport, and Storage (CCS) is a key technology for mitigating climate change. To accelerate the implementation of CCS projects, it is important to integrate technical, economic, societal, and environmental disciplines to support the decision-making process related to permitting and ensure containment and conformance of CO2 during geological storage.

This is the scope of the RamonCO "Risk-based framework for assessing CO2 storage monitoring" project, supported by the Clean Energy Transition (CET) Partnership initiative (https://cetpartnership.eu/calls/funded-project/ramonco). It involves thirteen organisations from six countries: Norway, Germany, Greece, Romania, the Netherlands, and USA.

As part of RamonCO project, focus group meetings were held with key stakeholders in all participating countries to assess the societal perception of CCS. This study presents the results of the two Greek focus group meetings. The meetings, entitled "Social Acceptance of Carbon Capture, Transport, and Storage: Opportunities and Risks," were held in Athens in May 2025, bringing together key stakeholders from the academic and research community, environmental Non-Governmental Organisations (NGOs), industry, municipalities, and the marine sector.

During the meetings, participants identified and evaluated opportunities and risks associated with social acceptance of CCS. Findings indicate that stakeholders prioritize opportunities including economic development, job creation, energy transition, and advancements in know-how and CCS technology. Conversely, the primary risks identified were public concerns over environmental pollution, an unclear regulatory framework, and the credibility of control mechanisms. Our analysis of the results highlighted challenges and questions for societally embedding CCS in Greece, as well as implications for risk governance strategies.

Key words: CCS; social acceptance; opportunities; risks; stakeholders; risk governance.

1. INTRODUCTION

Carbon Capture, Transport, and Storage (CCS) is a key technology for mitigating climate change and achieving climate neutrality, namely zero net CO2 addition to the environment by the year 2050. To accelerate the implementation of CCS projects, it is important to integrate technical, economic, societal, and environmental disciplines to support the decision-making process related to permitting and ensure containment and conformance of CO2 during geological storage.

This is the scope of the RamonCO "Risk-based framework for assessing CO2 storage monitoring" project (Nottveit et al., 2024), supported by the Clean Energy Transition (CET) Partnership initiative (https://cetpartnership.eu/calls/funded-project/ramonco). It involves thirteen organisations from six countries: NORCE (coordinator), Reach Subsea and Equinor from Norway, UFZ from Germany, CO2CLUB and GEOECOMAR from Romania, CRES from Greece, EBN BV, TNO, Neptune, Risktec, ENI and HARBOUR ENERGY from The

Netherlands, and LLNL Lawrence Livermore National Laboratory and UCSD University of California from USA.

The main objectives of RamonCO are to develop (i) an integrated set of geophysical methods for imaging and monitoring CO2 geological storage fields, (ii) risk governance strategies for societal embeddedness of CCS, and (iii) a multi-dimensional decision support framework.

Towards the development of societal risk governance strategies an interdisciplinary and transdisciplinary research approach is adopted, which involves identification, conceptualisation, assessment and evaluation of risks hindering the social embeddedness of CCS, and formulation of mitigating measures and risk reducing strategies (Sprenkeling et al., 2024).

The research is informed by the results of the Digimon project "Digital Monitoring of CO2 Storage Projects", which interpreted insights from semi-structured interviews, surveys, and stakeholder workshops across Norway, Greece, Germany and The Netherlands with an inter- and trans- disciplinary methodology, in order to develop a societally embedded CO2 storage monitoring system (Otto et al., 2024).

As part of RamonCO project and towards developing risk governance strategies for societal embeddedness of CCS, informed public opinion surveys were organised in Norway, The Netherlands, Germany, Romania and Greece to define attitudes and risk perceptions towards all CCS phases, namely capture, transport, storage and monitoring (Bentsen et al., 2025).

In addition, focus group meetings with key stakeholders here held in each country to examine opportunities and concerns towards societal embeddedness across the entire value chain of CCS. This study presents the results of the two focus group meetings, held in Athens, Greece in May 2025.

2. METHODOLOGY

On May 12th and May 27th, 2025, we conducted two focus group meetings entitled "Social Acceptance of CO2 Capture, Transport, and Storage: Opportunities and Risks", each lasting one working day. Both meetings represent an important research initiative aimed at understanding the social dimensions of carbon capture and storage technology from the perspective of stakeholders and interested parties.

The meetings operated under strict data protection protocols, ensuring that all participant information is used exclusively for scientific research purposes, with participants retaining the right to request deletion of their personal data at any time.

Focus groups participants came from local Authorities, environmentally oriented non-governmental organizations (CO2 Storage), the marine sector (CO2 Transport), industry (CO2 Capture) and the academic and research fields. Specifically, the focus groups were attended by professionals from the MUNICIPALITY OF KAVALA, the independent assurance and compliance services to maritime company LLOYD'S REGISTER, the MOTOR OIL refinery, the TITAN cement industry, the non-governmental organization ECOCITY, the higher education institution NTUA (National Technical University of Athens) and the research centre CRES (Centre for Renewable Energy Sources and Energy Saving).

The primary objectives of the focus groups were to document valuable stakeholder perspectives on CCS in Greece, investigate the social risks associated with CCS deployment, and explore the opportunities that could enhance social acceptance of the technology. More

important, the meetings recognize that there are no "correct" or "incorrect" answers, as all perspectives are equally valid contributions to understanding this complex issue.

The analytical framework guiding the focus group meetings examines social acceptance across four interconnected dimensions. The environmental dimension considers the direct environmental impacts of CCS, as well as strategies for controlling, preventing, and reducing these impacts, spatial planning considerations, and broader social consequences. The public and stakeholders dimension explores how different groups perceive and respond to CCS, including their arguments, opinions, interests, and concerns about the technology. The policy and institutional dimension examines the regulatory environment, industry objectives, and the clarity of roles and responsibilities. Finally, the market and financial resources dimension analyses the economic benefits and risks, available funding mechanisms, and the viability of different business models. (Mendrinos et al., 2022)

The focus groups were planned by the Greek team in collaboration with researchers from the RamonCO WP2 work package and implemented in (more or less) the same format with the cases in the other countries. The Greek focus groups were conducted in person. Participants were invited from a broad spectrum of interest groups, including industry representatives, NGOs, academia, and public authorities, providing comprehensive insights from various perspectives.

The focus groups were facilitated by a moderator from the Greek research team, supported by five additional team members. The first part of the focus group began with a brief introduction to the RamonCO project, followed by an explanation of the focus group's objectives. Participants were informed that the goal of the session was to identify societal opportunities and risks along the entire CCS value chain from capture to storage and monitoring, followed by a ranking and evaluation of these risks.

Each meeting was structured throughout a full day, beginning with participant introduction and moving into a collaborative process of identifying and analysing risks and opportunities. Participants were guided to think critically about how CCS technology might affect various aspects of society across four CCS stages: CO2 capture, transport, storage, and monitoring.

Through a structured three-phase methodology, participants firstly individually identified risks and opportunities across each CCS stage, considering how they might impact both their own work and society more broadly (early morning).

Secondly, after participants identified risks and opportunities, the CRES research team synthesized these responses and presented them for collective discussion (late morning). In parallel, other members of CRES team presented findings from the ongoing CCS research projects MOF4AIR (https://www.mof4air.eu/), SHEETS (https://axel-one.com/les-projets/sheets/), and HERCCULES (https://www.herccules.eu/home-page-en).

Thirdly, these presentations, combined with the preliminary synthesis of risks and opportunities identified by participants, provided context for subsequent discussions in the afternoon and helped frame the more detailed analysis task on evaluating opportunities and risks. Then, participants prioritized the most significant risks and opportunities, engaging in deeper conversations about what would actually happen if these risks materialized or opportunities emerged, why they matter, and how they would respond.

On screen excel file presentation was used both as a tool for collaboration and for visualizing the opportunities and risks and their rankings. This provided a structured and transparent way to work, specifically suited for in-person meetings, while encouraging interactive participation. We found the format to be engaging and effective in summarizing and evaluating the identified opportunities and risks, which was the primary goal of these

focus groups. From the participants' perspective, it was evident that they possessed substantial knowledge on the subject, and that they were very much interested and had the desire to dedicate one full day to the discussions. We took the opportunity to inform participating stakeholders that future stakeholder engagement activities may arise later in the project.

3. LIMITATIONS

This study focused specifically on the Greek context, with stakeholder perspectives shaped by national regulatory environments, environmental sensitivities, and economic conditions. While many findings likely have broader applicability, caution should be exercised in generalizing conclusions to substantially different contexts.

The focus group methodology, while providing rich qualitative insights, captures perspectives at a specific moment in time. As CCS technology matures, regulatory frameworks develop, and implementation experiences accumulate, stakeholder perceptions may evolve. Longitudinal studies tracking changing attitudes over time would provide valuable complementary insights.

4. RESULTS

Top-Ranked Opportunities

Participants identified as most important opportunities towards improving societal embeddedness of CCS the (1) job creation, (2) development of know-how and technology in CO2 capture, (3) strengthening energy transition and (4) increase in economic activity.

Job Creation

Stakeholders perceive job creation through CCS as a comprehensive opportunity extending far beyond immediate employment. They emphasize that CCS generates immediate job opportunities for local communities, particularly benefiting areas remote from urban centres where such projects are typically implemented. The technology creates positions across multiple phases, namely in construction, engineering design, operational maintenance, and ongoing support activities. There is strong recognition that each direct job has a multiplier effect by creating several ancillary positions. For every construction activity or technical role, additional support positions emerge to serve worker needs including food services, accommodation, and local infrastructure. This multiplier effect generates significant economic activity both directly for those employed and indirectly through increased local turnover. Stakeholders highlight the need for highly skilled personnel who understand and can effectively communicate CCS technology, creating the need for development of specialized workforce. These specialized positions, accompanied by high financial rewards, create incentives for professional development and career advancement in emerging technology sectors. Job creation spans a broad spectrum including construction workers, engineers, designers, support staff, decision-makers, and customer communication specialists. This sectoral diversity ensures opportunities across skill levels and professional backgrounds.

The innovative nature of CCS technology presents opportunities to reverse brain drain, potentially attracting Greeks working abroad to return. This contributes to both local economic development and national decentralization efforts. Implementation in remote areas can transform regional economic prospects, creating positive multi-level impacts on society. The projects bring economic activity to communities that may have limited alternative opportunities. CCS deployment creates pressure and incentives for educational institutions to

develop appropriate training programs. While relevant specialized education currently exists primarily abroad, domestic job creation could stimulate local educational capacity building. The presence of innovative technology projects can also enhance regional and national image. Opportunities to host conferences and events in project areas provide additional promotional benefits, positively impacting tourism alongside direct employment. Companies currently engaged in extraction of hydrocarbons may transition to CCS technology as extraction activities conclude, preserving employment and leveraging existing expertise in new applications.

For organizations and individuals in related sectors, CCS represents significant opportunity for professional development. Young professionals and those dealing with similar technical or environmental issues view this as a career advancement pathway. Expanding organizations anticipate challenges integrating highly skilled new personnel and managing internal communication with specialized teams, which are viewed as positive growth challenges. Organizations recognize economic benefits for hiring young employees and potential direct and indirect participation opportunities in CCS projects. Stakeholders express intention to actively participate throughout the CCS implementation process, drawing parallels to major economic events such as the Olympic Games in terms of comprehensive community involvement.

Participants indicate strongly positive reactions to job creation opportunities by expressing their intension to actively pursue participation in CCS processes, to attempt to secure both direct employment and indirect economic benefits, recognising CCS as an opportunity relevant to the entire local community and appreciating the positive publicity, which job creation brings to CCS technology.

Development of Know-How and Technology in CO2 Capture

Stakeholders perceive that the development of technology can contribute to social acceptance, as it responds to people's concerns about environmental issues and safety, offering solutions that protect society. When the indicators related to CO2 capture are optimized through the development of technology, social acceptance will be achieved by maximizing the commitment and its positive impacts for the environment, people, living conditions, etc. The development of technology requires development of a regulatory framework and the establishment of rules that will support its normal application. There is pressure to develop the technology quickly, evaluating also costs, as the achieved now-how will form the basis for stakeholders to become more receptive to CCS, promoting and making CO2 capture acceptable.

Know-how development provides added value through workforce training and attracting new investments.

Stakeholders report positive impact from this opportunity on their organizations. There are several people in their service with advanced qualifications who are involved and willing to deal with new technology issues. Technology development leads to more data, better information and increased options. For some stakeholders, technology development contributes to achievement of their professional and personal goals.

Strengthening Energy Transition

The energy transition is considered an important and necessary change for participating stakeholders' companies, aiming to adapt to new frameworks and protect the environment. CCS technology is linked to the energy transition by assisting reduction of environmental impacts and improving the environmental footprint. As CCS captures CO2, it supports the

energy transition. It creates trust in society and consumers, as a technology with a positive environmental impact.

The energy transition also includes energy security. As there will be penalties for non-compliance, many companies are affected. In that context, CCS technology is expected to help the growth of the shipping sector.

Increasing Economic Activity

Stakeholders recognize both direct and indirect economic benefits in the preparation, configuration, construction and operation phases of CCS. Examples include procurement and new business activities, and local economic growth including personnel and supplies.

Economic activity increases because know-how is transferred, creating the need for new supporting businesses, driving development at local and national level and leading to more accessible and acceptable technology for local communities.

Organizations report positive impact due to the growth created. Participants express their willingness to be engaged with the specific subject due to the development of technology, and the arising of new professional prospects in which they could be employed.

Participating stakeholders express positive reaction and effort to contribute to the implementation of the technology, to be active in all phases of CCS projects, identifying the need and effort to provide relevant services, indicating attempt to deal with issues of design, construction, and maintenance.

Top-Ranked Risks

The focus groups identified significant risks across the CCS value chain, with four concerns ranking as highest priority:

Unclear Regulatory/Legislative Framework

Unclear Regulatory/Legislative Framework emerged as the most prominent risk for both capture and transport phases. Stakeholders perceive this as creating insecurity comparable to "a game without rules," causing problems in procedure implementation, licensing delays, and potential loss of funds.

Stakeholder consultations revealed a pervasive concern regarding the absence of clear guidelines and standards governing CCS technology. This regulatory gap manifested across multiple dimensions of project development and implementation. Environmental permitting processes proved particularly problematic, as regulatory authorities lacked clear standards and conditions to reference when issuing permits. Engineers and project developers reported fundamental uncertainties about design specifications and implementation protocols, noting the absence of regulatory frameworks to guide technical decision-making.

The monitoring phase presented especially acute challenges. Critical operational parameters remained undefined, including the definition of CO2 leakage events and threshold levels triggering regulatory intervention. Stakeholders expressed concern that the state had proceeded with technology implementation without first establishing the regulatory boundaries necessary to govern operations effectively. This sequencing problem - implementing before regulating - represented a fundamental reversal of prudent governance practice.

The lack of defined monitoring standards raised significant questions about accountability and transparency. Citizens identified substantial uncertainty regarding what aspects of CCS operations would be monitored and which entities would bear monitoring responsibilities. Stakeholders emphasized that public trust would be enhanced if monitoring

fell under state oversight rather than private company control, with results made transparently available to the public.

In the shipping sector, regulatory ambiguity was particularly pronounced. Critical specifications remained undefined, including the precise nature of transported and stored materials. These unanswered questions generated substantial concern among citizens observing CCS development initiatives.

The regulatory vacuum created significant operational challenges for organizations implementing CCS technology. Without established standards, technology deployment became an exercise in interpretation rather than compliance. Companies struggled to understand requirements for project financing and basic operational execution. The absence of clear protocols in the shipping sector prevented the establishment of standardized procedures for CO2 transfer to vessels.

Project timelines suffered as teams found themselves unable to determine concrete requirements and deliverables. Substantial time and resources were diverted to unproductive activities, including interpreting ambiguous legal frameworks and seeking clarifications that should have been provided within initial regulatory guidance.

Regulatory ambiguity fundamentally undermined stakeholder confidence in CCS projects. Without standards of comparison or established roadmaps, doubt and suspicion emerged as natural responses to uncertainty. The situation was compounded by reported understaffing in relevant public regulatory bodies, further limiting capacity for effective oversight and guidance.

When individual companies determined their own implementation approaches rather than following state-established frameworks, citizens questioned whether projects would be executed appropriately. This lack of standardization raised concerns about consistency, safety, and environmental protection across different CCS initiatives.

The regulatory vacuum significantly impaired both internal organizational communication and external public engagement. Without clarity regarding necessary actions and requirements, organizations found it nearly impossible to properly inform the public about project activities and implications. This communication deficit was particularly problematic given that public trust and acceptance are essential prerequisites for successful CCS deployment.

Stakeholders emphasized that perpetuating regulatory ambiguity itself constituted a significant risk. Numerous fundamental questions required institutional frameworks to provide authoritative answers, including basic operational clarity regarding roles, responsibilities, and procedures.

Faced with persistent regulatory uncertainty, stakeholders outlined several pragmatic response approaches. Civil society organizations indicated they would convene all involved parties for structured discussions to address regulatory gaps and implementation challenges. The scientific community committed to informing local communities about CCS technology realities and requirements, enhancing public understanding.

Collaborative problem-solving emerged as a central theme in stakeholder responses. Working groups, expert consultations, and participation in European projects were identified as vehicles for addressing regulatory challenges. Significantly, stakeholders emphasized the importance of examining international experiences, seeking guidance from countries that had already developed CCS regulatory frameworks. This comparative approach offered potential pathways for developing appropriate domestic regulatory structures.

The regulatory vacuum surrounding CCS implementation in Greece represented a fundamental governance challenge with far-reaching implications for technology deployment,

stakeholder confidence, and public acceptance. The documented concerns underscore the critical importance of establishing clear regulatory frameworks prior to technology implementation rather than developing regulations reactively.

Effective CCS deployment requires comprehensive regulatory frameworks that define technical standards, monitoring protocols, oversight responsibilities, and accountability mechanisms. Without such frameworks, uncertainty persists, resources are inefficiently deployed, and public trust remains elusive. The experiences documented here highlight the necessity of proactive, transparent, and comprehensive regulatory development as a prerequisite for successful CCS technology implementation.

Environmental Impacts

Focus group discussions revealed multifaceted concerns regarding the environmental impacts of Carbon Capture and Storage (CCS) technology, spanning both specific threats to groundwater resources and broader ecosystem considerations. Stakeholder perspectives reflected tension between acknowledged environmental risks and the potential benefits of CCS deployment, complicated by public uncertainty about this emerging technology.

Participants identified groundwater pollution as a serious concern in the event of CO2 leakage from storage sites. Specific threats included potential acidification of aquifers through pH reduction, release of pollutants into groundwater when storage occurs in depleted oil reservoirs, and possible contamination from heavy hydrocarbons. Stakeholders noted that risks could manifest either through actual leakage events or through public fear of potential leaks stemming from inadequate understanding of the technology. The disruption of natural aquifer equilibrium represented an additional concern requiring careful consideration. These groundwater risks proved particularly challenging given what participants characterized as insufficiently developed risk management technology, coupled with the inherent difficulty of addressing subsurface environmental contamination, including potential oil residue contamination and water quality degradation.

Beyond groundwater concerns, stakeholders recognized that environmental impacts could occur across all stages of CCS technology implementation. Secondary waste generation, accidental spills posing risks to biodiversity, and impacts throughout the entire technology life cycle required comprehensive assessment. Participants acknowledged that all technological interventions produce some environmental effects, emphasizing the necessity of conducting thorough life cycle assessments to understand the full environmental footprint of CCS projects. Several stakeholders contextualized these concerns by noting that inaction on climate change also poses environmental risks, arguing that the comparative benefits of CCS deployment need careful evaluation alongside potential negative impacts.

The lack of clarity regarding environmental outcomes emerged as a significant issue. Participants expressed concern that public ignorance about CCS technology fuelled anxiety and opposition, with fear of the unknown driving negative perceptions. Stakeholders emphasized what they characterized as an imbalanced focus on negative environmental consequences, while positive effects of CO2 sequestration received insufficient attention. This perspective held that the public needed better information about technology's beneficial environmental effects to counter unwarranted fears. The challenge, as articulated by participants, involved minimizing negative consequences while maximizing positive environmental impacts from CCS application, though the absence of an established control and maintenance framework for projects complicated these objectives.

For organizations involved in CCS development, environmental concerns manifested in multiple operational dimensions. Long-term installation safety posed particular worry, with

potential corrosion over extended operational periods creating leakage risks that required ongoing attention. The need to shape and, when necessary, modify public perception emerged as a significant organizational concern. Participants stressed the importance of contextualizing negative consequences appropriately while highlighting positive environmental effects in public communication. Negative public perception was identified as directly influencing decision-maker attitudes, creating obstacles for organizations pursuing environmentally beneficial solutions. From technical perspectives, organizations emphasized the necessity of identifying negative consequences early, studying appropriate remediation approaches, and planning prevention strategies to avoid recurrence.

Stakeholder response strategies to environmental impact concerns centred on three interconnected approaches: proactive assessment and planning, strategic communication and education, and collaborative problem-solving. Participants advocated for conducting comprehensive simulations before project implementation and creating detailed protocols to address adverse environmental impacts. The goal involved reducing negative consequences, while increasing positive impacts to optimize overall environmental performance. Several stakeholders emphasized participation in consultation processes, though some noted that past consultations had not proven particularly effective, suggesting room for improvement in stakeholder engagement mechanisms.

Communication strategies featured prominently in proposed responses. Stakeholders recommended identifying influential individuals capable of positively shaping public opinion, informing these opinion leaders first, and leveraging their influence to disseminate knowledge to broader populations. Organizations indicated they would attempt to reframe public understanding through scientifically documented information, aiming to calm reactions that could be mitigated through better knowledge. The importance of accessible information in building credibility was repeatedly emphasized, with participants proposing various educational initiatives including information days featuring qualified scientists and organized site visits to CO2 capture and liquefaction facilities to combat fear of the unknown.

Collaborative approaches included creating initiatives for expert discussions aimed at studying potential problems and dissemination strategies, with findings directed toward decision-makers to inform policy development. Stakeholders recognized that addressing environmental impacts required collective effort across scientific, technical, regulatory, and public engagement domains. The establishment of comprehensive frameworks for project control and maintenance emerged as a foundational requirement for managing environmental risks effectively throughout the CCS technology life cycle.

The environmental impact concerns articulated by stakeholders reflect the complex challenge of deploying CCS technology in contexts where public understanding remains limited, regulatory frameworks are underdeveloped, and long-term environmental consequences remain incompletely characterized. Successfully navigating these concerns requires integrated approaches combining rigorous technical assessment, transparent communication, meaningful stakeholder engagement, and adaptive management strategies responsive to emerging evidence about environmental effects.

Distrust of Control Mechanisms

Focus group participants identified distrust of control mechanisms as a significant challenge for Carbon Capture and Storage (CCS) project implementation, though perspectives varied regarding the nature and severity of this risk. The discussions revealed complex relationships between communication practices, institutional credibility, and public confidence in oversight systems.

Participants characterized distrust as fundamentally rooted in communication failures that eroded public confidence in oversight processes. The purpose of control mechanisms, as articulated by stakeholders, is to mitigate potential distrust of companies implementing CCS projects by providing independent verification and accountability. When these mechanisms themselves become objects of suspicion, a lack of trust in audit outcomes emerges, undermining the legitimacy of the entire oversight framework. However, perspectives on the significance of this risk varied among participants. One stakeholder did not consider distrust of control mechanisms to be particularly significant, while another argued that the primary problem was not distrust of existing mechanisms, but rather the absence of adequate control mechanisms altogether. This distinction proved important, suggesting that concerns about oversight encompassed both the perceived inadequacy of existing systems and scepticisms about their effectiveness.

The consequences of distrust in control mechanisms manifested at multiple levels of CCS project development and implementation. Stakeholders emphasized that such distrust fundamentally undermined the credibility of CCS initiatives and created substantial obstacles to project execution. When public confidence in oversight is absent, the belief emerges that projects will not be implemented correctly or that problems, should they arise, will not be adequately addressed. This erosion of confidence created cascading difficulties for organizations attempting to advance CCS technology deployment.

For organizations involved in CCS projects, distrust of control mechanisms produced both opportunities and challenges. Some stakeholders noted that the existence of public distrust could catalyse civil society action, potentially serving as a mechanism for increased accountability and engagement. From this perspective, scepticisms functioned as a form of public vigilance that, while complicating implementation, could ultimately strengthen project oversight. Others emphasized that proper actions should be standard practice regardless of external control mechanisms, suggesting that robust internal governance should not depend on external monitoring to ensure appropriate conduct.

The practical impacts on organizational operations proved substantial. Distrust necessitated heightened transparency in project implementation processes, requiring organizations to document and communicate their activities more extensively than might otherwise be necessary. This increased transparency demand, while potentially beneficial for accountability, created operational challenges. Project implementation became more difficult as organizations faced inefficiencies and delays stemming from the constant requirement to demonstrate that actions were being taken correctly. The burden of proof shifted, with organizations needing to continuously validate their practices to sceptical audiences rather than operating under presumptions of good faith compliance.

Response strategies proposed by stakeholders centred on enhanced communication, institutional engagement, and transparent demonstration of compliance. Organizations indicated they would pursue dialogue with relevant authorities to address concerns and establish clearer oversight parameters. Increased communication emerged as a primary response mechanism, with stakeholders emphasizing the need to convince citizens to overcome scepticisms through concrete actions rather than merely rhetorical assurances. This approach involved communicating specific procedural steps that had been followed and sharing collected data to demonstrate compliance and effectiveness.

Stakeholders proposed proactive engagement with relevant regulatory bodies, including transparent communication about invitation processes and collaborative discussions. The goal involved creating mechanisms that demonstrably showed work was being conducted correctly, moving beyond assertions to provide tangible evidence of appropriate implementation.

Participants emphasized the importance of presenting scientific evidence in accessible formats, recognizing that effective communication required both technical rigor and comprehensibility for non-specialist audiences. The challenge involved proving project integrity through scientifically sound approaches while simultaneously simplifying presentations to ensure public understanding.

The distrust of control mechanisms identified by focus group participants reflects broader challenges in establishing legitimate governance structures for emerging technologies. When oversight systems lack credibility, whether due to perceived inadequacy, poor communication, or insufficient transparency, the resulting distrust creates operational obstacles and undermines public confidence essential for technology acceptance. Addressing this challenge requires integrated approaches combining robust control mechanisms, transparent communication about oversight processes, meaningful stakeholder engagement, and demonstrated commitment to accountability. The tension between the need for rigorous oversight and the operational burdens such oversight can create, highlights the importance of designing control mechanisms that are both effective and efficient, building public confidence without creating unsustainable compliance demands on implementing organizations.

5. ANALYSIS

Challenges and questions

The focus group discussions revealed a complex landscape of interconnected challenges spanning regulatory, technical, social, and economic dimensions. These challenges manifest as critical questions that must be addressed for successful CCS implementation in Greece.

Regulatory and Governance Uncertainties

The absence of a comprehensive regulatory framework emerged as a fundamental obstacle, with stakeholders characterizing the current situation as operating within undefined parameters. This regulatory vacuum raises critical questions about the establishment of standards and monitoring protocols prior to technology deployment. The ambiguity extends to the distribution of responsibilities across governmental levels and private sector entities, creating uncertainty about accountability structures. A particularly contentious issue concerns whether monitoring functions should be state-controlled or privately operated, with significant implications for public trust and credibility.

The regulatory gaps identified in the capture and transport phases create implementation insecurity, potentially leading to licensing delays and unclear delineation of institutional roles. Without established frameworks, stakeholders struggle to navigate approval processes, risking project delays and financial losses.

Environmental and Technical Concerns

Environmental impacts constitute a significant area of stakeholder concern across all CCS phases. Participants expressed apprehension about secondary waste generation, biodiversity threats, and broader life cycle implications of the technology. The novelty of CCS technology amplifies these concerns, as stakeholders grapple with uncertainties about long-term environmental consequences.

Groundwater pollution emerged as a specific high-priority risk, with stakeholders highlighting potential water acidification, pollutant release, and disruption of aquifer equilibrium. The perception that risk management protocols remain insufficiently developed compounds these concerns. Technical questions arise regarding the standardization of CO2

purity specifications across different phases, the adequacy of monitoring point distribution, and the prediction and prevention of chemical reactions between injected CO2 and geological reservoir components.

The question of appropriate Technology Readiness Levels and Operational Readiness Levels for large-scale implementation remains unresolved, reflecting stakeholder uncertainty about whether current technological maturity justifies widespread deployment.

Communication and Public Trust Deficits

A significant challenge lies in bridging the gap between technical complexity and public understanding. Stakeholders identified the difficulty of communicating scientific information to citizens in accessible formats without sacrificing accuracy. This communication challenge is compounded by the proliferation of superficial or misleading information from unreliable sources, which can shape public perception more effectively than scientific evidence.

The monitoring phase faces particular credibility challenges, with stakeholders expressing distrust toward control mechanisms. This distrust stems from concerns about inadequate communication, lack of independent oversight, and questions about the integrity of monitoring processes. The challenge of identifying and engaging influential community members who could facilitate positive public opinion formation, adds another layer of complexity to stakeholder engagement strategies.

Furthermore, stakeholders noted insufficient public awareness about the magnitude of climate change, which affects the perceived urgency and necessity of CCS technology.

Social Acceptance and Community Relations

The implementation of CCS infrastructure faces potential resistance from local communities, including NIMBY (not in my backyard) opposition. Stakeholders identified the challenge of balancing community demands for reciprocal benefits with project economic feasibility. The relatively new nature of the technology raises legitimate public health concerns, that must be addressed through evidence and transparent communication.

Managing rivalries between affected communities and involved parties presents an additional social challenge. The question of how tourism and property values might be affected by CCS infrastructure development, adds economic dimensions to community acceptance issues.

Economic and Infrastructure Constraints

Financial feasibility emerges as a critical concern, particularly regarding how expensive CCS solutions can be financed, when costs fall primarily on implementing companies. The absence of existing transport infrastructure poses logistical challenges for establishing effective CO2 transport networks.

CCS must also compete with alternative decarbonization technologies, including green fuel production and hydrogen infrastructure. This competitive landscape raises questions about optimal resource allocation and technological prioritization within broader energy transition strategies.

Implications for risk governance strategies

The challenges identified through stakeholder engagement point toward specific governance strategies necessary for successful CCS implementation. These implications span institutional, procedural, and communicative dimensions of risk governance.

Regulatory Framework Development as Foundation

The establishment of a comprehensive regulatory framework must precede large-scale implementation to provide legal clarity and institutional stability. This framework should define measurable standards and limits for all CCS phases, establish clear jurisdictional boundaries, and delineate responsibilities across state entities, local governments, and private operators. Regulatory development should include realistic licensing timelines, to prevent project delays while maintaining rigorous safety standards.

The framework must also establish institutional mechanisms for managing potential impacts, including threshold definitions for intervention and protocols for addressing adverse outcomes. This proactive regulatory approach can transform the current "game without rules" into a structured, predictable environment that facilitates investment while protecting public interests.

Independent Monitoring and Transparency Mechanisms

To address credibility concerns, risk governance strategies must prioritize independent monitoring systems separated from private operator control. State-led or independently managed monitoring bodies can enhance public trust by providing unbiased oversight. These systems should incorporate transparent reporting mechanisms that make monitoring data accessible to citizens in interpretable formats.

Monitoring protocols must be sufficiently comprehensive, with adequate spatial distribution of measurement points across storage areas. Pre-implementation simulations can help identify potential failure modes and inform monitoring network design. The development of emergency response procedures for potential leaks and environmental incidents represents a critical component of protective monitoring strategies.

Proactive Communication and Stakeholder Engagement

Risk governance must incorporate robust communication strategies that engage qualified scientists in public information campaigns. These strategies should utilize multiple channels, including information days, facility site visits, and accessible digital platforms. Scientific documentation should be translated into simple, understandable formats without compromising accuracy.

Early identification and engagement of influential opinion leaders can facilitate knowledge dissemination through trusted community networks. Communication strategies must be proactive rather than reactive, addressing concerns about unknown risks before they solidify into opposition. Stakeholder engagement should begin at early project stages, incorporating local community input into planning processes and creating mechanisms for ongoing dialogue.

The development of frameworks for reciprocal benefits to local communities can help align project implementation with community development goals, transforming potential opposition into partnership opportunities.

Comprehensive Environmental Risk Management

Life Cycle Assessments must be conducted for all CCS phases to provide evidence-based evaluation of environmental impacts. Risk management protocols should specifically address groundwater protection, given stakeholder prioritization of this concern. The objective study of both positive and negative environmental consequences demonstrates scientific rigor and builds credibility.

Long-term maintenance protocols for facility operation ensure that environmental protection extends beyond initial implementation phases. Emergency response procedures must be established before operations begin, providing clear protocols for addressing potential adverse impacts.

Strategic Economic Opportunity Framing

Risk governance strategies should leverage economic opportunities, particularly job creation, as prominent elements of project communication. The development of domestic educational programs can support specialized workforce needs, while demonstrating long-term commitment to local capacity building. Creating transition pathways for existing fossil fuel industry workers acknowledges economic transition challenges, while providing concrete solutions.

Frameworks for local business development alongside CCS projects can embed economic benefits within affected communities. Using CCS projects to enhance regional branding and attract complementary investments extends economic benefits beyond direct project impacts.

Multi-Level Governance Coordination

Successful risk governance requires alignment across national, regional, and local government levels. Spatial planning must explicitly consider CCS infrastructure needs to prevent land-use conflicts. Multi-sectoral expert working groups can integrate diverse knowledge domains into coherent governance approaches.

Participation in European and international projects provides opportunities to learn from international experiences and adopt proven practices. Long-term planning frameworks recognize that CCS infrastructure represents multi-decadal commitments requiring sustained governance attention.

Trust Building Through Demonstrated Competence

Risk governance strategies must recognize that trust emerges from demonstrated competence rather than rhetorical assurance. Verifiable scientific approaches to implementation provide tangible evidence of safety and effectiveness. Engaging civil society organizations in oversight roles incorporates diverse perspectives into governance processes while enhancing legitimacy.

Addressing distrust through increased transparency rather than defensive responses acknowledges legitimate stakeholder concerns. Proper communication, as stakeholders emphasized, is vital for trust and acceptance, making communication strategy a central rather than peripheral element of risk governance.

Integrated and Adaptive Approach

The implications point toward integrated risk governance that is coordinated across institutions, comprehensive in scope, and proactive in orientation. This approach addresses stakeholder concerns before they become implementation barriers, transforming potential opposition into informed support. The governance strategies must be adaptive, incorporating stakeholder feedback and adjusting approaches based on monitoring evidence and changing circumstances.

Successful CCS implementation in Greece requires simultaneous attention to regulatory clarity, environmental protection, economic opportunity, and public trust. Risk governance strategies that integrate these dimensions while maintaining transparency and accountability

offer the most promising pathway towards societal acceptance and effective climate action through CCS technology.

Implications for future research

Future research should examine the effectiveness of different governance strategies in building social acceptance, comparing outcomes across legal frameworks with varying regulatory approaches, communication strategies, and stakeholder engagement mechanisms. Quantitative assessment of public attitudes towards CCS, complementing the qualitative focus group findings, would provide a more comprehensive understanding of social acceptance dynamics.

Additionally, research examining the long-term outcomes of CCS projects in terms of delivered benefits and managed risks, would provide empirical evidence, either supporting or challenging stakeholder expectations documented in this study. Such evidence could inform more effective governance strategy design and stakeholder communication approaches.

6. CONCLUSIONS

This study examined societal perceptions of Carbon Capture, Transport, and Storage technology in Greece through structured focus group discussions with diverse stakeholders representing academia, industry, local authorities, and civil society. The research provides valuable insights into the complex interplay of opportunities, risks, and governance requirements necessary for successful CCS implementation within the Greek context.

The focus group discussions revealed that stakeholder perspectives on CCS are characterized by simultaneous recognition of both substantial opportunities and significant concerns. Job creation emerged as the most compelling opportunity, transcending simple employment generation to encompass broader economic transformation through multiplier effects, specialized workforce development, and potential reversal of brain drain. Stakeholders viewed CCS as a catalyst for regional development, particularly benefiting communities remote from urban centres, while creating pathways for professional advancement across diverse skill levels.

The development of technological know-how, strengthening of energy transition, and increased economic activity were identified as additional critical opportunities. These opportunities are interconnected, with technology development driving social acceptance, regulatory framework evolution, and workforce capability enhancement. Stakeholders demonstrated genuine enthusiasm for active participation in CCS deployment, drawing parallels to major economic initiatives in terms of potential community-wide impact.

However, this optimism is tempered by substantial concerns that must be addressed for successful implementation. The absence of a comprehensive regulatory framework emerged as the most fundamental obstacle, creating what stakeholders characterized as operating within a "game without rules." This regulatory vacuum generates uncertainty across all project phases, potentially undermining investment confidence and delaying implementation timelines.

Environmental concerns, particularly regarding groundwater pollution, ranked as priority risks requiring robust management protocols. The novelty of CCS technology amplifies these concerns, as stakeholders grapple with uncertainties about long-term consequences and the adequacy of current risk management capabilities. Distrust of control mechanisms, rooted in communication deficits and lack of independent oversight, presents additional challenges to social acceptance.

The research findings point toward clear governance imperatives for successful CCS deployment in Greece. Regulatory framework development must precede large-scale implementation, providing legal clarity, institutional stability, and defined accountability structures. This framework should establish measurable standards, realistic licensing timelines, and clear delineation of responsibilities across governmental levels and private operators.

Independent monitoring systems separated from operator control emerge as essential for building public trust. These systems must incorporate transparent reporting mechanisms, comprehensive spatial coverage, and pre-implementation simulations to identify potential failure modes. The integration of state-led or independently managed oversight bodies can provide the credibility necessary for social acceptance.

Proactive communication strategies engaging qualified scientists and utilizing multiple channels represent critical components of risk governance. These strategies must translate technical complexity into accessible formats without sacrificing accuracy, while addressing concerns about unknown risks before they solidify into opposition. Early identification and engagement of influential opinion leaders can facilitate knowledge dissemination through trusted community networks.

Comprehensive environmental risk management, including Life Cycle Assessments across all CCS phases and specific protocols for groundwater protection, addresses stakeholder priorities while demonstrating scientific rigor. The strategic framing of economic opportunities, particularly job creation and local business development, can transform potential opposition into partnership opportunities, when embedded within frameworks for reciprocal community benefits.

The Greek case study provides insights relevant beyond national boundaries. The challenges identified, namely regulatory uncertainty, environmental concerns, communication deficits, and social acceptance barriers, represent common themes in CCS deployment contexts globally. The governance strategies emerging from stakeholder engagement in Greece may offer transferable lessons for other legal environments navigating similar implementation challenges.

The research underscores that successful CCS implementation requires simultaneous attention to multiple dimensions: regulatory clarity, environmental protection, economic opportunity, and public trust. These dimensions are not independent but interconnected, with progress in one area facilitating advancement in others. Regulatory clarity enables environmental protection measures; economic opportunities enhance social acceptance; public trust supports political will for regulatory development.

The findings also highlight the importance of proactive rather than reactive governance approaches. Addressing stakeholder concerns before they become implementation barriers proves more effective than attempting to overcome established opposition. This requires early-stage stakeholder engagement, transparent communication about uncertainties and risks, and genuine incorporation of community input into project planning.

Carbon Capture, Transport, and Storage represents a potentially significant tool for climate change mitigation, but its successful deployment depends on achieving social acceptance alongside technical and economic feasibility. The Greek stakeholder engagement experience demonstrates that such acceptance is achievable, when governance strategies address legitimate concerns through regulatory clarity, independent oversight, transparent communication, comprehensive environmental protection and strategic economic opportunity framing.

The challenges are substantial but not impossible to overcome. Stakeholders demonstrated willingness to engage constructively with CCS technology, when provided with

credible information, opportunities for meaningful input, and confidence in governance systems. This constructive engagement, combined with coordinated, comprehensive and proactive governance approaches, offers a pathway towards societal embeddedness of CCS technology.

The success of CCS in contributing to climate neutrality goals will ultimately depend not only on technical performance, but on the ability to build and maintain social trust through demonstrated competence, transparent communication and genuine responsiveness to community concerns. The risk governance strategies identified through this research provide a foundation for such trust-building, transforming CCS from a technology imposed on communities into a collaborative effort toward shared climate objectives.

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THE CONTRIBUTION OF SMART AGRICULTURE AND SMALLHOLDERS TO SUSTAINABLE LOCAL DEVELOPMENT IN THE CONTEXT OF CLIMATE CHANGE: THE CASE OF GREECE

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Abstract
The transition towards a more sustainable model of agricultural production, constitutes a central challenge for the primary sector in Greece, particularly under the pressures of climate change. This study explores the role of smart agriculture and innovative technologies—such as the Internet of Things (IoT), automation, and artificial intelligence—in supporting smallholders. It examines the potential of these technologies to increase productivity, reduce environmental impact, and enhance resilience against climate pressures. At the same time, it analyzes the contribution of smart agriculture to sustainable local development through the strengthening of rural community economies and the support of traditional, high value-added products. The findings highlight that, despite barriers related to cost, training, and infrastructure, smallholders recognize the importance of technological innovation both for the sustainability of their farms and for the preservation of social cohesion at the local level.

Key words: smart agriculture, small-scale farmers, sustainable development, climate change, local development, Western Macedonia, traditional products, Internet of Things (IoT), artificial intelligence

THE EVOLUTION OF EUROPEAN ENVIRONMENTAL POLICY AND THE TRANSITION TO THE SUSTAINABLE DEVELOPMENT MODEL

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Abstract
The aim of the present study is to investigate European environmental and sustainable development policy as it has evolved from 1972 to the present, through Environmental Action Programmes and successive Treaties.

The currently applicable 8th Environment Action Programme (2022–2030) establishes priorities such as the reduction of emissions, the circular economy, biodiversity protection, and the achievement of zero pollution.

The fundamental principles of European law—prevention, precaution, restoration, and the "polluter pays" principle—provide the framework for environmental legislation, while the relationship between the economy and the environment is acknowledged as integral to sustainable development.

The study concludes by identifying ways in which the new economic model can be implemented across the main sectors of the market.

Key words: New development model, European environmental legislation, European policy, green economy, sustainability, sustainable production, biodiversity.

1.1 Global Environmental Problems Requiring the Adoption of a New Development Model

The loss of biodiversity, combined with climate change, currently constitutes the most serious environmental problems facing the planet (Kallia-Antoniou, 2011). Global warming and the depletion of natural resources, which are a prerequisite for all forms of life and development, represent the greatest risks that humanity is called upon to confront today (FAO, 2001; WWF, 2007). The Earth's natural systems regulate both non-renewable and renewable natural resources. The impacts of the overexploitation of natural resources are initially felt at the local level; however, the increasing interdependence of states and the expansion of international trade render their management an issue of global concern (Turner, 1993; UNEP, 2008).

The conservation of biodiversity in all its dimensions—including the diversity of ecosystems, animal and plant species, and genes—is inextricably linked to the security of human life (IUCN/UNEP/WWF, 1991). Biodiversity constitutes our natural capital and provides the ecosystem services upon which the economy depends (TEEB, 2010). Economic prosperity and human well-being rely on this natural capital and on ecosystems, which supply fundamental goods and services (Myers and Kent, 2001). The development model adopted in

the past treated ecosystem services as inexhaustible, wasting them, degrading them, or polluting them as if they were "free" goods (Kallia-Antoniou, 1995). This policy, which has not yet been fully abandoned, threatens long-term sustainability and the planet's resilience to environmental crises (WWF, 2007). The degradation and loss of biodiversity jeopardize the provision of these services and lead to the loss of species and habitats (FAO, 2001).

It should be noted that global demand for natural resources has increased dramatically in recent decades and is expected to continue rising in the future (UNEP, 2011). This trend is mainly attributable to population growth, increasing wealth, and rising consumption levels (Kallia-Antoniou, 2011). The most significant population growth is observed in developing countries, whereas the highest levels of wealth and consumption are found in developed countries (OECD, 2005).

Global consumption has significant and irreversible impacts on global ecosystems. Indicatively, approximately 130,000 square kilometres of tropical forest are deforested each year, while from 1960 to the present, one third of the world's cultivated land has been abandoned or exhausted as a result of overexploitation and soil degradation (World Resources Institute, 2011). The current rate of species loss is estimated to be between one hundred and one thousand times higher than the natural background rate, primarily as a result of human activities (WWF, 2007).

According to the Food and Agriculture Organization of the United Nations (FAO, 2001):

- 60% of the world's ecosystems are degraded or used in a manner contrary to the principles of sustainability,
- 75% of fish stocks are overexploited or depleted to the point of exhaustion,
- Since 1990, 75% of the genetic diversity of cultivated plants has been lost worldwide,
- 13 million hectares of tropical forests are deforested annually,
- 20% of the world's coral reefs have already disappeared and, unless climate change is mitigated, 95% are at risk of destruction or severe damage by 2050.

1.2 Addressing Problems at the European Level

Within the European Union (EU), despite the measures that have been adopted to address biodiversity loss, only 17% of habitats and species and 11% of ecosystems protected under EU legislation are currently in a favourable conservation status (European Commission, 2011). Legislative measures for the protection of biodiversity and species have been implemented in the EU since the late 1970s, while in 2001 a target was set to halt biodiversity loss by 2010 (Kallia-Antoniou, 2011). However, the benefits of conservation measures have been outweighed by the ongoing and intensifying pressures on biodiversity, namely land-use change, overexploitation of natural resources, the spread of invasive alien species, pollution, and climate change (UNEP, 2008).

At the same time, biodiversity is further affected by population growth, limited public information, knowledge, and awareness, as well as by the fact that the economic value of biodiversity is not adequately reflected in decision-making processes, despite the significant economic value of biodiversity and the ecosystem services it provides, which is rarely assessed (TEEB, 2010). The ecological footprint quantifies humanity's demands on the planet's ecosystems. It measures the terrestrial and marine area required to produce the resources consumed and to absorb the corresponding waste generated (European Environment Agency, 2010). In 2003, the ecological footprint of the European Union amounted to 2.26 billion global hectares, or 4.7 global hectares per capita. In contrast, the total productive area of the EU was 1.06 billion global hectares, or 2.2 global hectares per capita (European Environment Agency, 2010). "If people around the world lived like Europeans, humanity

would require more than two and a half planets like Earth to provide the resources consumed, absorb the waste produced, and still leave some 'space' for wildlife" (Kallia-Antoniou, 2011). As a result of the continuously expanding global trade, an increasing share of the environmental pressures caused by consumption in EU countries is felt outside Europe (Myers and Kent, 2001). In this sense, the European Union exports the environmental impacts of its consumption to countries where environmental policies are often inadequate, thereby placing additional burdens on local populations and their environments (OECD, 2005).

It is now widely acknowledged that identifying the most effective solutions to these problems requires a coordinated approach at both the European and international levels (UNEP, 2011). To address the current situation, the model of sustainable development is proposed, the principles of which govern each sector of human activity individually as well as their combined interactions (WCED, 1987). The concept of sustainable development has engaged Europe's scientific and political communities since the 1990s, when relevant strategies and measures were adopted (Kallia-Antoniou, 2011). Today, sustainable development is regarded as a necessary precondition for survival and is increasingly integrated into every action and policy (ICLEI, 1994).

2.1 The Concept of Sustainable Development

The concept of sustainable development is synonymous with that of sustainability, the main characteristic of which is continuity over time, with its primary objective being the assurance of quality of life across all sectors—environmental, economic, cultural, and others—for everyone, now and in the future (WCED, 1987; Kallia-Antoniou, 2011). Today, this term has transcended a strictly environmental framework. More specifically, it refers to environmental factors in combination with economic, social, cultural, and other dimensions, aiming at their harmonious coexistence both in the present and in the future, within a continuous and sustainable model (IUCN/UNEP/WWF, 1991; UNEP, 1996).

In the early 1980s, humanity began to recognize the global reality shaped by emerging ecological problems and rising unemployment in economically developed countries (Turner, 1993). On the one hand, it became evident that natural resources are not inexhaustible; on the other, nature itself is not capable of continuously offsetting the disturbances caused by economic development (WCED, 1987). Consequently, the international community turned toward a new policy approach, that of sustainable development. In 1983, the establishment of a World Commission on Environment and Development was decided, chaired by Gro Harlem Brundtland, former Prime Minister of Norway (WCED, 1987). This was followed by the publication of the Brundtland Report in 1987, *Our Common Future* (WCED, 1987). The report provided a clear and concise definition of sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). The text emphasized that prevailing conditions require the "marriage" of economics and ecology, so that governments and citizens assume responsibility not only for environmental damage, but also for the policies that lead to such damage (WCED, 1987; Kallia-Antoniou, 2011).

The Brundtland Report also stated that there is no single ideal model of sustainable development, since social, economic, and environmental conditions vary from country to country (WCED, 1987). Nevertheless, sustainable development must constitute a goal to be pursued at the global level (Kallia-Antoniou, 2011). The Rio Earth Summit in 1992 placed sustainable development at the forefront of global priorities, stating in the Rio Declaration on Environment and Development that "human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with

nature" (UN, 1992). At the same time, Agenda 21 was adopted as the first strategic plan for the implementation of a global environmental policy within the framework of sustainable development (UN, 1992).

In 1994, the Charter of European Cities and Towns Towards Sustainability, known as the Aalborg Charter, was adopted, establishing the concept of the sustainable city through the integration of the principles of sustainable development, economic efficiency, social progress, and environmental protection into urban policies (Charter of European Cities & Towns Towards Sustainability, 1994). At the same time, sustainable development was gradually adopted by states through the implementation of United Nations policies and those of its specialized agencies (FAO, UNICEF, UNDP, UNEP, WHO, World Bank), as well as by the Organisation for Economic Co-operation and Development (OECD, 2005).

For a more comprehensive presentation of the concept of sustainable development, some of the most widely accepted definitions are presented below:

- "Sustainable development: development that does not reduce productive capacity in the future" (OECD, 1990).
- "Sustainable development: improving the quality of human life while living within the carrying capacity of the ecosystems that support life on Earth" (IUCN/UNEP/WWF, 1991).
- "Sustainable development: development that respects the environment, is technologically appropriate, economically viable, socially acceptable, and meets the needs of the present generation without jeopardizing the ability of future generations to meet their own needs" (UNEP, 1996).

Sustainable development is based on three core components: the environment, the economy, and society (Kallia-Antoniou, 2011). Its objective is the fullest possible integration of the natural environment into decision-making processes and the examination of interactions between socio-economic and environmental factors involved in these processes (Zagorianakos,2002). According to IUCN (IUCN/UNEP/WWF, 1991), the objectives of sustainable development are as follows:

- improving the quality of human life,
- avoiding the depletion of non-renewable resources,
- living within the Earth's carrying capacity,
- transforming personal attitudes and practices,
- enhancing the capacity of societies to care for their own environment,
- promoting national frameworks for development and environmental protection, to be achieved through:
    - recognition of the fact that every system affects, and is affected by, larger or smaller systems,
    - linking economic policy to the environmental carrying capacity,
    - increasing the benefits derived from resource stocks,
    - promoting technologies that use resources more efficiently, and
    - ensuring appropriate valuation and pricing of resources.

Finally, sustainable development requires the creation of a global alliance, as the protection of global resources can only be achieved through cooperation and coalition-building among nations (IUNC,1991; Kallia-Antoniou, 2011; UNEP, 2008).

2.2 The Concept of Sustainable Development at the Local Level

2.2.1 Local Development

The term local development refers to the achievement of one or more positive changes in the fundamental components of the socio-economic activities of people (Coffey and Polese, 1985). Coffey and Polese note that local development concerns both a specific spatial unit and any event, activity, or process that is initiated by, or supported by, the population of that spatial unit (Coffey and Polese, 1985). The concept of local development should not be equated with the development of a specific geographical area per se, but rather with development that is based on local factors. In local development processes, the primary driving forces are local actors, including local organizations and institutions, local enterprises, local initiatives, and entrepreneurship (Blakely, 1994; Papadaskalopoulos, 1995).

Local factors include the geographical and natural characteristics of spatial units (local natural comparative advantages, natural resources, mineral wealth, etc.), as well as the socio-cultural characteristics of local production related to the development process (Gatel and Passaris, 1986). Thus, spatial units with local disadvantages may promote their development through the utilization of know-how and the enhancement of local entrepreneurial activity. Through local development, new institutions are created, alternative activities are developed, workers' skills are improved in order to produce higher-quality products and services, new markets are identified, knowledge is transferred, and new entrepreneurial activities emerge (Blakely, 1994). Local development is observed more intensively in degraded zones, disadvantaged areas, as well as during periods of crisis (Coffey and Polese, 1985).

2.2.2 Local Sustainable Development

Within this framework, sustainable development is closely linked to the process of local development (ICLEI, 1994). This view is supported by the definition of sustainable development formulated by the International Council for Local Environmental Initiatives (ICLEI), which provides a more practical interpretation of sustainable development at the local level: "Sustainable development is development that delivers basic environmental, social, and economic services to all residents of a community without threatening the viability of the natural, built, and social systems upon which the provision of these services depends" (ICLEI, 1994).

According to Agenda 21, sustainable development cannot be achieved through traditional decision-making processes (UN, 1992). An environmental strategy can only have limited effectiveness if it does not ensure the active participation of citizens, a high level of awareness, environmental consciousness, responsibility, and "alternative" patterns of behaviour, both as producers and as consumers (UNEP, 1996; Kallia-Antoniou, 2011).

In this context, Local Government, as the level of administration closest to citizens, plays a decisive role in education and in raising public awareness for the achievement of sustainability. For this reason, local authorities worldwide proceeded with the adoption of Agenda 21 and developed their own Local Agenda 21, which primarily constitutes a strategic process for the planning and implementation of appropriate actions leading toward sustainability, with the participation of all social stakeholders at the local level (ICLEI, 1994; UN, 1992).

2.3 International and European Policy for the Promotion of Sustainable Development

2.3.1 The Legal Concept of Sustainable Development

According to its legal interpretation, sustainable development constitutes a restorative and comprehensive policy, namely a unified set of public policies aimed at restoring balance both among all types of human-made systems and among the planet's ecosystems (Dekleris, 2000; Kallia-Antoniou, 1999). More specifically, through this system of restorative public policies, the following objectives are pursued (Kallia-Antoniou, 2011):
(a) the elevation of intangible spiritual and intellectual legal values over material ones;
(b) the preservation of cultural heritage;
(c) the autonomy of education;
(d) the consolidation of genuine social justice; and
(e) the prevention of further degradation of natural capital, so that it may be transferred intact to future generations (Dekleris, 2000).

The principles of sustainable development have been adopted and further elaborated in the case law of the Greek Council of State (Supreme Administrative Court) and the Court of Justice of the European Union (CJEU) (Kallia-Antoniou, 1999; Kallia-Antoniou, 2011).

2.3.1.1 Principles of Sustainable Development

Sustainable development is qualitative and controlled in nature. It is governed by a set of general principles whose ultimate purpose is to regulate the simultaneous evolution of human-made systems and natural ecosystems (Kallia-Antoniou, 2011).

1. Principle of Public Ecological Order

The principle of public ecological order establishes the mandatory nature of state control aimed at serving the general interest, not only of the present generation but also of future generations. Sustainable development is not left to market forces; rather, it constitutes a responsibility of the state (Dekleris, 2000; Kallia-Antoniou, 2011).

This principle was established by the Stockholm Declaration (1972) through the following provisions (UN, 1972):

- Principle 17: "Appropriate national institutions must be entrusted with the task of planning, managing, and controlling the environmental resources of States, with a view to enhancing their quality."
- Principle 18: "Science and technology must be applied to the identification, avoidance, and control of environmental risks and to the solution of environmental problems for the common good of mankind."

2. Principle of Sustainability

The principle of sustainability requires the harmonization of all public policies and prohibits any further reduction or degradation of natural capital. This principle is enshrined in the Stockholm Declaration (1972) (UN, 1972):

- Principle 2: "The natural resources of the Earth, including the air, water, land, flora and fauna, and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management."
- Principle 5: "The non-renewable resources of the Earth must be employed in such a way as to guard against the danger of their future exhaustion and to ensure that the benefits of such employment are shared by all mankind."

- Principle 8: "Economic and social development is essential for ensuring a favourable living and working environment for humanity and for improving the quality of life."

The principle of sustainability received its formal definition in the Rio Declaration (1992) (UN, 1992):

- Principle 3: "The right to development must be fulfilled so as to equitably meet the developmental and environmental needs of present and future generations."

3. Principle of Carrying Capacity

This principle requires respect for the carrying capacity of both human-made systems and natural ecosystems (Kallia-Antoniou, 2011).

The principle is first proclaimed in the Stockholm Declaration with reference to the productive capacity of the Earth (UN, 1972):

- Principle 3: "The capacity of the Earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved."

The same principle is reaffirmed in relation to pollution:

- Principle 6: "The discharge of toxic substances or other substances and the release of heat in such quantities or concentrations as to exceed the capacity of the environment to render them harmless must be halted in order to prevent serious or irreversible damage to ecosystems" (UN, 1972).

4. Principle of Mandatory Restoration of Disturbed Ecosystems

This principle requires the correction of environmental damage wherever still feasible, namely the restoration of disturbed ecosystems, in order to prevent the reduction of natural capital (Kallia-Antoniou, 2011; Dekleris, 2000).

5. Principle of Biodiversity

This principle demands the protection of biodiversity in order to maintain ecosystem balance. It is incorporated in Article 3 and related provisions of the Bern Convention on the Conservation of European Wildlife and Natural Habitats (Council of Europe, 1979).

6. Principle of Common Natural Heritage

The principle of common natural heritage is enshrined in Article 4 of the Paris Convention (UNESCO, 1972), where it is linked to the protection of World Cultural Heritage. The same principle is also proclaimed in the Stockholm Declaration (UN, 1972):

- Principle 4: "Man has a special responsibility to safeguard and wisely manage the heritage of wildlife and its habitat, which are now gravely imperilled by a combination of adverse factors. Nature conservation, including wildlife, must therefore receive importance in planning for economic development."

7. Principle of Gentle Development of Vulnerable Ecosystems

This principle requires mild and carefully controlled development of fragile ecosystems (Kallia-Antoniou, 2011).

8. Principle of Spatial Planning (Land-Use Planning)

The principle of spatial planning is explicitly articulated in the Stockholm Declaration (UN, 1972), which advocates integrated development through rational planning:

- Principle 13: "In order to achieve more rational management of resources and thus improve the environment, States should adopt an integrated and coordinated approach

to development planning to ensure that development is compatible with the need to protect and improve the environment for the benefit of their population."

- Principle 14: "Rational planning constitutes an essential tool for reconciling any conflict between the needs of development and the need to protect and improve the environment."

9. Principle of Cultural Heritage
The principle of cultural heritage is summarized in Article 3 of the Granada Convention for the Protection of the Architectural Heritage of Europe (Council of Europe, 1985).

10. Principle of the Sustainable Urban Environment
This principle seeks to address the problems of modern settlements and improve quality of life in cities. It is proclaimed in the Stockholm Declaration (UN, 1972):

- Principle 15: "Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic, and environmental benefits for all."

11. Principle of the Aesthetic Value of Nature
This principle promotes qualitative development and the satisfaction of the aesthetic needs of human beings through the preservation of natural beauty (Kallia-Antoniou, 2011).

12. Principle of Ecological Awareness
The final principle establishes sound value systems and ecological awareness among individuals as the ultimate guarantee of the entire framework of sustainable development. The principle is articulated in the Stockholm Declaration (UN, 1972):

- Principle 19: "Education in environmental matters, for the younger generation as well as adults, with particular attention to the less privileged, is essential in order to broaden the basis for enlightened public opinion and responsible conduct by individuals, enterprises, and communities in protecting and improving the environment."
- Principle 20: "Scientific research and development in relation to environmental problems, both national and multinational, must be promoted in all countries, especially developing countries. The free flow of up-to-date scientific information and the transfer of experience must be supported and facilitated in order to assist in the solution of environmental problems. Environmental technologies should be made available to developing countries under conditions that encourage their wide dissemination and do not impose an economic burden upon them."

Based on these principles, which together constitute the model of a sustainable society, both general and specific solutions are designed to address corresponding environmental and socio-economic challenges (Kallia-Antoniou, 2011).

2.3.2 International Policy
The World Summit on Sustainable Development, held in Johannesburg (26 August – 4 September 2002), constitutes the culmination of the earlier Stockholm Conference on the Human Environment (1972) and the Rio Conference on Environment and Development (1992), which introduced the principle of sustainable development (UN, 1972; UN, 1992; Kallia-Antoniou, 2011).

The United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012 (also known as Rio+20) focused on strengthening sustainable development and

promoting the "green economy" through the integration of environmental and social objectives into economic growth. The main outcomes included a commitment to adopting the green economy model and the recognition that sustainable development is an achievable goal rather than an abstract concept, alongside the signing of various action-oriented agreements (UN, 2012).

Key conclusions of the Conference included:

- **Strengthening the green economy:** Emphasis was placed on adopting a green economy model aimed at integrating environmental, social, and economic dimensions of development (UN, 2012).
- **Integration of the three pillars:** The need for balanced integration of the economic, social, and environmental pillars of sustainable development was acknowledged (UN, 2012).
- **Recognition of sustainable development as an attainable goal:** The Conference reaffirmed that sustainable development is a realistic and feasible objective (UN, 2012).
- **Commitment to action:** Agreements and commitments were undertaken by 192 UN Member States to promote sustainable development and address global environmental challenges (UN, 2012).

United Nations Resolution: "Transforming our World: the 2030 Agenda for Sustainable Development"

In September 2015, UN Member States adopted the 2030 Agenda for Sustainable Development, emphasizing that the 17 Sustainable Development Goals (SDGs) and their 169 targets are integrated and indivisible, balancing the economic, social, and environmental dimensions of sustainable development (UN, 2015). The Agenda provides a holistic vision for the well-being of people and the planet, centered on equality and resilience.

It constitutes the only universally accepted and universally applicable framework for evidence-based global policymaking during this critical decade. The interlinkages and integrated nature of the SDGs are essential for the effective implementation of the 2030 Agenda. In light of the COVID-19 pandemic, the SDGs offer a unique framework for recovery and for "building back better", namely for constructing a more just and resilient world that prospers within planetary boundaries while leaving no one behind (UN, 2015; Kallia-Antoniou, 2021).

2.3.3 European Policy – Institutional Framework

A significant proportion of the environmental legislation applied in EU Member States originates from European Union regulations and rules. Environmental protection within the EU is institutionalized through both primary and secondary EU law (European Commission, 2022). Today, European environmental policy covers almost all environmental sectors.

In 1972, at the Paris Summit, EU Member States agreed to prioritize environmental protection and requested the European Commission to develop an Environmental Action Programme (European Commission, 1973). In 1973, the first Environmental Action Programme (1973–1976) was adopted. Subsequently, environmental protection became increasingly central to EU policy priorities, with successive Action Programmes adopted in 1977, 1983, 1987, 1992, 2002, 2014, and 2022 (European Commission, 2022).

Currently, the **Eighth Environment Action Programme (2022–2030)** is in force, establishing the main priorities and strategic directions for environmental policy and the promotion of sustainable development (European Commission, 2022).

Priority objectives of the 8th Environment Action Programme

- Achieving the 2030 greenhouse gas emission reduction targets and climate neutrality by 2050 (European Commission, 2022).
- Enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change (European Commission, 2022).
- Transitioning towards a regenerative growth model by decoupling economic growth from resource use and environmental degradation, accelerating the shift to a circular economy (European Commission, 2022).
- Achieving zero pollution of air, water, and soil and protecting human health and well-being (European Commission, 2022).
- Protecting, conserving, and restoring biodiversity, improving ecosystem conditions, and combating desertification and land degradation (European Commission, 2022).
- Reducing environmental and climate pressures arising from production and consumption, particularly in the sectors of energy, industry, buildings and infrastructure, mobility, and food systems (European Commission, 2022).

2.3.3.1 Treaties

Explicit reference to environmental protection in the EU Treaties was first made in 1992. The gradual integration of environmental policy into EU primary law is reflected in the following Treaties (European Commission, 2022; Kallia-Antoniou, 2011):

Single European Act (1987)

Introduced specific provisions on environmental protection and assigned responsibility for environmental policy to the European Community (European Commission, 1987).

Treaty of Maastricht (1993)

Elevated environmental policy to an official EU policy area, established the objective of a high level of environmental protection, introduced the prevention principle, and required the integration of environmental considerations into other sectoral policies. Environmental decision-making by qualified majority voting was also introduced (European Commission, 1993).

Treaty of Amsterdam (1997)

Further expanded environmental objectives, incorporated sustainable development into the EU's core objectives, and recognized environmental protection as a fundamental policy priority (European Commission, 1997).

Treaty of Lisbon (2009)

Entered into force in December 2009. Articles 191–193 TFEU define EU environmental policy objectives, while Article 21 TEU establishes sustainable development as a binding objective of EU external action, including relations with developing countries (European Commission, 2009).

2.3.3.2 Principles

The EU Treaties enshrine the following fundamental principles governing European environmental law (European Commission, 2022; Kallia-Antoniou, 2011):

- **Prevention principle:** Environmental damage should be prevented rather than remedied after occurrence.
- **Restoration principle:** Environmental damage must be remedied and ecosystems restored when preventive measures fail.
- **Precautionary principle:** Preventive action must be taken even in the absence of full scientific certainty where serious risks are identified.

- **Carrying capacity principle:** Ecosystems have limits beyond which irreversible damage occurs.
- **Integration principle:** Environmental protection must be integrated into all EU policies (Article 6, Amsterdam Treaty) (European Commission, 1997).
- **Polluter pays principle:** The cost of environmental damage restoration is borne by the party responsible.

The above principles are further specified through the adoption of Directives, Regulations, and Decisions, which are incorporated into Member States' legislation to create an effective institutional framework for environmental protection and the promotion of sustainable development (European Commission, 2022). Environmental Directives issued over the past five decades cover a broad range of topics, including provisions regarding air and water quality, noise control, wildlife and habitat conservation, waste management and recycling, protection against hazardous substances and industrial accidents, regulation of biotechnology, as well as general issues such as environmental impact assessment, public access to environmental information, environmental inspections and liability, eco-labeling of products, and environmental standards. Of particular importance are Directive 92/43 on natural habitats and Directive 79/409, also known as the Birds Directive, which aim to ensure the rational use of Europe's natural environment (European Commission, 1992; European Commission, 1979).

Given that only five years remain to achieve the Sustainable Development Goals (SDGs) set out in the 2030 Agenda, it is imperative for the EU to intensify its global efforts to achieve all 17 SDGs (UN, 2015; European Commission, 2022). To this end, the EU report focuses on the tools currently available to the EU to contribute to the global implementation of the SDGs. Rather than concentrating on specific SDG targets and the progress made to date, the report identifies remaining gaps and challenges and explores opportunities that will support the EU's global efforts to achieve all 17 SDGs by 2030 (European Commission, 2022).

Long-term planning alone is no longer sufficient to achieve the SDGs; urgent action is now required. Despite significant efforts to map EU progress on the SDGs, the EU has not yet fully assumed a leading role in the global effort to achieve all 17 SDGs. Therefore, better implementation is needed, requiring more coherent funding and, above all, stronger leadership both within the EU and internationally. As highlighted by the milestone European Green Deal, sustainable development lies at the core of the EU's identity. The EU has taken a leading role in the revision of the Millennium Development Goals (MDGs) and in negotiations for the 2030 Agenda. Article 3 of the Treaty on European Union commits the EU to promoting sustainable development in Europe, while Article 21 explicitly establishes that the EU promotes sustainable development beyond its borders, including in developing countries (European Commission, 2019; UN, 2015).

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SESSION

"Urban Resilience and Quality of Life"

Chaired by **Prof Salvati Luca** and
Assoc Prof Papadas Dimitrios

NATURAL DISASTERS, URBAN TRADE DISRUPTIONS, AND SUSTAINABLE ECONOMIC DEVELOPMENT IN MENA CITIES: ENERGY AND FOOD SECURITY PERSPECTIVES

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Abstract
The Middle East and North Africa (MENA) region, marked by escalating climate-driven natural disasters such as droughts, heatwaves, and floods, faces significant challenges to sustainable urban development, particularly in its rapidly growing cities reliant on energy exports and food imports. This study investigates how disaster frequency and intensity disrupt trade flows and economic stability in urban centers across 18 MENA countries (1995–2024), with a focus on Gulf Cooperation Council (GCC) cities (e.g., Dubai, Riyadh) versus North African urban hubs (e.g., Cairo, Casablanca). Employing gravity models with fixed-effects regressions and instrumental variable approaches (inspired by Felbermayr and Gröschl, 2013; El Hadri et al., 2018), the analysis uses EM-DAT and GeoMet data to assess impacts on urban trade networks. Preliminary findings reveal that droughts and floods severely disrupt food imports in North African cities, exacerbating trade deficits and food insecurity (up to 6% urban GDP declines in disaster years), while GCC cities' energy trade shows resilience but faces risks from events like the 2024 Dubai floods. Institutional quality, urban governance, and regional trade agreements (e.g., GAFTA) mitigate impacts unevenly, with conflict-affected cities (e.g., Sana'a) showing heightened social and economic vulnerabilities. Quantile regressions highlight stronger effects in lower-growth urban economies, underscoring the need for climate-adaptive urban trade policies. This study fills a gap in MENA-specific urban sustainability research by linking disaster-driven trade disruptions to food and energy security, offering policy recommendations for resilient urban infrastructure, disaster risk financing, and regional cooperation to support sustainable development in climate-vulnerable MENA cities.

Key words: Natural Disasters ; Sustainable Development ; Trade ; Urban; MENA

SUSTAINABLE STORMWATER MANAGEMENT IN URBAN AREAS OF HIGH FLOOD RISK: DESIGN, SIMULATION AND EVALUATION OF THE APPLICATION OF NATURE-BASED SOLUTIONS IN THE CITY OF THESSALONIKI

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Abstract
The present paper explores sustainable stormwater management in urban areas with high flood risk, using Thessaloniki, Greece, as a case study. The primary objective is to assess the effectiveness of Nature-based Solutions (NbS) - specifically rain gardens and permeable pavements - in mitigating surface runoff and improving urban climate resilience. The study aims to provide practical insights for integrating NbS into Mediterranean cities.

The methodology combines meteorological data analysis, spatial identification of potential intervention sites along Aristotelous Square and the development of a hydrological model using EPA SWMM software. Multiple design alternatives were simulated, reproducing the intense rainfall events of 2022 and 2023, both with and without NbS implementation. Key performance measures such as runoff volume, peak discharge and runoff coefficient were compared across the examined cases.

Results reveal a substantial reduction in surface runoff and peak flow, with the combined application of NbS achieving up to 35-45% runoff reduction in critical subcatchments. Beyond flood mitigation, NbS demonstrated co-benefits including improved water quality, enhanced urban biodiversity and increased thermal comfort through evapotranspiration.

The findings highlight the potential of NbS as cost-effective and multifunctional tools for climate adaptation. The paper concludes by emphasizing the importance of integrating NbS into urban planning policies, supported by pilot projects, long-term monitoring and public engagement to maximize environmental, social and economic benefits.

Keywords: Flood Risk, Urban Environment, Sustainable Stormwater Management, Nature-based Solutions, Thessaloniki, Aristotelous Square, EPA SWMM software

INTRODUCTION

Urban areas around the world are increasingly facing the combined effects of rapid urban growth, climate change and ageing stormwater management infrastructure. Mediterranean cities are particularly vulnerable due to their climatic characteristics, which include long dry periods followed by short and intense rainfall events. These conditions, intensified in recent years, have increased the frequency and the impact of urban flooding (Giorgi, 2006; Zanis et al., 2008; Diakakis et al., 2012; Evelpidou et al., 2023; National Academies of Sciences, Engineering, and Medicine, 2019).

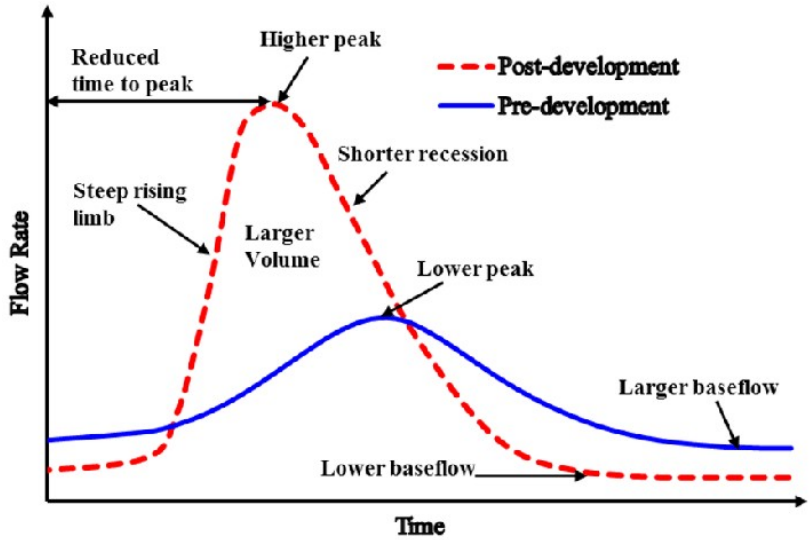

Figure 1: Schematic graph of the relative effects of urbanization on catchment hydrology (Source: Rezaei et al., 2019)

Urbanization significantly alters the natural hydrological cycle. The expansion of impervious surfaces reduces infiltration, limits groundwater recharge and increases surface runoff. As a result, even moderate rainfall events can produce higher peak flows and faster runoff response times compared to natural conditions. In densely built environments, this transformation increases flood risk and places pressure on existing drainage stormwater management systems (Construction Industry Research and Information Association [CIRIA], 2007; Kazak et al., 2022; National Academies of Sciences, Engineering, and Medicine, 2019).

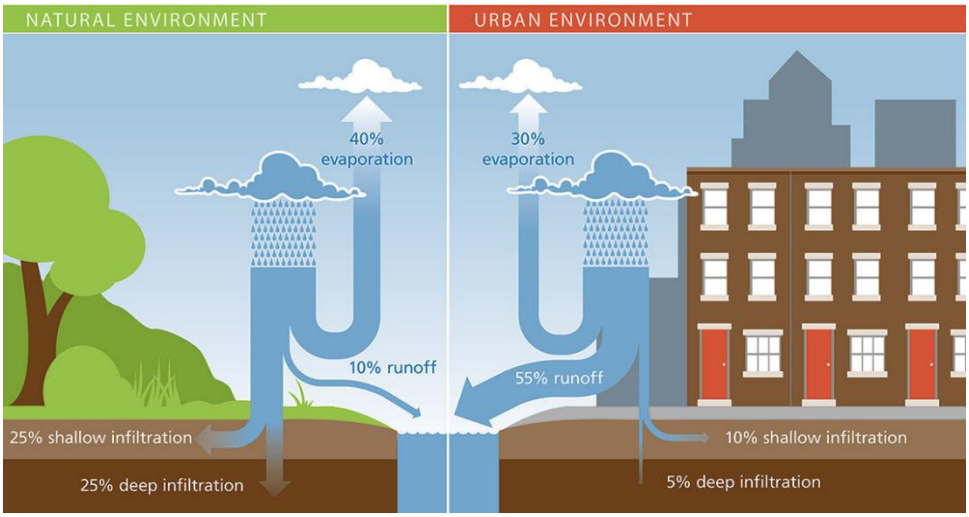

Figure 2: The presence of trees and natural vegetation significantly reduces surface runoff and enhances water infiltration into the soil compared to urban environments (Source: The Nature Conservancy, 2022)

In Greece, flood events have become more frequent and more impactful in recent decades, particularly in large urban centers (Papagiannaki et al., 2021). Regional flood assessments indicate that Central Macedonia and particularly Thessaloniki, experience a high frequency of urban flood events. Thessaloniki is the second-largest city in the country. The city has been identified as an area of elevated flood risk due to its dense development, geomorphological features and ageing drainage network (Evelpidou et al., 2023; Lazaridis and Latinopoulos, 2022). Several central districts have experienced repeated surface flooding during high-intensity rainfall events.

Region	Number of floods	Frequency per year
Western Macedonia	24	0,18
North Aegean	57	0,42
Ionian Islands	64	0,47
South Aegean	68	0,5
Western Greece	99	0,73
Crete	117	0,86
Peloponnese	123	0,9
Epirus	127	0,93
Central Greece	202	1,49
Attica	210	1,54
Thessaly	223	1,64
Eastern Macedonia and Thrace	267	1,96
Central Macedonia	413	3,04
Total	**1994**	**14,66**

Table 1: Number of flood events per region during the period 1886-2022 (Source: Evelpidou et al., 2023)

Stormwater management in Greek cities traditionally relies on underground pipe systems designed to quickly carry runoff away from urban areas. However, these systems were developed based on historical rainfall data and are often unable to cope with currentwith more intense rainfall events linked to climate change. Moreover, conventional grey infrastructure solutions - such as enlarging pipes or constructing detention basins - require high investment costs and provide limited additional environmental benefits. Finally, there is degradation of aquatic ecosystems and disruption of the hydrological balance due to the transport of pollutants and the lack of natural filtration by soil and vegetation (CIRIA, 2007; Huang et al., 2020; Kazak et al., 2022; Malinauskaite et al., 2023; National Academies of Sciences, Engineering, and Medicine, 2019; Sun et al., 2024).

Figure 3:Intense rainfall events caused significant disruption (Source: iefimerida.gr, 2020)

In recent years, there has been growing interest in nature-based approaches to stormwater management. Nature-based Solutions (NbS) integrate ecological processes into urban

infrastructure and aim to address challenges such as flood risk, while also improving environmental and social conditions. In the context of stormwater management, NbS include rain gardens, permeable pavements and bioretention systems such as bioretention tree pits, which reduce runoff by promoting infiltration, temporary storage and evapotranspiration (CIRIA, 2007). Beyond hydraulic performance, Nature-based Solutions can improve urban environmental quality by enhancing biodiversity, reducing surface temperatures and contributing to more attractive public spaces. Despite increasing policy support across Europe, the implementation of NbS in Mediterranean cities remains limited. One of the main challenges is the need for clear quantitative evidence demonstrating their effectiveness under real rainfall conditions (CIRIA, 2007; Huang et al., 2020; Kazak et al., 2022; Malinauskaite et al., 2023; Sun et al., 2024; Bagiouk et al., 2024; Basdeki et al., 2024; Jeffers et al., 2022).

This study seeks to address this need by combining hydrological modeling with spatial urban analysis in a central district of Thessaloniki. The focus area is the Aristotelous Square area, a central and heavily used public space corridor characterized by mixed land use and a high percentage of impervious surfaces (Lazaridis and Latinopoulos, 2022).

The objectives of this paper are to quantify the hydraulic performance of selected Nature-based Solutions, including rain gardens and permeable pavements, under different rainfall events. The study also aims to compare runoff volume, peak discharge and runoff coefficient values between without and with NbS applications, to examine how hydraulic improvements are distributed across different urban subcatchments and to explore the broader implications of NbS implementation for enhancing urban resilience in densely built Mediterranean cities. The study uses the EPA Storm Water Management Model (SWMM) software to simulate two rainfall events comparing current conditions with conditions including NbS interventions. Through this approach, the paper links quantitative hydraulic performance with wider considerations of sustainable urban development and climate adaptation.

STUDY AREA

Thessaloniki is the second-largest city in Greece and serves as the main administrative and economic center of Northern Greece. Located along the Thermaic Gulf, the city is characterized by dense urban development, limited open space in its historic core and a drainage system influenced by both topography and coastal proximity. Rapid urban expansion during the second half of the 20th century significantly increased impervious surface coverage and altered natural drainage pathways (Lazaridis and Latinopoulos, 2022). The study area belongs to the Water District of Central Macedonia (WD10), where several urban zones are classified as areas of potentially high flood risk (Ministry of Environment and Energy, n.d.).

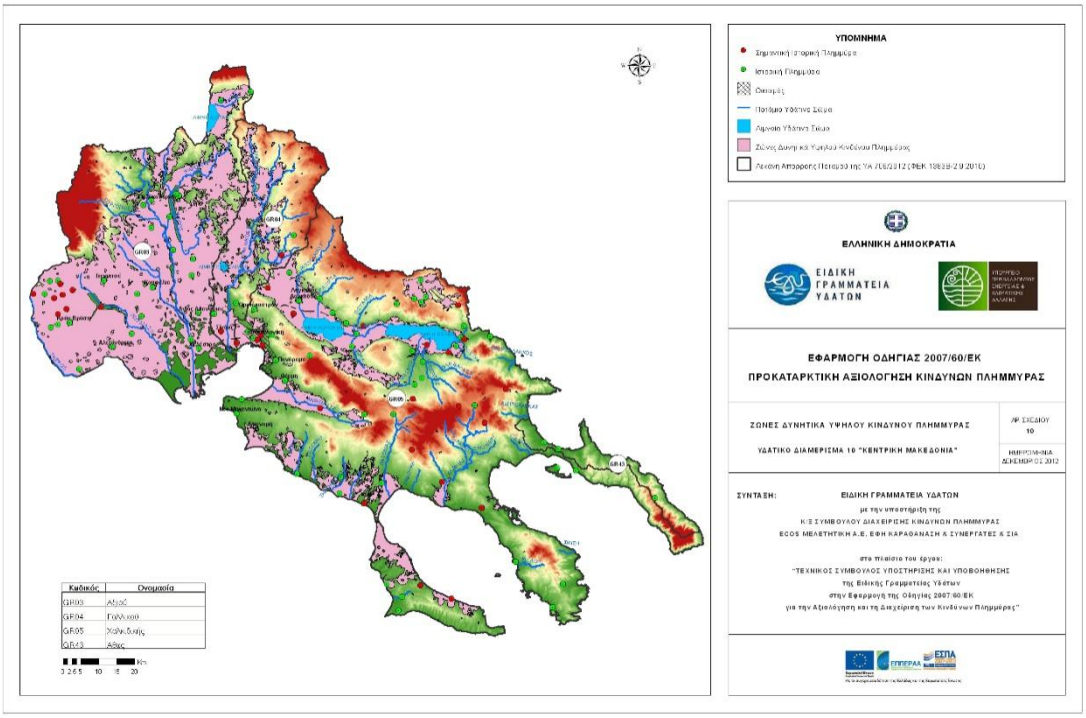

Figure 4: Central Macedonia Water District (WD10) (Source: Ministry of Environment, Energy and Climate Change)

The city experiences a typical Mediterranean climate, with hot, dry summers and mild, rainy winters. In recent years, rainfall events have increasingly included short-duration but high-intensity storm events, particularly during transitional seasons. These intense rainfall episodes are often associated with flash flooding in urbanized areas. Flood risk assessments have identified parts of central Thessaloniki as areas of elevated flood risk (Papagiannaki et al., 2021; Evelpidou et al., 2023).

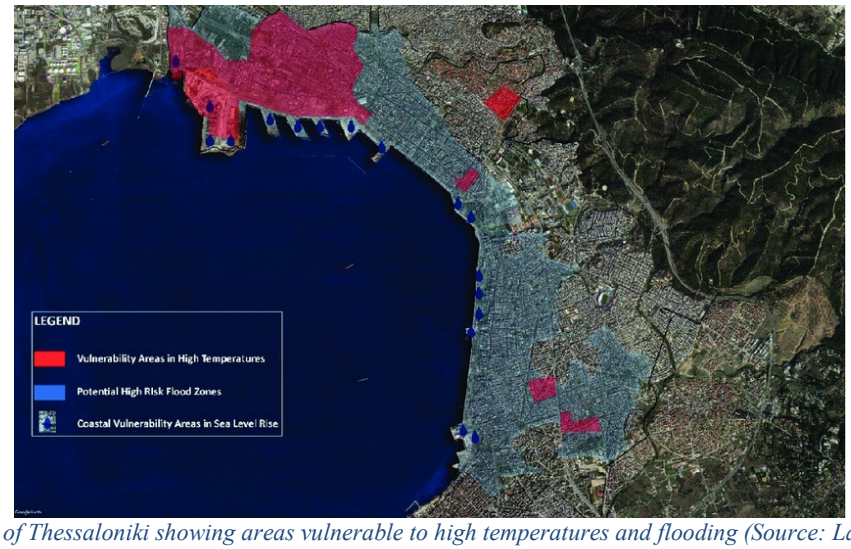

Figure 5: Map of Thessaloniki showing areas vulnerable to high temperatures and flooding (Source: Lazaridis & Latinopoulos, 2022)

Recent flood incidents in Thessaloniki have caused infrastructure damage and disruptions, highlighting the vulnerability of central urban districts. The focus of this study is the Aristotelous Square area, one of the most recognizable and active public space in Thessaloniki.

The area extends from the waterfront toward the upper part of the city and includes public and commercial areas, pedestrian paths and surrounding streets. Due to its central location and high daily usage, any intervention in this area must carefully balance hydraulic performance with urban functionality and public space quality.

From a hydrological perspective, the study area has a high percentage of impervious surfaces, including paved paths, roads and building footprints. The limited availability of permeable surfaces reduces infiltration capacity and promotes rapid surface runoff during intense rainfall events. Previous studies indicate that runoff in highly urbanized areas may be up to five times greater compared to natural soil conditions (CIRIA, 2007). The existing combined overflow drainage system primarily consists of underground pipe networks designed for quick runoff conveyance,with limited runoff retention capacity during intense storms (Kazak et al., 2022; National Academies of Sciences, Engineering, and Medicine, 2019).

For modeling purposes, the area was divided into multiple subcatchments based on surface slope, flow direction and drainage connectivity. This subdivision allowed a detailed representation of runoff generation and routing within the EPA SWMM model. Each subcatchment was defined using parameters such as area, percentage of impervious surfaces, slope and roughness coefficients.

Potential locations for Nature-based Solutions were identified through spatial analysis and on-site observation. Existing green areas and selected paved surfaces were evaluated as suitable areas for rain gardens and permeable pavements. The objective was to integrate these interventions into the existing urban layout without affecting urban mobility or altering the character of the space.

Given the historic and symbolic importance of Aristotelous Square axis, the integration of NbS required a balanced approach. Hydraulic improvement needed to be achieved while maintaining the identity and daily use of the public space.

By selecting a central and highly visible urban area, this study provides a realistic assessment of how Nature-based Solutions can be implemented in dense Mediterranean cities where space is limited and urban constraints are significant. The Aristotelous Square therefore serves as a representative example for evaluating distributed stormwater management approaches under real urban conditions.

METHODOLOGY

To evaluate the hydraulic performance of Nature-based Solutions, the study uses the EPA Storm Water Management Model (SWMM), a widely used tool for simulating rainfall-runoff processes in urban environments. EPA SWMM enables event-based simulation of runoff, flow routing, infiltration and temporary storage within urban catchments (Rossman & Simon, 2022).

The model was set up to simulate two recorded rainfall events that occurred in Thessaloniki on 4 September 2022 and 9 May 2023. These events were selected because they reflect different rainfall patterns. The first event was characterized by high precipitationand short duration, whereasthe second event was characterized by lower total rainfall and a longer duration. This contrast allowed the evaluation of NbS performance under different rainfall events and runoff generation conditions.

Time (h)	04/09/2022 (mm/h)	09/05/2023 (mm/h)
0	0,0	0,2
1	0,0	0,0
2	0,0	0,2
3	0,0	0,0
4	0,0	0,0
5	0,0	0,0
6	6,8	0,2
7	2,6	0,2
8	22,0	0,0
9	47,8	0,6
10	3,6	1,2
11	0,8	0,4
12	1,6	0,6
13	0,2	0,4
14	0,2	0,8
15	0,0	0,4
16	0,0	2,2
17	0,0	0,6
18	0,0	0,4
19	0,0	0,2
20	0,0	0,2
21	0,0	0,0
22	0,0	0,2
23	0,0	0,6
Total	**85,6**	**9,6**

Table 2: Timeseries of the two rainfall events (Source: Meteorological Station of Aristotle University of Thessaloniki)

Rainfall timeseries were obtained from the Meteorological Station of Aristotle University of Thessaloniki, ensuring that model inputs reflected local climatic conditions. Simulations were performed using the "Kinematic Wave" as routing method and "Horton" as infiltration model in EPA SWMM, allowing realistic representation of hydraulic interactions within the NbS implementation (Source: Rossman & Simon, 2022).

The study area along the Aristotelous Square axis was subdivided into multiple subcatchments based on topography, surface flow direction, drainage connectivity and land-use characteristics. This subdivision enabled a more detailed representation of runoff volume and routing processes across the area.

Figure 6: Subdivision of the study area into subcatchments along the Aristotelous Square axis, above Egnatia Street (Source: e-poleodomia)

Figure 7: Subdivision of the study area into subcatchments along the Aristotelous Square axis, between Egnatia and Ermou Street (Source: e-poleodomia)

Figure 8: Subdivision of the study area into subcatchments along the Aristotelous Square axis, between Egnatia and Ermou Street (Source: e-poleodomia)

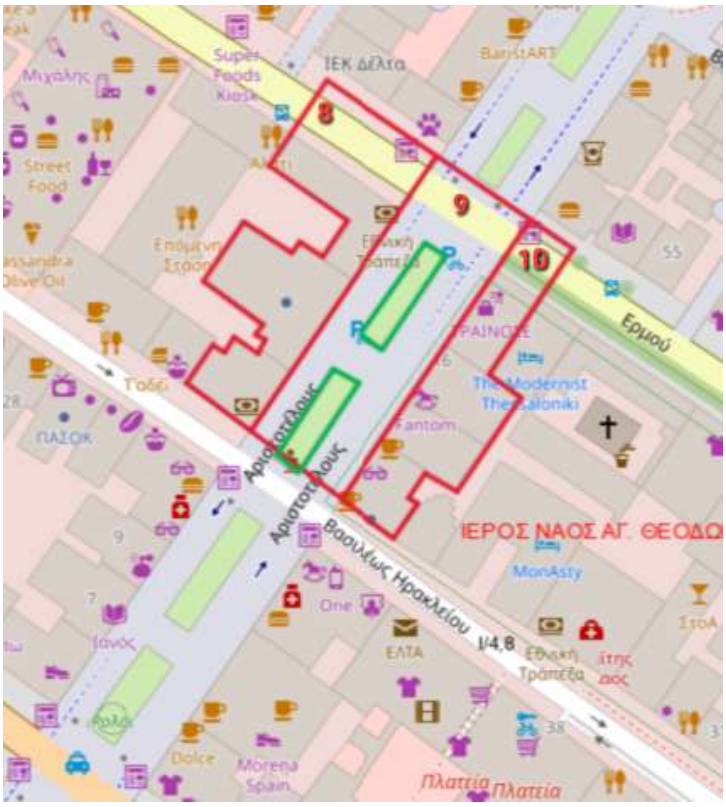

Figure 9: Subdivision of the study area into subcatchments along the Aristotelous Square axis, between Ermou and Vasileos Irakleiou Street (Source: e-poleodomia)

Figure 10: Subdivision of the study area into subcatchments along the Aristotelous Square axis, between Vasileos Irakleiou and Tsimiski Ioanni Street (Source: e-poleodomia)

Figure 11: Subdivision of the study area into subcatchments along the Aristotelous Square axis, between Tsimiski Ioanni and Mitropoleos Street (Source: e-poleodomia)

Figure 12: Subdivision of the study area into subcatchments along the Aristotelous Square axis, between Mitropoleos Street and Nikis Avenue (Source: e-poleodomia)

Subcatchment	Area (m²)	Total Area (m²)
Sub_1	4960	4960
Sub_2	1680	8430
Sub_3	5200	
Sub_4	1550	
Sub_5	1060	4220
Sub_6	2120	
Sub_7	1040	
Sub_8	2450	6960
Sub_9	2830	
Sub_10	1680	
Sub_11	1940	7060
Sub_12	2730	
Sub_13	2390	
Sub_14	2190	8290
Sub_15	3650	
Sub_16	2450	
Sub_17	4300	15015
Sub_18	6195	
Sub_19	4520	

Table 3: Calculated subcatchment areas by subcatchment number (Source: e-poleodomia)

Each subcatchment was defined using parameters such as total area, percentage of impervious surface, average slope, Manning's roughness coefficients for both pervious and

impervious surfaces and storage parameters. Impervious surface percentages were estimated according to surface type, including paved areas, building roofs and road surfaces, while pervious surfaces mainly referred to existing green strips and landscaped spaces. Rain gardens differ from conventional green planting areas, as they are specifically designed for the collection, temporary storage and infiltration of stormwater, functioning as bioretention systems within the urban environment (Source: CIRIA (2007); Bagiouk et al. (2024); Basdeki et al. (2024); e-Poleodomia).

This spatial analysis supported the identification of areas with higher runoff volume and allowed comparison of hydraulic behavior among different parts of the study area.

The existing situation represented current urban conditions without the implementation of Nature-based Solutions. Surface runoff was calculated according to existing land cover characteristics and routed through the drainage network without additional detention or infiltration measures.

For each rainfall event, the model calculated total runoff volume per subcatchment, peak discharge and runoff coefficient values, defined as the ratio between runoff volume and total rainfall input. These outputs served as reference values for evaluating the effectiveness of NbS interventions (U.S. Environmental Protection Agency, 2022).

The NbS implementation included two intervention types: rain gardens and permeable pavements. Potential installation sites were identified through spatial analysis and field observation, focusing on existing green areas and selected paved areas along the study axis.

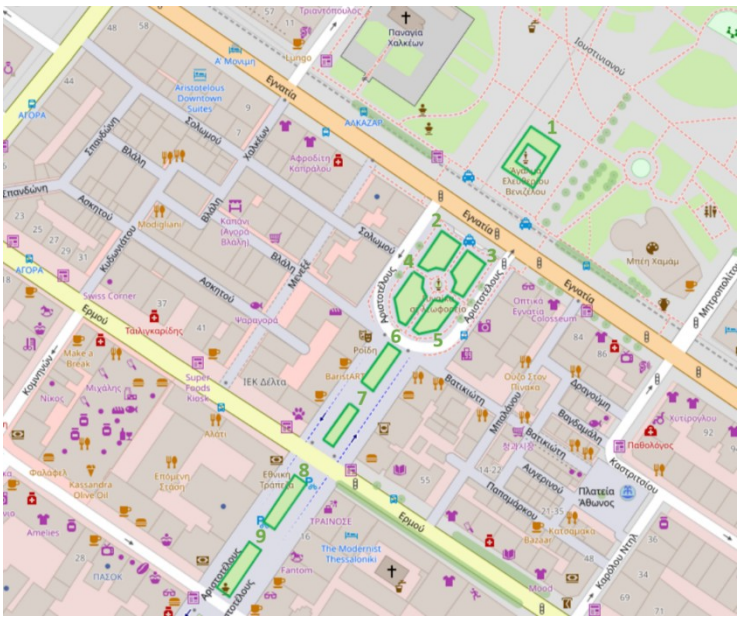

Figure 13: Placement of rain gardens 1–9 within existing landscaped areas along the Aristotelous Square axis (Source: e-poleodomia)

Figure 14: Placement of rain gardens 10–18 within existing landscaped areas along the Aristotelous Square axis (Source: e-poleodomia)

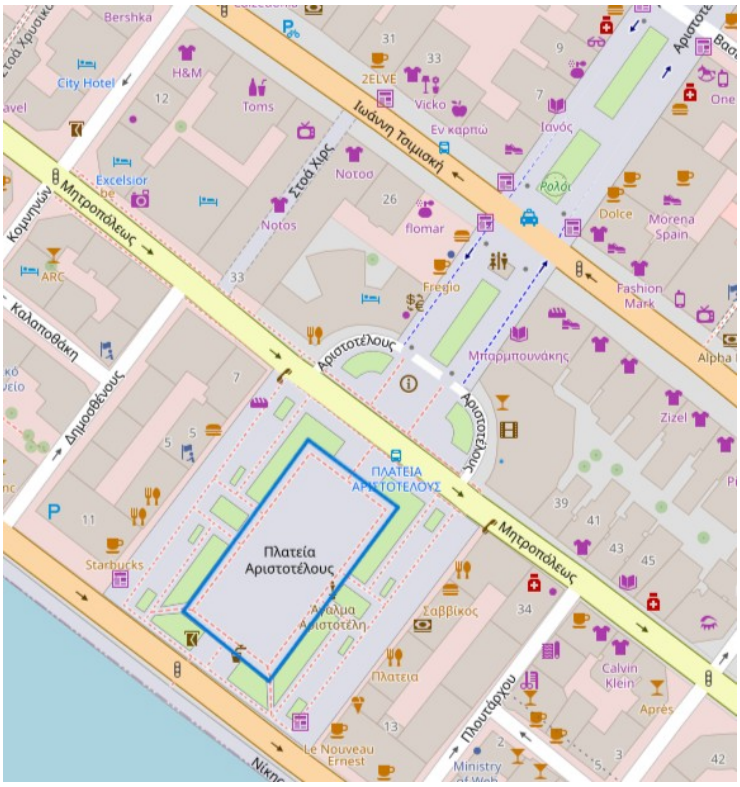

Figure 15: Placement of permeable pavement at Aristotelous Square, between Mitropoleos Street and Nikis Avenue, within the blue outline (Source: e-poleodomia)

Figure 16: Placement of the 1st rain garden installation (Source: Personal archive)

Figure 17: Placement of the 10th rain garden installation from Vasileos Irakleiou Street (Source: Personal archive)

Figure 18: Placement of permeable pavement installation (Source: Personal archive)

Within EPA SWMM, rain gardens were represented using Low Impact Development (LID) bioretention controls. Parameterization included surface storage characteristics, soil media properties and drainage layer configuration, based on the minimum values in order to examine the maximum potential performance, adopted from the literature (Rossman & Simon, 2022).

Rain gardens were designed to promote infiltration and temporary storage, while permeable pavements enhanced subsurface storage and delayed runoff discharge. The total area allocated to NbS was spread across multiple subcatchments, representing an implementation strategy.

Number of Rain Garden	Area (m²)
1	315
2	220
3	230
4	240
5	240
6	190
7	155
8	230
9	240
10	300
11	260
12	280
13	110
14	110
15	330
16	330
17	330
18	330

Table 4: Rain garden area table by number (Source: e-poleodomia)

In addition, the area of the proposed permeable pavement installation site was estimated at 3,060 m² (Source: e-poleodomia).

Both rainfall events were simulated under identical modeling assumptions with and without NbS implementation. This approach enabled direct comparison between storm events, evaluation of NbS performance under different rainfall events and identification of subcatchments showing consistent hydraulic improvement.

By maintaining consistent model parameters across scenarios, observed differences in runoff response could be attributed directly to the implementation of Nature-based Solutions.

NbS implementation (Number of Rain Garden and Permeable Pavement)	Area (m²)	Number of Rain Garden and Permeable Pavement	Total Area (m²)	Percentage of impervious surface covered by NbS (%)
1	315	1	315	6,35
2	220	2, 3, 4, 5	930	11,03
3	230			
4	240			
5	240			
6	190	6, 7	345	8,18
7	155			
8	230	8, 9	470	6,75
9	240			
10	300	10, 11	560	7,93
11	260			
12	280	12, 13, 14	500	6,03
13	110			
14	110			
15	330	15, 16, 17, 18, Permeable Pavement	4380	29,17
16	330			
17	330			
18	330			
Permeable Pavement	3060			

Table 5: Table of area per rain garden and Permeable Pavement, total Nature-Based Solutions (NbS) intervention area, and coverage percentages relative to the impervious surfaces of the study area (Source: e-poleodomia)

RESULTS

The simulation results demonstrated a clear improvement in hydraulic performance following the implementation of Nature-Based Solutions (NbS), including rain gardens and permeable pavement, across the examined subcatchments of the study area.

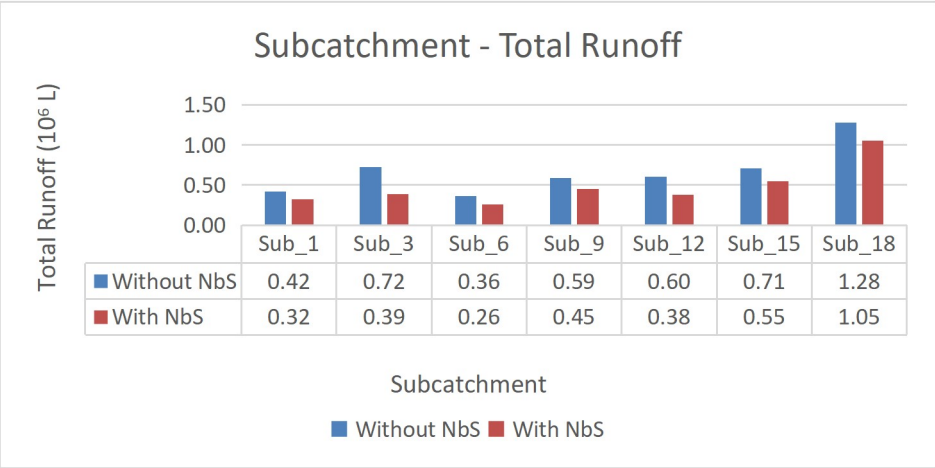

Figure 19: Comparison of total runoff per subcatchment, without and with LID implementation, for the rainfall event of 04/09/2022 (Source: EPA SWMM)

For the rainfall event of 04/09/2022, characterized by high intensity and short duration, a reduction in peak discharge was observed in all subcatchments. In addition, both total runoff volume and runoff coefficient value showed noticeable decreases compared to the current scenario, without NbS implementation. The most significant hydraulic improvement was recorded in subcatchment "Sub_3", where total runoff volume decreased from 720 * 10^3 L to 390 * 10^3 L (-45,8%), peak discharge decreased from 111,81 L/s to 98,44 L/s (-15,2%) and the runoff coefficient decreased from 0,994 to 0,535 (-46,2%). These results indicated that the combined application of rain gardens and permeable pavement could substantially reduce runoff generation and improve flow regulation during intense rainfall events.

For the rainfall event of 09/05/2023, which was characterized by low intensity and longer duration, significant reductions were also observed in peak discharge and runoff coefficient across all subcatchments. Although the total rainfall input was lower, the relative hydraulic improvements remained consistent, demonstrating that NbS performance is effective under different rainfall events and runoff generation scenarios.

Overall, the results confirmed that NbS implementation contributed to increased infiltration, temporary storage and delayed runoff response, leading to improved hydraulic behavior throughout the study area.

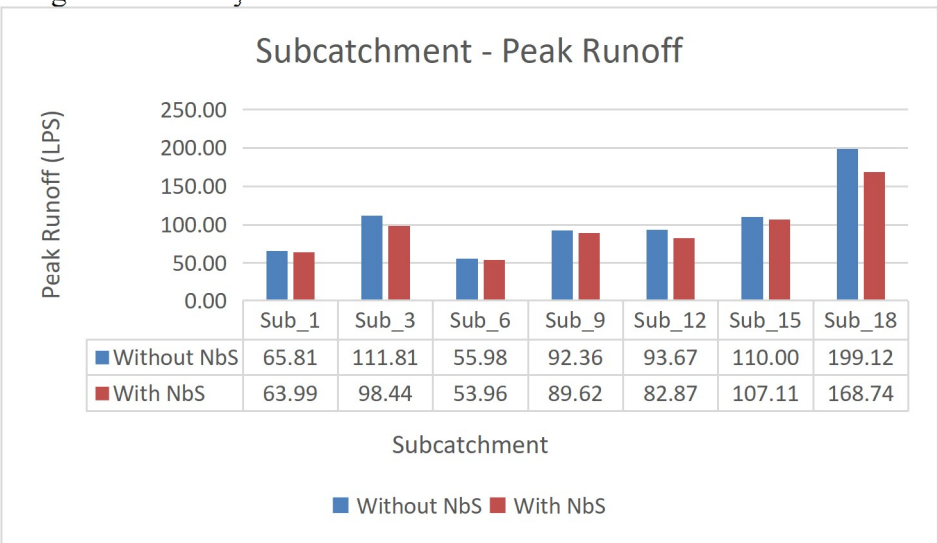

Figure 20: Comparison of peak runoff per subcatchment, without and with LID implementation, for the rainfall event of 04/09/2022 (Source: EPA SWMM)

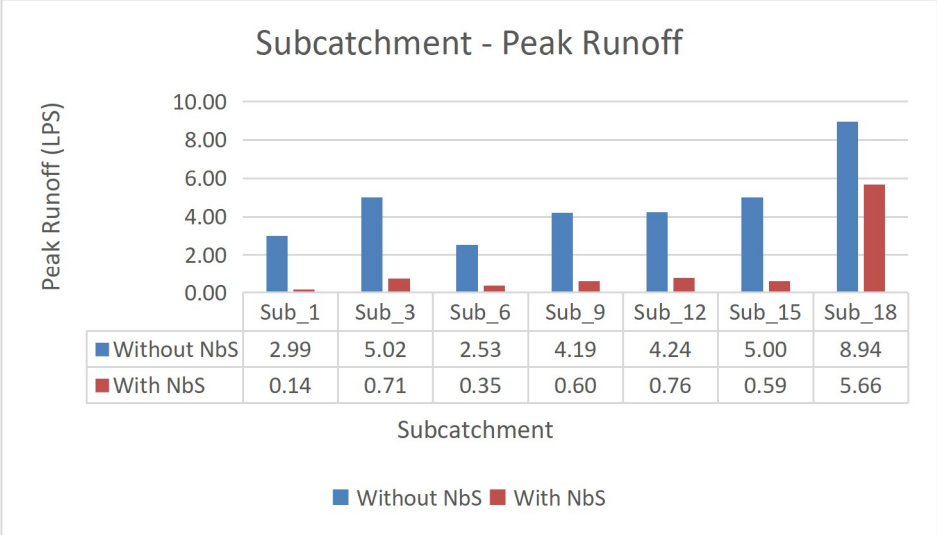

Figure 21: Comparison of peak runoff per subcatchment, without and with LID implementation, for the rainfall event of 09/05/2023 (Source: EPA SWMM)

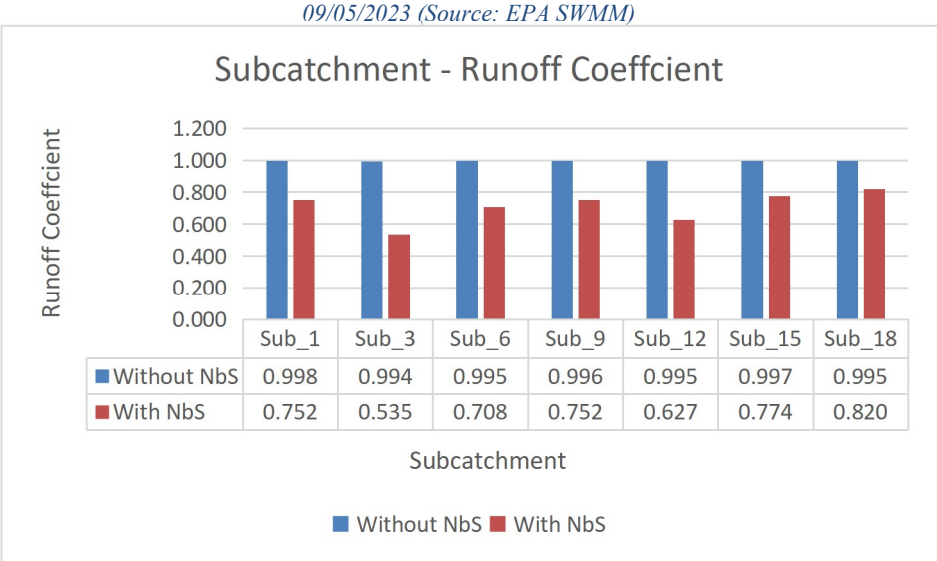

Figure 22: Comparison of runoff coefficient per subcatchment, without and with LID implementation, for the rainfall event of 04/09/2022 (Source: EPA SWMM)

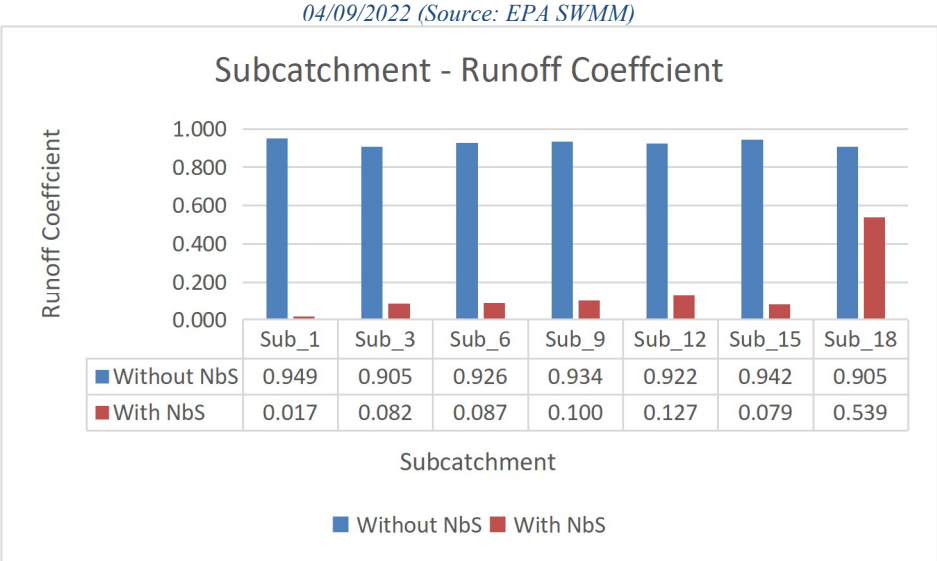

Figure 23: Comparison of runoff coefficient per subcatchment, without and with LID implementation, for the rainfall event of 09/05/2023 (Source: EPA SWMM)

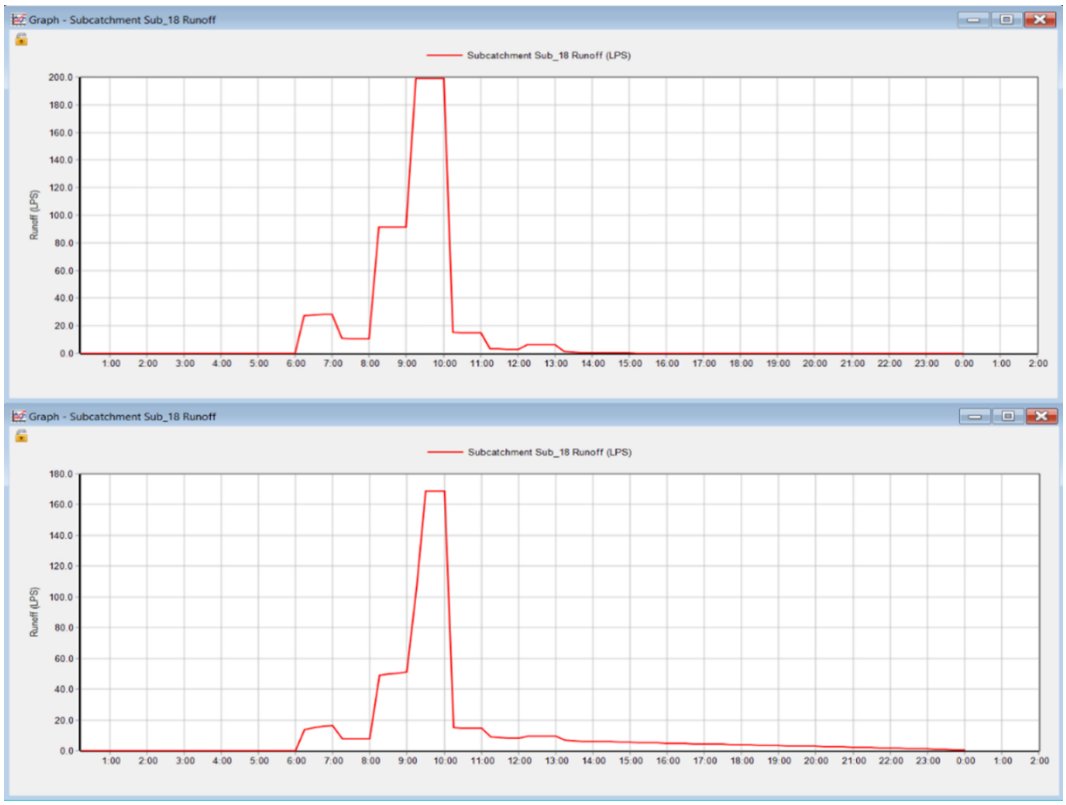

Figure 24: Simulation's results - Subcatchment's 18 runoff diagrams for both rainfall events, without/with NbS, for the rainfall event of 04/09/2022 (Source: EPA SWMM)

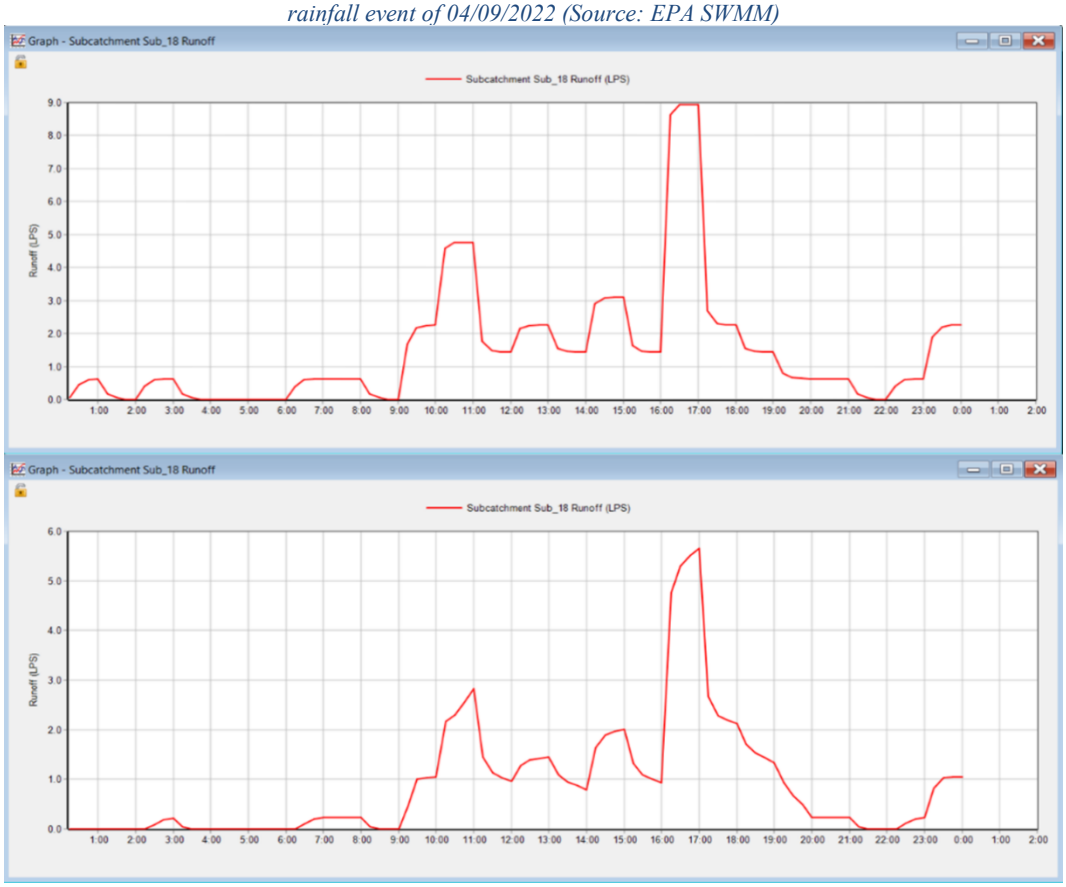

Figure 25: Simulation's results - Subcatchment's 18 runoff diagrams for both rainfall events, without/with NbS, for the rainfall event of 09/05/2023 (Source: EPA SWMM)

DISCUSSION

The results of the hydrological simulations show that Nature-based Solutions (NbS) can provide clear and measurable hydraulic benefits in dense Mediterranean urban environments. The consistent reductions observed in runoff volume and peak discharge across both rainfall events confirm that they can effectively complement existing drainage systems, even in areas with high impervious percentage.

The reductions observed in runoff volume, reaching up to 35-45% in critical subcatchments, indicate that relatively small and distributed interventions can significantly influence overall system performance. Unlike storage systems, NbS act close to the source of runoff, reducing flow accumulation before it reaches downstream parts of the network. This distributed approach improves system flexibility and lowers the risk of local hydraulic overload.

Peak discharge reductions further highlight the flood mitigation potential of NbS. The smoother hydrograph profiles and delayed peak timing suggest that runoff is released more gradually, reducing pressure on existing infrastructure during intense rainfall events. In highly urbanized areas where drainage systems often operate close to capacity, even moderate reductions in peak flow can meaningfully decrease flood risk.

An important outcome of the study is the demonstration that NbS can be integrated into a highly active and historically significant urban corridor such as the Aristotelous axis. Dense urban centers often present limited available space, making large-scale structural interventions difficult to implement. The results show that distributed and small-scale implements can still achieve substantial hydraulic improvements without major alterations to the existing urban layout.

By incorporating rain gardens and permeable pavements into existing pedestrian areas and green strips, the interventions support both hydraulic performance and urban functionality. This approach allows environmental improvements while preserving circulation patterns and the visual character of the public space.

The observed differences among subcatchments also emphasize the importance of strategic placement. Areas with higher impervious areas and larger intervention coverage achieved stronger results, indicating that careful spatial planning is essential for maximizing effectiveness.

Beyond their hydraulic role, NbS contribute to broader urban resilience goals. Mediterranean cities face multiple environmental pressures, including flood risk, heat stress and reduced ecological quality in dense urban areas. NbS can help address these challenges simultaneously by improving microclimatic conditions, supporting biodiversity and enhancing the overall quality of public space.

Rather than functioning only as drainage elements, NbS operates as multifunctional urban components that combine environmental, technical and social benefits. In highly used public spaces such as Aristotelous Square, this multifunctionality becomes particularly important, as hydraulic improvements can be achieved while also enhancing everyday urban experience.

The comparison between the two rainfall events demonstrates that NbS maintained stable performance despite differences in rainfall intensity and duration. The consistent reductions across all key indicators suggest that NbS can operate effectively under different storm types.

This stability is especially relevant under climate uncertainty, where rainfall patterns are expected to become increasingly variable. Flexible and distributed systems such as NbS may therefore provide more reliable long-term performance compared to traditional stormwater management infrastructures.

The findings support the broader integration of Nature-based Solutions into urban planning and stormwater management strategies. In Greece, stormwater management is still largely based on conventional grey infrastructure and practical examples of NbS implementation remain limited. The measurable results presented in this study provide a useful basis for supporting policy decisions and encouraging pilot applications.

Implementing NbS in central urban corridors can also serve as demonstration projects, helping municipalities evaluate performance while increasing public awareness and acceptance. Long-term monitoring and evaluation would further strengthen the evidence base and support wider adoption.

Overall, the study highlights how hydrological modeling combined with spatial urban analysis can support the transition toward more climate-adaptive and resilient stormwater management strategies in Mediterranean cities.

CONCLUSION

This study evaluated the hydraulic and spatial performance of Nature-based Solutions (NbS) applied along the Aristotelous Square axis in Thessaloniki, Greece, under two documented rainfall events with different characteristics. By combining event-based hydrological modeling in EPA SWMM software with spatial urban analysis, the research provided a quantitative evaluation of NbS performance in a dense Mediterranean urban environment.

The results showed that the implementation of rain gardens and permeable pavements can significantly reduce surface runoff and peak discharge across multiple subcatchments. Runoff volume reductions reached up to 35-45% in critical areas, while peak discharge reductions reached a maximum value of approximately 15%, depending on local conditions and spatial allocation. These findings confirmed that distributed NbS interventions could effectively improve hydraulic performance even in highly impervious and spatially constrained urban areas.

Beyond hydraulic improvements, the study also emphasized the multifunctional role of NbS within urban space. The integration of NbS along the Aristotelous axis shows that flood mitigation measures can be incorporated into active public spaces without disrupting their character or functionality. In addition to runoff control, such interventions can contribute to improved environmental quality, microclimatic conditions and overall urban livability.

The observed spatial differences among subcatchments underline the importance of careful planning and targeted placement of interventions. Hydraulic efficiency depends strongly on the proportion of impervious surfaces treated and the positioning of NbS within runoff pathways, highlighting the need to combine hydrological modeling with spatial analysis during the design process.

From a planning perspective, the results supported the wider integration of Nature-based Solutions into municipal stormwater management strategies. In cities such as Thessaloniki, where conventional grey infrastructure still dominates, the quantitative evidence provided by this study offers practical support for pilot applications and future policy development.

Overall, the methodological approach adopted in this research provides a transferable framework for other Mediterranean cities facing similar climatic and spatial challenges. Future work could focus on cost-benefit assessment, long-term monitoring and the evaluation of hybrid green-grey infrastructure systems in order to further support implementation at larger scales.

In conclusion, Nature-based Solutions represent an effective and realistic pathway toward more resilient, multifunctional and climate-adaptive urban stormwater management.

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LISTENING TO CHILDREN: PARTICIPATORY PRACTICES IN THE DESIGN OF OPEN SPACES FOR PLAY

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Abstract
In the current urban reality, the quality of daily life for children in cities is impacted by increasing traffic, long distances, lack of safety, and poorly designed play areas. These problems are exacerbated when the design of public spaces fails to take into account children's needs and desires. In this context, participatory design emerges as an effective tool, allowing children themselves to express their opinions and actively contribute to the shaping of their spaces.

This paper highlights the importance of participatory design with children both from a theoretical and a practical perspective. It aims to respond to critical questions regarding the ways design can respond to the contemporary challenges of urban childhood and whether child-friendly spaces enhance urban resilience.

The study area is located in the municipality of Kalamaria in the greater urban area of Thessaloniki, Greece and it comprises the planning unit of Byzantio and part of the planning unit of Limenergaton. This area is characterized by a densely populated urban fabric, crossed by two major roads with heavy traffic, lack of green spaces and a few abandoned open spaces, such as Rodon Park. The analysis focused on playgrounds and included data collection through questionnaires for children and parents, using digital media, as well as a participatory workshop for children that focused on mapping their desires for a new design for Rodon Park. The results from all sources led to the formation of a design proposal for upgrading and revitalizing Rodon Square, while at the same time enhancing resilience. The paper focuses on the methodology of the participatory practices that were applied, with the ultimate goal of extracting models of participatory practices for the design of open spaces for play.

Key words: Participatory design, children, play spaces, urban resilience

1. INTRODUCTION

Rapid urbanization has led to the concentration of a great percentage of people in cities, and therefore a large number of children living in them. Specifically, it is estimated that by the year 2050, 70% of children worldwide will live in urban areas. The relationship between children and cities is beneficial for the development of both (Andrea et al., 2023). Cities are considered cultural and political centers of societies, and the way they treat children is a key factor of how humane and generous they are (Chawla, 2003). However, cities are often

characterized as dangerous and "contagious" places for children. This approach, both on the part of planners and parents, distances them not only from danger but also from life. As mentioned in Jane Jacobs' book, it is important for children to learn the basic principles of social urban life by being able to live and play in the streets (Noschis, 1992). Nevertheless, urban spaces are being developed in a restricted way and they leave no room for freedom and independence (Θανάση&Φορούλη, 2018).

This evolution in public spaces is also a consequence of the challenges that urban childhoods have to deal with, which include crime and criminality, social anxiety and fear, risk avoidance, inadequate and not equal access to the city and isolation (ARUP, 2017). According to research, there is a tendency for children to spend their free time indoors, while it has been observed that children in cities experience significant isolation, leading them to be unfamiliar with the traffic system, behavior at public events, planning activities and responding to issues and situations (Τσεβρένη, 2008).

Urban design that focuses on children's needs and resilience can promote social cohesion by transforming the open areas of a neighborhood or city, which leads to the creation of opportunities for playing, learning and healthy development (Andrea et al., 2023). However, proper design is the result of multiple levels of planning (city-neighborhood-home). Therefore, small interventions can improve the child-friendliness of an area. On the other hand, a holistic approach to the design process should be based on specific data, while at the same time putting the user at the center. In this case, it is important to understand the perspective of the children themselves, who can offer solutions and innovative ideas. Equally important in this process is the evaluation of initiatives to provide feedback and reach conclusions (ARUP, 2017).

This paper, based on a diploma thesis project, aims to present a process of children's participation in the design of public space in a medium-sized Municipality in Greece. In a society where children are considered to be passive and without opinions, this project attempted to bring them at the forefront by listening to their views, suggestions and desires; children are not treated as passive recipients but as active citizens. This participatory approach reinforces democracy by supporting children's opinions and leads to the creation of inclusive spaces that are not segregated playgrounds but operate as living environments that encourage expression, creativity and social interaction. The area of study, Byzantion in Kalamaria, Greece, is an area that lacks liveliness and safety, so the project focused on it in order to make it more sustainable. The result – the proposal of the project – is not just a technical solution but sets the foundations for a city that is humane, inclusive and more child-friendly.

The paper is structured around three main areas: the theoretical background, the methodology and its results, and the proposal. The theoretical framework will refer to the importance of play in children's lives, as well as its place in the urban environment and the potential problems that arise. In addition, participatory design and various approaching methods will be discussed. Next, the steps and methods used to conduct the research will be outlined. Also, statistical data from the research, from the two questionnaires and the pilot participatory workshop, are analyzed. Finally, the final proposal is presented, along with key findings and conclusions.

2. A THEORETICAL FRAMEWORK FOR CHILD-FRIENDLY URBAN DESIGN

It is worth analyzing specifically three paradigms of urban design that lead and contribute to a holistic and child-friendly approach. These are: Human-centered design, Nature-based design and play and Inclusive design.

Human-centered design
The shift in design from aesthetics and functionality to a human-centered approach resulted in the incorporation of the needs and desires of residents themselves into the urban and built environment. The specific period in which this change took place was a period of crisis for the modern movement and modern culture (Τσουκαλά, 2006) . Human-centered design also includes "placemaking" which is the participatory process of imagining and creating with other people. This practice cultivates a sense of hope and possibility, while placemaking with children is important not only because of the insights they can offer, but also because of the positive energy they transmit to adults, serving as source of inspiration for intergenerational action (Derr et al., 2018).

Nature-based play
The natural environment provides many opportunities to engage all the senses in play, while also facilitating social interaction by supporting cooperative play (Little, 2020). Nature-based play can be creative, spontaneous and free and can transform into different types and forms. Nature provides the opportunity for a variety of play experiences (Candiracci et al., 2022).

Therefore, nature-based play can help develop greater empathy and respect for nature, as well as enhance resilience. Promoting nature-based solutions in combination with the addition of play elements can create resilient environments, educate on biodiversity and climate action issues and open up new spaces for different types of play (Arup, 2023) . Creating cities with opportunities for direct contact with nature creates inclusive cities that can better adapt to climate crisis issues (Candiracci et al., 2022).

The solution for creating high-quality and connected play infrastructure in nature is the "ecological greening" of urban communities. Some of the key elements that must be included in the design is the multifunctionality of neighborhoods but also opportunities for nature-based play. The presence of water is also an important aspect as it offers opportunities for play, stimulation and relaxation. However, the most important factor to consider is the quality of the place where the children play (Candiracci et al., 2022).

Inclusive design
Physical and mental accessibility is one of the fundamental principles of sustainable urban design (Krishnamurthy et al., 2018) . Inclusive design is mainly based on inclusion but also takes into account the needs of all social groups, ages etc. Such design can be applied to play. Through play, individuals can develop their skills and solve their problems in a creative and enjoyable way. Play is ideal, in order to develop cognitive, emotional, social and creative skills (Candiracci et al., 2022) . Play can have a positive effect on intergenerational connections. More specifically it is important to appreciate the advantages that each generation has to offer. Public parks and urban design can help in this process by providing the right environment for people of different ages to meet and coexist (Washington et al., 2019).

3. THE IMPORTANCE OF PARTICIPATORY DESIGN WITH CHILDREN

In order to gain a deeper understanding of the needs of children, their participation is of great importance. A participatory design process in which children take part leads to the broadening of horizons for both children and adults, the development of personal responsibility and also moral and personal growth. Furthermore, it contributes to increased self-motivation and self-esteem, while it can also help with social connection and decision-making (Fernandez et al.,

2020). The identity of a space has a particular connection with the identity of the "self" and contributes to the child's overall development. Therefore, these types of processes are essential for cognitive and social development, adaptation to the environment and the creation of autonomy, so it is clear that the participation in such design activities takes on both socio-political and psychological dimensions (Τσουκαλά, 2013).
Is should be understood that children have more knowledge about the "recipe" for the proper design of play areas, while they have better understanding of the space in which they play and activate (Freeman, 1995). However, they usually treated as innocent beings who are unable to express their opinions and their own ideas without adult guidance - a notion that has become ingrained in the foundations of childhood culture (Baraldi, 2003). The "antidote" to this situation is the participatory design, which can motivate young people to co-create their future. Thus, instead of being objects of research, children take an active role and become co-researchers and co-creators (Kleine et al., 2016).

Therefore, a "proper" participatory process must understand the needs and interests of children and young people, as well as the ability to participate in such processes. These methods are designed in such a way in order to support active participation and generate wealth of information that can serve as a source of insight for local plans, policies and co-design spaces. These actions serve as a lesson in the effective involvement of young children in planning and as a catalyst for creating strong social outcomes (Corkery & Bishop, 2020). Therefore, with the right tools, children can be an important factor in shaping spaces and decision-making.

According to Hart, who based his work on the forms of participation applied by Arnstein, there are eight forms of child participation, which are grouped into two categories: participation and non-participation (Τσουκαλά, 2013). However, proper participatory design with children is important to follow some of the forms of participation in order to have a meaningful participation of children in the process. To achieve this, various tools are used to help children and young people develop their ideas, suggestions and concerns. Some of the tools that are widely used in such processes are the following:

- Painting: An important tool for expressing ideas, describing experiences and communicating. However, this method can lead to confusion by misinterpreting meanings. For this reason, it is important to discuss the pictures in order to understand the children's perspectives.
- Mapping: Maps are an important source of information and provide cultural, geographical, environmental and other data. They can contribute to the perception of a space, serve as a topic for discussion and motivate young people to create new maps. At the same time, it gives children the opportunity to identify elements that are important to them. Through maps, children can develop their own perspectives and ideas for change and improvement (Derr et al., 2018).
- Photography: This method is particularly useful when the photographers are the children themselves, as it depicts their own field of vision that make others understand the difference of perspective and height. Taking photographs makes children think about the significance of objects, places and people (Clark, 2024). There are many ways in which photography can be used as a tool, such as photo-voice, photo-elicitation, photo-drawing and photo-framing (Derr et al., 2018).
- Interviews: This is a difficult but very important tool that contributes to the process. Various factors must be taken into account, such as the children's age, interests and

skills. Interviews can take place individually or in groups, depending on the preference of each child. In any case, flexibility is very important (Clark, 2024).

- Model making/building: This method gives the opportunity to children to explore their local environment and suggest new solutions. Additionally, three-dimensional models help children understand the space better and also serve as a catalyst for discussion about their experiences and knowledge about the area.
- Role-playing: By taking on a role and "hiding behind a puppet" children feel more comfortable, making it easier for them to express their thoughts and feelings (Derr et al., 2018).

Some additional tools are storytelling, creating photo books, observations and collage-making. In general, all the participatory methods mentioned above should have the following characteristics:

- Relevance: Children should find the topic interesting and relevant to their priorities
- Creativity: Creative methods keep children engaged and motivate them to participate and share their ideas.
- Participation: By providing feedback on the approaches used and the opportunity to influence and co-shape the research, children feel that they are participating in the final outcome.
- Flexibility: Processes must remain open and flexible.
- Empowerment: Processes should aim to stimulate children's thinking, providing new knowledge and boosting self-confidence, increasing their ability to speak freely and act independently (Kleine et al., 2016).

It is important to note that the above methods could be combined to create different approaches. As Hart points out, if we want to build more democratic communities it is important to go beyond the simple listening strategies (Derr et al., 2018). An approach that is used very often at this kind of workshop is the Mosaic Approach. This method provides a set of narrative tools that are properly adapted for implementation with young children (Clark, 2024). The variety of methods helps to highlight the strengths rather than the weaknesses of young children, which boosts self-confidence and motivates them to participate. Additionally, the use of different methods allows them to develop their creativity and imagination (Γκέσιου&Σακελλαρίου, 2018). Some of the tools are observation, the creation of photobooks, guided tours for children, slide show or "Magic Carpet" (with images from various playgrounds abroad), and map making. The Mosaic approach gives children the opportunity to reconsider their answers and change their opinions. This approach is structured in three stages. The first stage includes collecting verbal and visual material. The second stage entails reviewing the material collected, and finally, the third stage is the decision-making stage.

Also, this approach enables both children and researchers to take on multiple roles during the research process (Clark, 2024). At the same time, the children themselves actively participate in the research process as active individuals. Therefore, the approach is characterized as follows:

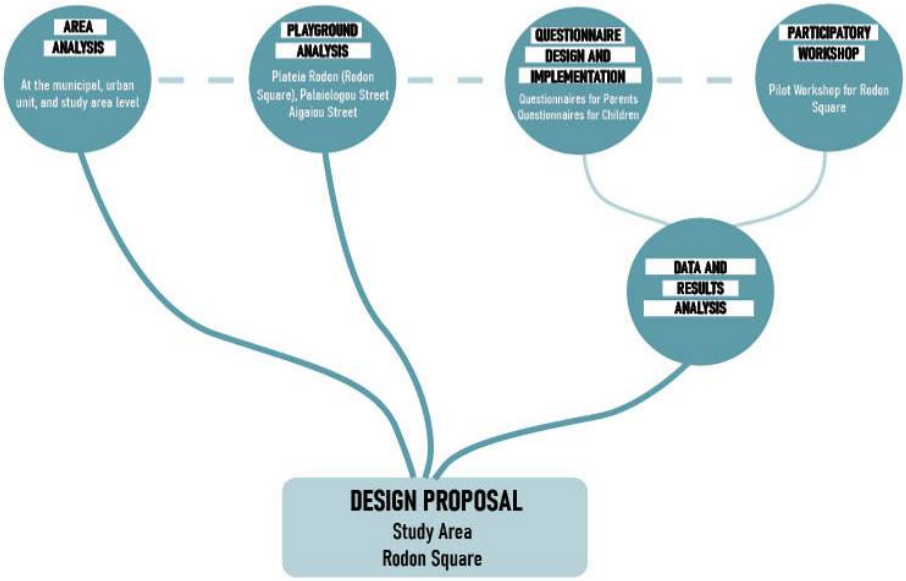
- Multimethod: It recognizes the different voices of children's language using multiple tools.
- Participatory: Putting children at the center and considering them experts.
- Adaptable: it can be applied on a wide scale.

- Focused on children's experiences: taking into account children's memories and everyday life rather than their knowledge.
- Committed: to practice (Γκλούμπου&Κακανά, 2018).

4. METHODOLOGY

The first part of the methodological process was the analysis of the area, which was carried out through field research and the collection of information after extensive observation of both the problems of the area and the behavior and actions of individuals. Next, a thorough analysis of playgrounds, open play areas and schools in the area –places where children spend time– was also carried out. The next stage of the research was the collection of questionnaires from both children and parents/guardians. Specifically, the parents' questionnaires were completed on site (at the playgrounds within the study area). The playgrounds where the research took place were the playground on Aigaiou Street, the playground in Rodon Square and the playground on Pasalidi Street. The questionnaire included 16 questions related to safety, freedom, and improvements to playgrounds and open play areas. Data collection took place during the period of December 2024 – January 2025, specifically between December 5th and January 4th. Most of the questions in the questionnaire were closed-ended, with one exception (open-ended). While completing the questionnaire, parents made comments and observations about the current situation, which contributed significantly to the research.

Figure 1: Conceptual diagram of research methodology



As for the children's questionnaire, according to (Kleine et al., 2016) and the rapid development of technology, it was decided to use digital media (tablets) and the Typeform software, a platform for conducting online forms and surveys. The questionnaire was designed in a child-friendly way, and it consisted of two parts, choosing between photos and rating images using stars. The questionnaire consisted of 19 slides, 14 of which involved choosing a photo and five of which involved rating a photo. More specifically, the selected photographs were categorized appropriately in order to refine the research and draw clearer conclusions.

The categories are as follows: Color, Materials, Size of Intervention, Specification of Play, Freedom of Movement, road, schoolyard, DIY, Activities, Nature, Diversity (of games). Consequently, each child's choice contributed to the mosaic of the playground of their dreams. The sample was collected at the same time as the adults' sample (between December 5th, 2024 and January 4th, 2025), and the average time taken to complete the survey was no more than five minutes. The questionnaires were collected in person at the playgrounds in the area after parental consent.

Considering the importance of celebration and reward in such processes with children as mentioned by Derr, Chawla and Mintzer (2018) in the book "Placemaking with children and Youth", after each child completed the questionnaire a hero character appeared on screen (Nature and City) who represents the child's preference. These heroes were created with the help of artificial intelligence, taking into account the preferences data. Depending on the hero that appeared on the screen, the corresponding gift was offered. The reward process helped the children realize the value of their opinions and participation.

To ensure that the results are fully in line with the children's preferences, a small group of children was selected to organize a small pilot workshop in the study area, specifically in the intervention area. The small group of children was selected for safety and supervision reasons. The children's ages ranged from 10 to 14. Initially, the workshop began with a visit to the area where the children identified elements they liked and disliked about the space, while at the same time, they took photographs of elements that caught their attention both positively and negatively. This was followed by discussion about the photos for further research. The next step was to create their own free play area in Rodon Square. The process was carried out on an A1 board and was divided into three parts. The first part of the process was to create a list of their wishes. Then, their wishes were mapped out in the form of numbers, and they had the opportunity to design on top of that, creating paths and additional elements. The last part consisted of designing over photographs of the space and transforming it based on their own thoughts and preferences. At the end of the process, there was a celebration with the distribution of commemorative gifts.

Taking into account the opinions, views and wishes expressed in the questionnaires and the participatory design workshop, a comprehensive understanding was developed of the elements that would constitute an ideal playground, serving both young and adult users. Consequently, the next and final stage of the methodology was the design of the space, including the design of the larger area- all the study area - and on a smaller scale, specifically redesigning Rodon Park. Drafting software applications for two-dimensional and three-dimensional design were used to develop the final drawings.

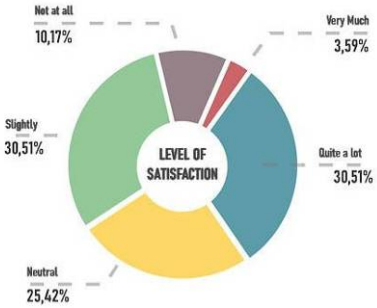
5. RESULTS

Parents' Survey Results

As mentioned in methodology, a survey with parents was conducted in the playgrounds of the area. This process gathered a considerable amount of data on safety and satisfaction issues relating to existing free play areas. This process helped the research a lot. Below are some of the charts and analyses that resulted from the 59 collected questionnaires.

Regarding the level of satisfaction with the condition of playgrounds (Figure 2), 30.51% stated that they were quite satisfied, while another 30.51% appeared to have moderate satisfaction. Fifteen of the 59 respondents were neutral, while a minority of respondents gave one of the extreme responses (very satisfied or not at all satisfied). To summarize the responses, satisfaction tends to lean toward the negative side.

Figure 2: Level of satisfaction from the area's playgrounds



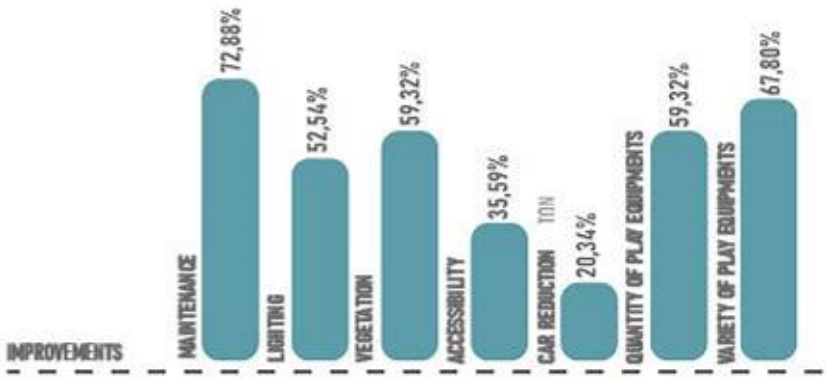
A correlation analysis was performed to investigate the relation between how satisfied parents were from the playgrounds with how often their children visited them. The table below (Figure 3) shows the correlations between the satisfaction of parents and the frequency of visits to the playgrounds of the area. It was observed that those who reported being quite satisfied with the condition of the playgrounds chose to visit the playgrounds on a daily basis (p=0.047). Visiting a few times a week was associated with neutral satisfaction (p=0.013) and low satisfaction (p=0.016). Those who visited the play areas only once a week reported being very satisfied with the current state of the playgrounds (p=0.001). Finally, dissatisfaction was associated with daily visits (p=0.002) and visits several times a week (p=0.131).

Figure 3: Correlations between parents' satisfaction level and frequency of visits to playgrounds

	DAILY	***SEVERAL TIMES/WEEK***	***ONCE A WEEK***	***SEVERAL TIMES/MONTH***
LEVEL OF SATISFACTION				
Very much	0,360	0,186	0,001*	0,628
Quite a lot	0,047*	0,117	0,842	0,874
Neutral	0,125	0,013*	0,284	0,603
Slightly	0,079	0,016*	0,842	0,274
Not at all	0,002*	0,131	0,273	0,385

Regarding suggestions for improvements, results are presented in Figure 4. Some of these are the ban of smoking in playgrounds (although there are signs, this is not always respected), the addition of more trash cans, more shaded areas and kiosks, clean water and public fountains. There were also several complaints about teenagers (due to broken glasses and cigarettes they may leave behind) and animals that may pose a risk to children (due to their behavior and uncleanliness). The fencing around the swings was also mentioned, while the addition of defibrillators in playgrounds was highlighted as important. Finally, one improvement mentioned by many parents is that playgrounds should become more in scale and number, providing more opportunities for children.

Figure 4: Areas for improvement, according to parents' survey



Regarding the installation of non-strict fencing around playgrounds, a large percentage (89,83%) were reluctant at this kind of practice due to safety issues that could occur. Many believe that the infrastructure to implement such a measure in Greece does not exist, making them feel insecure about possible accidents. However, they are not opposed to natural fencing. As for the participatory workshop, 58 out of 59 respondents said that they would like to participate in such practices with their children, considering the contribution and opinion of the children themselves to be important.

Children's Survey Results

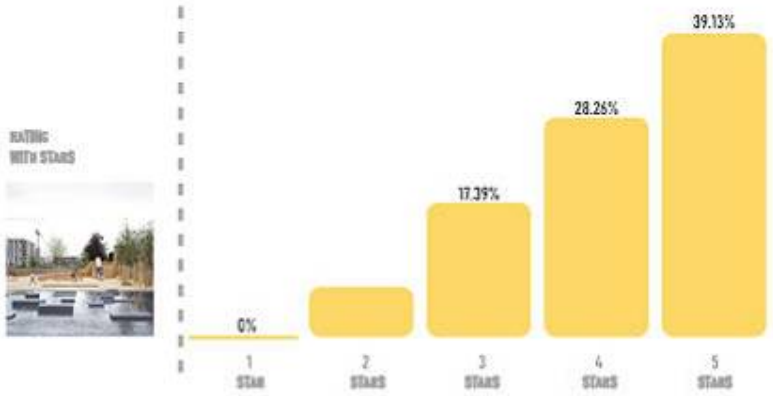
As mentioned in the methodology, the questionnaire was completed by the children in an interactive and entertaining way with the help of technology. This process yielded important results regarding children's preferences from the choice of materials to the overall design of the play space.

Figure 5: Choice of environment

In the question regarding which category of playgrounds they preferred (with or without natural elements), the majority of children chose the first image, which clearly shows the presence of nature. This choice received 76.09% of the responses (Figure 5). In the category of images related to color, 63.04% of children preferred a play area with color in order to create a more friendly atmosphere. There was also a significant difference in the responses

regarding the choice between cognitive games and conventional play equipment. Most children chose the first answer and the maze with 63.05%. Children showed their need for game and play equipment that will develop all their senses and are different from the usual ones.

Figure 6: Rating a park with stars



In the second part of the questionnaire and on a chart that shows a park with natural elements and unconventional play equipment, the votes increased progressively, with fewer votes concentrated on the 2 stars, while the most were concentrated on the 5 stars with 39,13% (Figure 6).

Participatory workshop analysis

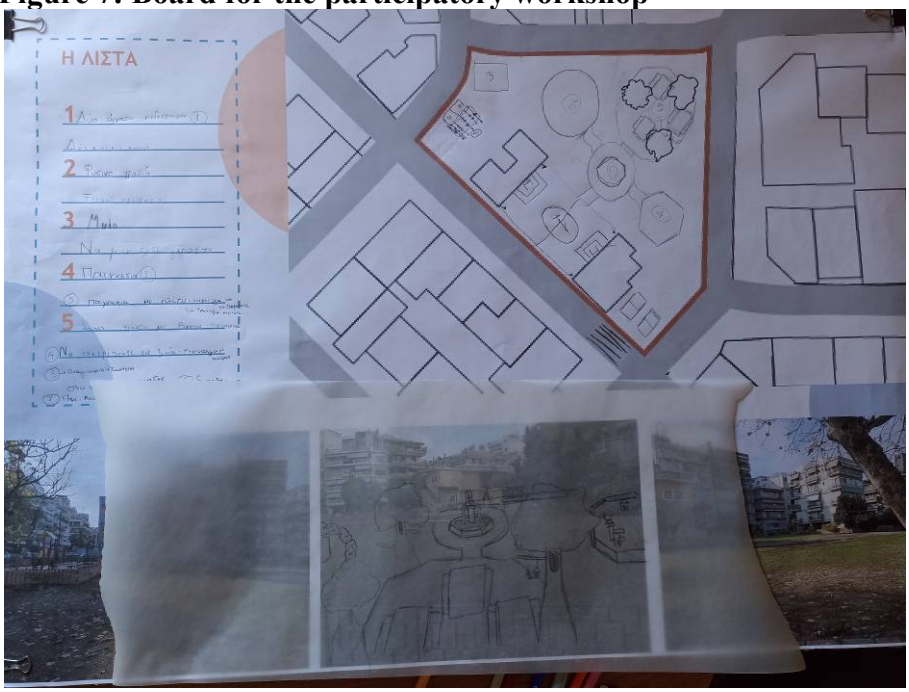
In order to acquire direct input from children regarding the new design, a participatory workshop was held with the involvement of children aged 10-14. This workshop contributed to a deeper understanding of the needs and desires of children. The process included various activities, each of which contributed significantly to the overall design proposal for Rodon Park.

The first stage of the workshop included a visit to the park so that the children could get an overall impression of the space and focus on its most important features. The children took photographs to help them in this process. Specifically, they were divided into two groups and asked to take photographs of three elements they liked and three they did not like in the area. As positive elements they mentioned presence of greenery, safety issues (with the addition of railings in the playground) and cleanliness. Regarding negative aspects, both groups of children focused on graffiti that was present on the playground equipment and on the walls. In addition, the negative aspects included photos of benches without backrests as well as the potholes in the area, which could injure people, while other group listed the cemented area as a negative one, suggested that it would be better to cover it with grass

The second stage was the design process. In the first part, the children were asked to express their wishes for Rodon Park, and from the results it appears that the children had many ideas and wishes. At first, they focused more on specific games and mentioned some that they would like to see in the playground, such as a merry-go-round, circular swings and a climbing wall. In addition, they would like to see a sport court for ball games. Particular emphasis was placed on their desire for natural grass and the avoidance of graffiti. They expressed their need for benches with backrests as well as picnic tables. They also wanted adequate lighting at night and natural fencing to create a sense of security. They also wanted

animals to be allowed but in a fenced-in area. They envisioned a park that would be accessible and inclusive. Last they added a wish for a refreshment area as well as a meeting point. The girls also mentioned public toilets.

Figure 7: Board for the participatory workshop



However, in order to express their wishes at a design level, the children proceeded to the next design phase, where they sketched on a map how they would like the elements mentioned above to be arranged (Figure 7). The elements were also marked with numbers. It appears that they chose a solution that does not restrict the natural grass and movement is via small paths made from stone slabs. Centrally located is the picnic area, where trees have been planted for shade, while the refreshment area is located in the left corner in order to be accessible from all areas. The sport court was placed by the children between the two existing buildings. In addition, there are also ping-pong tables. It is worth noting that the children mentioned the importance of reducing traffic on the surrounding roads for safe play.

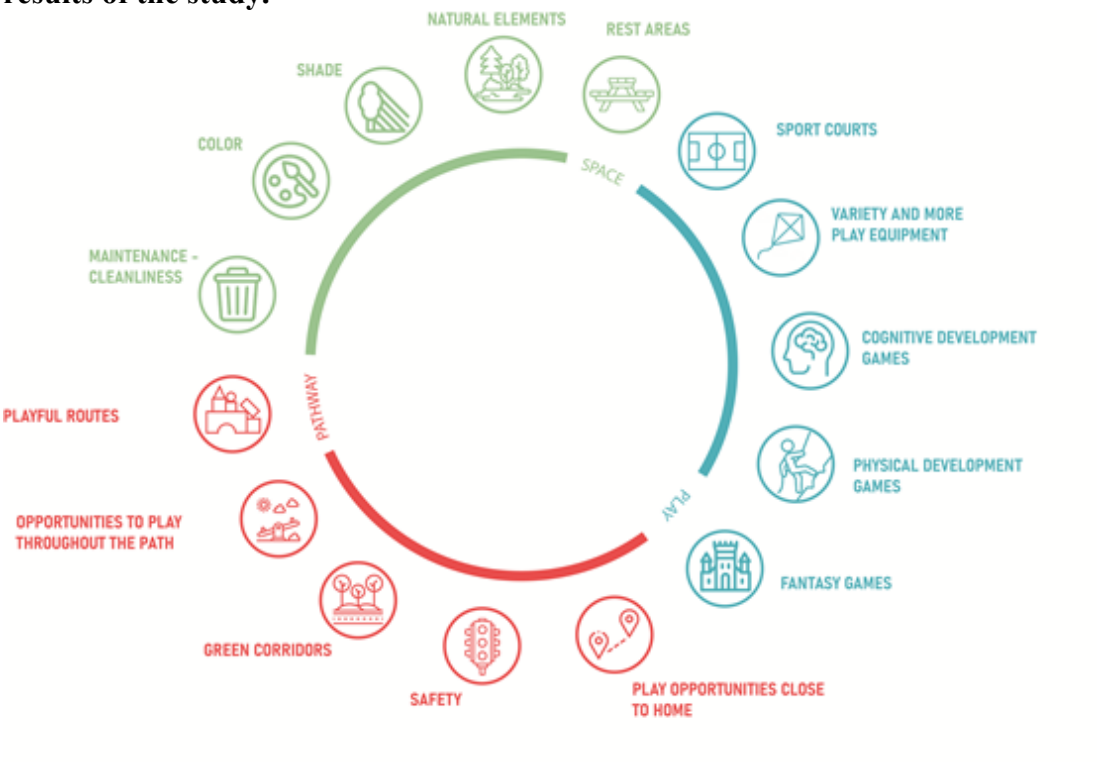
In the last activity, the children were asked to draw a picture of the park of their dreams. At this phase, the children were satisfied with the idea they had proposed, so they followed it at this stage as well. For this reason, they assigned this task to a specific person-child because they believed that this person would best capture what they had proposed. During this time, the children supervised the process and made corrections, suggesting green fences and bushes. Unfortunately, due to lack of time, the process was limited to a single image. However, even this managed to capture an overall view of the open space.

6. DISCUSSION

Based on the results of the participatory process, the wishes and opinions of parents and children, based on the survey and the participatory workshop, are summarized in a diagram (Fig. 8). Following a three-part structure, the diagram attempts to categorize the wishes and also to identify certain elements that are important to all three sources of information. More specifically they are divided into:

I. *Pathway*: Based on the three sources of information, the main concern was safe routes. Parents and children consider independent mobility an important aspect, with the addition of crossings and safe roads. Furthermore, particular emphasis was given on the possibility of playing close to home, as well as opportunities to play throughout. The inclusion of natural elements in the pathway is also an important factor.
II. *Space*: Parents mainly focused on the problems that currently exist in play areas, so they are looking for elements such as cleanliness and shading. In addition, parents and children consider rest areas an important element, while children placed particular emphasis on color. Natural environment also played a special role in this category.
III. *Play*: There were several elements that both children and parents considered important for play. Initially, emphasis was placed on the variety and quantity of play elements. Therefore, it is necessary to include games that strengthen mental and physical abilities, games that have a competitive element (such as sports), as well as games that stimulate imagination.

Figure 8: Diagram showing the three pillars of design for the study area, based on the results of the study.



7. DESIGN PROPOSAL

The design proposal at the neighborhood level (Figure 9) included the design of a network of pedestrian streets and sidewalks, while also recommending traffic-calming measures in several locations. A network of green routes is also proposed, mainly on major road axes. The most important part of the proposal is the emphasis on play opportunities, which are not limited to existing playgrounds but also extend to parks and open spaces that do not currently have a specific designated use.

Figure 9: Design intervention for the study area

Specifically for Rodon Park, the design was largely shaped by the proposals generated during the participatory workshop with the children (Figure 10, 11, 12). The park was divided into five main zones: the playground, the resting area, the fountain, the dog park and the sports courts. Special emphasis was placed on preserving natural environment and ensuring minimal intervention. At the images below it is clear the proposed design for the park, featuring the use of permeable materials, added lighting and the thoughtful use of color. Additionally, in the design of the playground, very crucial is the addition of unconventional play equipment that stimulates imagination and encourages spontaneous play. Throughout the entire area, the use of soft protective surfaces is avoided, as these can be toxic to children, especially when heated (Katsavounidou, 2025).

Figure 10: Design Proposal for Rodon Park

Figure 11-12: Visualizations of the new design for Rodon Park

8. CONCLUSIONS

The contribution of the project is significant. Specifically, it can contribute to the literature on participatory design and in particular workshops related to play areas. At the same time, it is an example that can serve as a basis for similar large-scale designs at both the municipal and national levels.

The study shows the importance of child-friendly design for enhancing urban resilience. At the level of social resilience, this was achieved through the contribution of children to the

planning and designing process, where it became apparent that they had the knowledge and experience, as well as the willingness to contribute and express their desires and needs. Consequently, it is worthwhile to give them a voice and treat them as active citizens with views, knowledge and opinions. In addition, the design and proposals that were suggested aim at inclusion and social contact. By creating well-designed spaces for children, they come into contact with many different stimuli and images, contributing to the overall development and growth into well-rounded individuals with sensitivity and empathy. In addition to social resilience, these proposals contribute to climate resilience, promoting nature-based solutions that contribute to children's development while preventing problems caused by potential disasters due to extreme weather events. Therefore, designing for urban childhood is a multi-dimensional solution that must be prioritized.

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CARTOGRAPHIES OF URBAN METABOLISM TOWARDS SELF-SUSTAINING TERRITORIAL SYSTEMS

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Abstract
This paper addresses the question of a transition of cities from energy-dependent entities to self-sustaining systems. It investigates the concepts of urban metabolism and bioregionalism, interrogating how urban territories might reorganize themselves to optimize energy production and consumption. Applying these metaphors to cities, it examines how territories might evolve from heterotrophic, dependency-based systems towards more autotrophic urban ecosystems. As urban regions are traditionally structured by administrative boundaries disregarding energy balance questions, the research aims to challenge the spatial paradigms to a cartography redefining them.

To frame the context, the research first examines and interprets case studies and urban planning paradigms applying methods and tools linked to urban metabolism as well as research on bioregionalism.

This is followed by a a case-specific exploration that uses spatial data to evaluate energy production and consumption patterns to a selected territory.

Methodologically, the study combines spatial data with GIS tools to map and analyze a specific case's land use data, translating spatial patterns into energy balances. More specifically, potential energy -producing and energy-consuming spaces are mapped, revealing sub-spaces with potentialities for energy autonomy.

By removing administrative borders from the mapping process, a new cartography emerges, redefining potential territories based on energy potential by identifyingzones with potential for energy self-sufficiency, but also reading spatial inequalities.

This exploration suggests a reinterpretation of urban spatial models challenging centralized energy networks towards decentralized and polycentric or micro-systems. A reorganization of urban space based on energy metabolism could provide a framework addressing systemically ecological autonomies and socio-spatial equities.

The paper aims to be an empirical basis for rethinking energy governance and infrastructure planning particularly in light of climate and energy crises.

Key words: urban metabolism, territorial metabolism, bioregionalism, sustainable cities, land use, energy autonomy

ROAD MANAGEMENT REGARDING WILDFIRE VULNERABILITY IN THE REGION OF THESSALY, GREECE

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Abstract
The escalating frequency and severity of wildfire events have revealed fundamental deficiencies in conventional management approaches centered primarily on mitigation efforts. This necessitates a paradigm shift toward proactive strategies grounded in adaptive frameworks that recognize fire as an inherently dynamic ecological phenomenon. Central to this transformation is the reconceptualization of road infrastructure from fixed assets to adaptable systems with the capacity to facilitate both preventive measures and rapid emergency response. Within this shift, road networks assume a complex and essential function. Rather than serving solely as transportation pathways, roads must be understood as integrated, multi-purpose elements within resilient landscape systems. This research consolidates insights from wildfire risk assessment and road network analysis to develop an adaptive management framework for road infrastructure in the Thessaly Region. The approach is grounded in comprehensive wildfire risk evaluation, which enables the classification of road networks into distinct risk zones suitable for tailored management interventions. These interventions must operate as ongoing, responsive processes rather than static, single-occurrence measures, continuously evolving in response to emerging scientific evidence and systematic monitoring. This cyclical approach guarantees that management practices remain both effective and responsive to changing environmental dynamics, thereby strengthening landscape resilience in the face of wildfire threats.

Key words: Road network management, wildfire risk, public policy, GIS, Thessaly Region

1. INTRODUCTION

The Mediterranean Basin is currently navigating a precarious ecological shift often termed a "pyric transition." We are witnessing the rise of "mega-fires" events of such ferocity and speed that they render standard firefighting capabilities obsolete (Moreira et al., 2020). Within this volatile environment, a region's road network plays a complicated, dual role. It is, undeniably, the backbone of civil protection, serving as the primary escape route for civilians and the entry point for suppression forces (Molina-Terrén et al., 2019). Yet, paradoxically, these same roads fragment habitats and can act as vectors for human-caused ignitions (Leone et al., 2023).

For decades, forest management in Southern Europe viewed roads merely as static assets, maintained strictly for logistical efficiency or biomass exploitation. However, the accelerating climate crisis demands, we rethink this approach. Roads must evolve into dynamic lines of defense integral parts of a "fire-smart" landscape designed to mitigate fire behavior rather than just facilitate travel (Fernandes, 2013). This evolution is particularly pressing in Greece, where the rugged topography creates a logistical nightmare for emergency planners (Xanthopoulos et al., 2022). Previous research has highlighted the importance of optimizing these networks not just for timber transport, but for multi-criteria decision making that includes fire prevention (Liampas, Stamatiou, and Drosos, 2019).

The Region of Thessaly offers the necessary diversity to test this new approach. It presents a landscape of extremes: from the flat agropastoral expanse of the central plain to the steep, inaccessible slopes of the Pindos mountains and the tourist-dense coastlines of Magnesia. While recent Greek legislation (Circular YPEN/DAOKA/42966/1311, 2024) has rightly focused on hardening properties near forests, there is a glaring lack of strategy regarding the resilience of the road network itself.

The aim of this paper is to union the wildfire risk data with detailed network topology, to strengthening landscape resilience in the face of wildfire threats framework. Our goal is to move beyond static maintenance schedules to a system of continuous risk assessment (Chuvieco et al., 2023). The study aims to quantify the "accessibility deficit" in Thessaly, identifying exactly where the need for protection is mostly needed and pinpoint the operational "blind spots" that compromise safety (Palaiologou et al., 2020).

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

The struggle to align road ecology with wildfire defense is not unique to Greece; it is a priority shared across the Mediterranean, with pivotal research emerging from Portugal, Spain, and Italy. Following Portugal's tragic 2017 fire season, the scientific consensus shifted away from pure suppression. Researchers like Moreira et al. (2020) championed the idea of "Fire-Smart Territories." The core argument is that we cannot simply fight fires; we must engineer landscapes that resist them. In this view, road networks should do more than connect point A to point B, they should compartmentalize the land, breaking up continuous fuel loads into manageable blocks (Tedim et al., 2018). Major arteries thus become strategic "anchor points" for counter-fire operations (Castellnou et al., 2019).

There is a counter-intuitive thread in the literature regarding road density. Conventional wisdom suggests that more roads equal faster response times, which is crucial for stopping a fire early (Plucinski, 2019). However, Leone et al. (2023), working in the Apulia region of Italy, uncovered a complication: higher road density often leads to higher ignition frequency simply because it brings more people into the forest. This "accessibility paradox" suggests that paving more roads into the wilderness is not a silver bullet (Ricotta et al., 2018). The solution lies not in quantity, but in the defensibility of the existing corridors (Dunn et al., 2020).

Effective management requires sophisticated decision support systems. Palaiologou, Papageorgiou et al. (2021) demonstrated that spatial optimization frameworks are essential for balancing competing forest management priorities, such as timber production versus fire resilience. Their work in Macedonia, Greece, highlighted that trade-offs are inevitable, and that optimal infrastructure planning must account for these conflicting goals. Similarly, Liampas, Stamatiou, and Drosos (2019) utilized Least Cost Path Analysis (LCPA) to prove that road network planning must integrate biomass exploitation with fire prevention logic to be economically and ecologically viable.

The Vulnerability of the Wildland-Urban Interface (WUI) is the critical zone where human settlements meet combustible vegetation. In Greece, unmanaged WUI expansion has

been identified as a primary driver of risk (Mitsopoulos et al., 2020). Studies by Badia et al. (2019) in Spain confirm that roads in these zones often fail during mass evacuations due to smoke occlusion and panic. In this study, the analysis of Thessaly's road network specifically targets these interface zones, applying the lessons from the catastrophic Mati fire of 2018 (Lekkas et al., 2018).

3. METHODOLOGY

To rigorously evaluate the interplay between infrastructure and fire risk, we adopted a geospatial analysis approach covering the entirety of the Region of Thessaly. The Study Area of Thessaly acts as a crucial ecological crossroad in Greece. Administratively split into four units of Karditsa, Larissa, Magnesia (including the Sporades), and Trikala, the region is defined by a massive central plain ringed by mountains (Olympus, Ossa, Pelion, Pindos). This semispherical shape creates diverse microclimates, transitioning from lowland scrub to high-altitude coniferous forests, each presenting distinct fire behaviors (Koutsias et al., 2016).

The methodology to calculate the wildfire risk is based in the National Wildfire Risk Assessment Framework (Gitas et al., 2021). This standard evaluates risk through 14 parameters across six groups: morphology, climate, slope, vegetation, infrastructure, and incident history. For this study we tweaked the model and make a Wildfire Risk Map using only five of the six groups, deliberately excluding the "infrastructure" parameter. We did this to avoid circular logic; we wanted to assess the inherent danger of the landscape before overlaying the road network to see how well the infrastructure serves the terrain (Salavati et al., 2022).

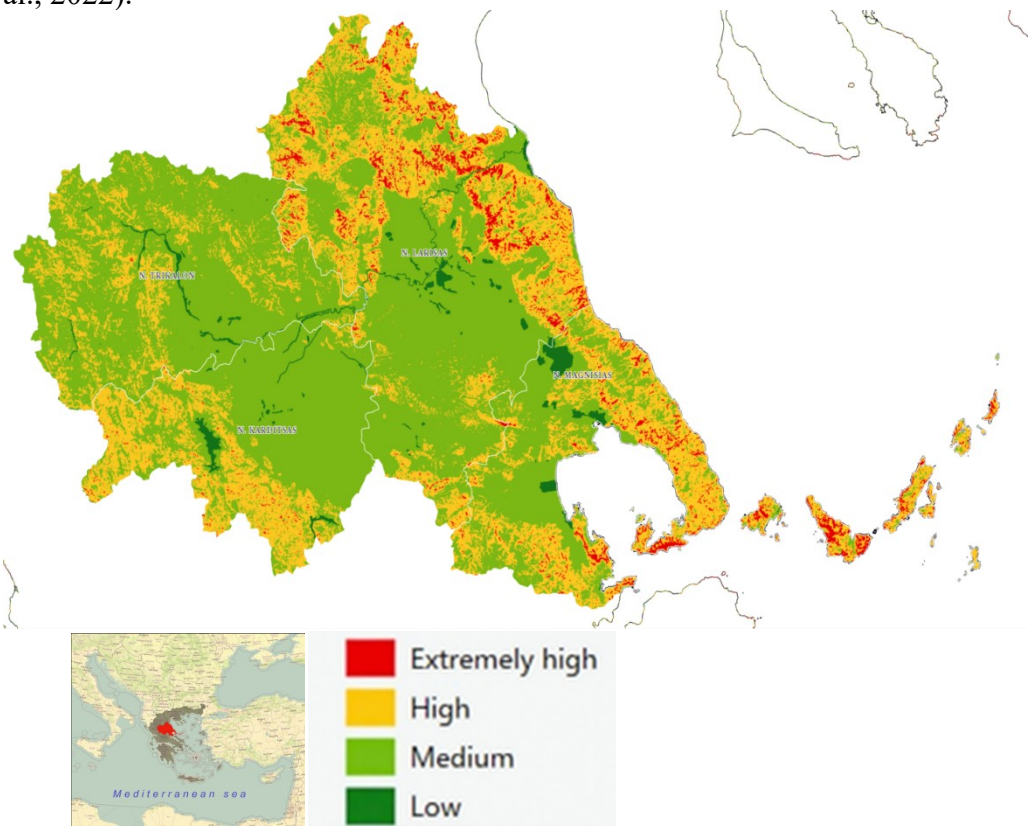

Figure 1. Wildfire risk mapping of Thessaly

The Geospatial Analysis workflow was implemented through a four-stage process. In the initial stage, road network data were acquired from open-source repositories within the

OpenStreetMap (OSM) framework, and a comprehensive vector dataset was compiled specifically for the Thessaly Region. This compilation yielded a total road network extent of 41,798 km of infrastructure (note that road length measurements throughout this study represent horizontal plane projections). The second step is to overlay the road network to the wildfire risk map using GIS. This allowed us to tag every single kilometer of road with the risk level of the land it crosses (Low, Medium, High, Extremely High). The third step is the extraction, where we analyze the numbers, calculating road lengths per risk category at the Regional, Prefecture, and Municipal levels. The last step is the Indicator Development. To make sense of the raw data, we developed the "Accessibility-Risk Mismatch" indicator. This metric compares the percentage of land requiring protection against the percentage of infrastructure available to provide it.

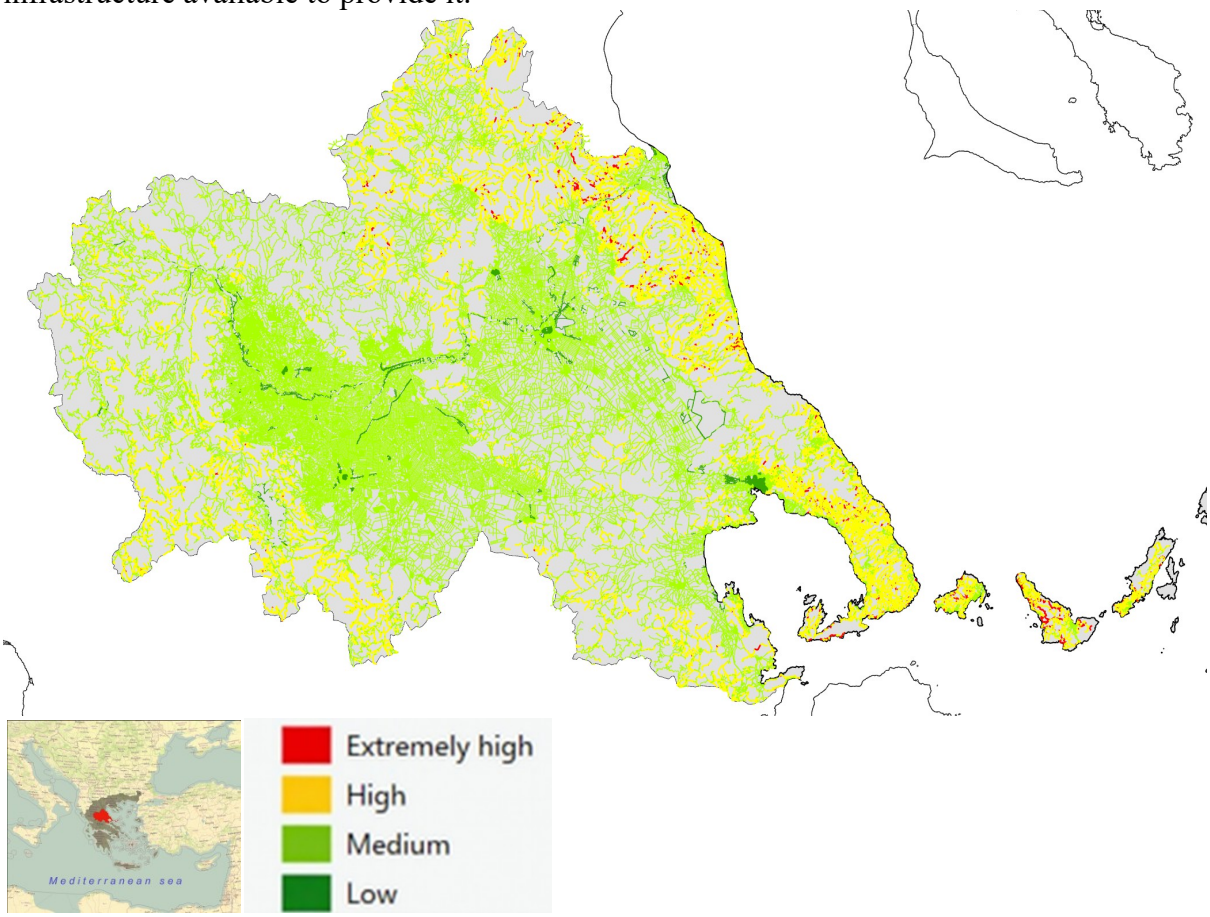

Figure 2. Wildfire risk mapping of the road network

4. STATISTICAL DATA & RESULTS

Analyzing nearly 42,000 km of roads against the fire risk landscape exposed deep inequalities in Thessaly's resilience profile.

The Regional Risk Distribution, the data reveals a stark imbalance. Most of the region's roads pass through relatively safe areas, while the most dangerous zones are under-served.

Table 1. Comparison of Land Area vs. Road Network Length per Risk Category

Wildfire Risk	Area (km^2)	Area (km^2) Percentage	Road network (km)	Road network (km) Percentage
Extremely High	1215.61	8.7%	583.42	1.4%
High	3953.23	28.1%	8058.98	19.3%
Medium	8449.29	60.1%	31893.98	76.3%
Low	430.65	3.1%	1262.56	3.0%
Total	14048.78	100.0%	41798.93	100.0%

- Low Risk: This covers 3.1% of the land and contains a proportional 3.0% (1,262 km) of the roads.
- Medium Risk: This category dominates, covering 60.1% of the land and holding the vast majority—76.3% (31,894 km)—of the network. This makes sense, as this includes the agricultural plains where road density is naturally high.
- High Risk: Here, the gap widens. High-risk land accounts for 28.1% of the region, yet it contains only 19.3% (8,059 km) of the roads.
- Extremely High Risk: This is the crucial finding. The most dangerous 8.7% of the land (1,215 km^2) is served by a meager 1.4% (583 km) of the road network.

Table 2. Data of Land Area vs. Road Network Length Data per Risk Category per Regional Unit & Municipality and Municipality Population

Regional unit	Municipality	Population	Extremely High	High	Medium	Low	Total
Karditsa	Argithea	3498	5.84	367.39	250.91	0.42	624.57
	Karditsa	55979	4.07	362.38	2211.74	87.58	2665.77
	Lake Plastiras	5234	4.02	169.28	345.75	21.98	541.02
	Mouzaki	11246	3.25	196.67	1233.41	8.34	1441.67
	Palamas	13427		11.05	2017.81	58.81	2087.67
	Sofades	16927	3.94	238.27	2138.25	2.54	2383.01
	Total Karditsa	**106311**	**21.12**	**1345.04**	**8197.87**	**179.68**	**9743.72**
Larissa	Agia	10710	113.41	1027.17	760.14	22.96	1923.67
	Elassona	25459	82.63	1254.75	1997.48		3334.86
	Kileler	18070	0.44	86.31	2721.81	89.79	2898.35
	Larissa	164093		26.78	1568.61	164.23	1759.63
	Tempi	12005	105.67	595.58	1082.78	51.70	1835.73
	Tyrnavos	22283	16.43	240.11	1125.10	55.00	1436.64
	Farsala	16342	2.57	148.71	1609.30	14.90	1775.48
	Total Larissa	**268962**	**321.15**	**3379.41**	**10865.22**	**398.59**	**14964.37**
Magnesia & Sporades	Almyros	16073	10.55	440.42	1442.85	13.90	1907.72
	Alonnisos	3138	15.61	109.34	33.03		157.97
	Volos	139672	19.90	414.60	1124.96	318.25	1877.71
	Zagora-Mouresi	4562	13.74	263.39	221.61		498.73
	South Pelion	8276	90.56	1011.62	218.03		1320.20
	Rigas Feraios	8869	1.20	109.76	803.04	73.38	987.37

	Skiathos	5804	21.79	112.46	75.05	0.99	210.29
	Skopelos	4520	66.95	166.34	54.62		287.91
	Total Magnesia & Sporades	**190914**	**240.30**	**2627.93**	**3973.17**	**406.52**	**7247.92**
Trikala	Meteora	19276	0.60	402.61	2909.69	56.22	3369.12
	Pyli	12851	0.25	227.76	1782.53	30.67	2041.21
	Trikala	78608		51.61	2754.53	111.57	2917.70
	Farkadona	11350		24.62	1410.97	79.32	1514.90
	Total Trikala	**122085**	**0.84**	**706.60**	**8857.72**	**277.77**	**9842.93**
Total Thessalia		**688272**	**583.42**	**8058.98**	**31893.97**	**1262.56**	**41798.93**

In the analysis by Regional Unit, it is perceived that the risk is not shared equally among the prefectures.

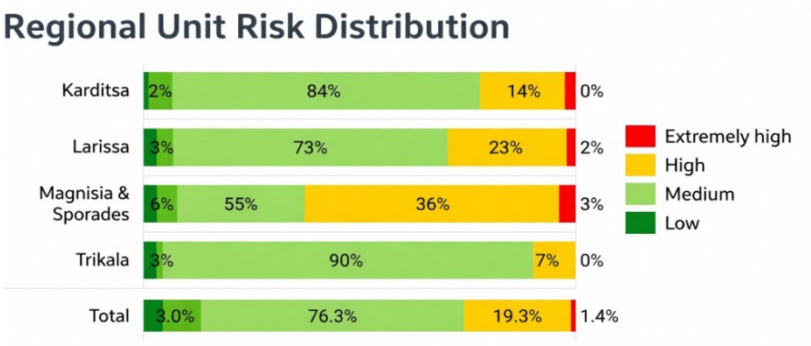

Figure 3. Comparison of Regional Units vs Percentage of Road Network Length per Risk Category

- Larissa: This unit faces the highest absolute exposure, with 321 km of roads in "Particularly High" risk zones and over 3,300 km in "High" risk zones.
- Magnesia & Sporades: While smaller in area, this unit faces the most acute relative threat. A staggering 36% of its road network sits in "High" risk zones, with another 3% in "Particularly High" zones.
- Trikala & Karditsa: These units are comparatively sheltered. Trikala has less than 1 km of road in the highest risk category, and Karditsa has only about 21 km. The overwhelming majority of their networks (90% and 84%, respectively) sit in "Medium" risk territory.

In the analysis by altitude, it is perceived that the vertical distribution of risk challenges follows the assumption that the highest peaks are the most dangerous.

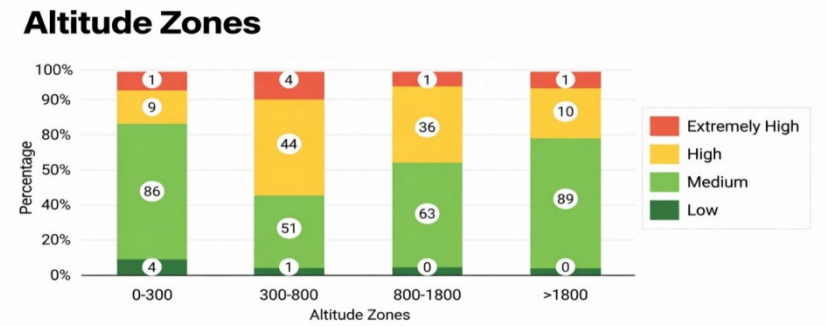

Figure 4. Distribution of High-Risk Road Networks by Altitude Zone.

- 0 – 300 m: The lowlands are mostly safe, containing 86% of the Medium-risk network.
- 300 – 800 m: This is the "Danger Zone." This mid-altitude belt contains 44% of the region's total "High" risk roads. This elevation typically marks the WUI, where human activity impinges on forest land (Radeloff et al., 2018).
- 800 – 1800 m: While this zone holds 36% of the "High" risk network, the "Particularly High" risk drops to just 1%.

A further analysis has been conducted for the 502 local communities of the 25 Municipalities. After thorough investigation into the municipal level of community, specific "Red Areas" emerge that are disproportionately exposed to wildfire risk. The road length of each community is recorded in the Figure 5 below, indicating the high or extremely high risk zones.

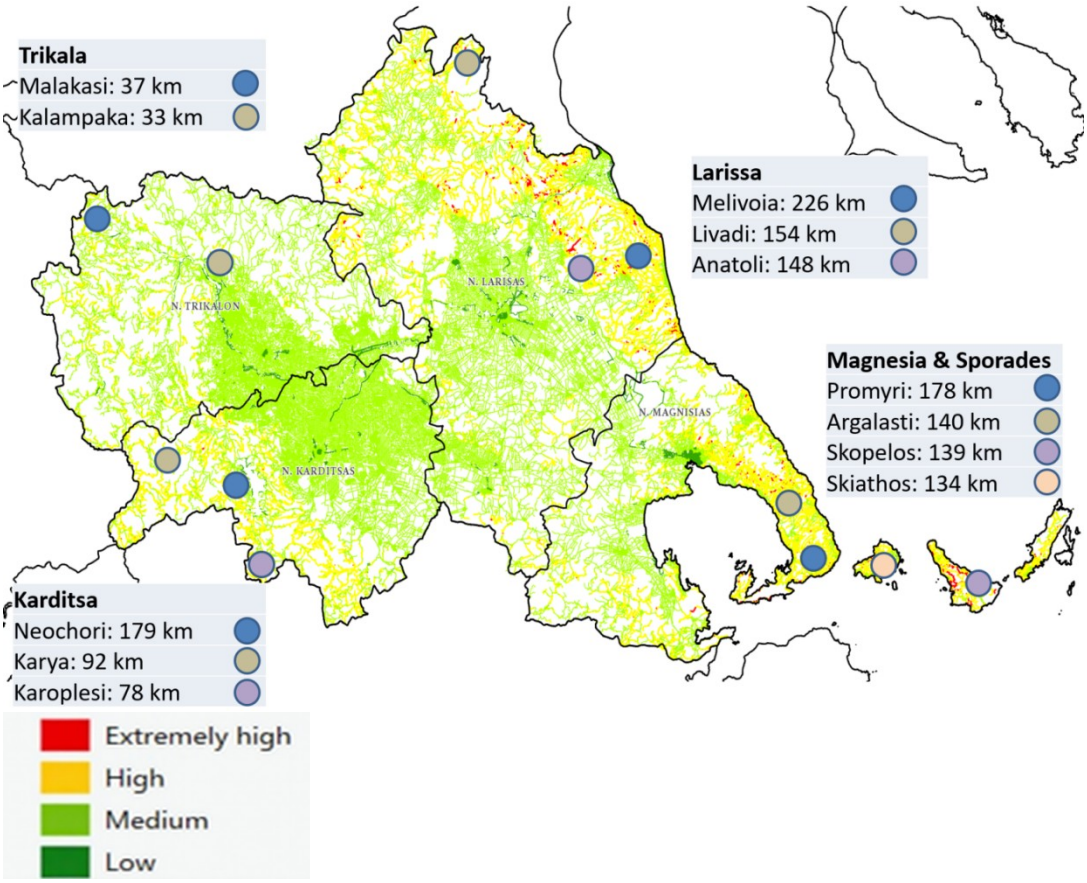

Figure 5. Municipal Communities - *Absolute Length of High-Risk Road Network (km)*

- The "Red" leaders: The Municipal community of Melivoia (Larissa) tops the regional list with 226 km of its roads in "Particularly High" risk zones. It is followed by Neochori (Karditsa) with 179 km and Promyri (Magnesia) with 178 km.
- The Island vulnerability: The situation on the island of Skopelos is alarming. With 66.95 km of roads in "Particularly High" risk and 166.34 km in "High" risk, over 80% of the island's entire infrastructure is in dangerous territory (Stefanidis et al., 2020). South Pelion faces a similar challenge with 90.56 km in the highest bracket.

An analysis of risk concentration reveals an extremely unequal distribution of risk.

- The Top 10%: The top 10% of municipalities/communities (just 43 Local Government Units) accounts for 54.7% of the region's total high-risk road network.

- Affected Population: Approximately 54,347 people reside in these 43 areas. This is the population located on the "front line" of risk.
- Based on road length (km):
    - Melivoia (Larissa): 226 km
    - Neochori (Karditsa): 179 km
    - Promyri (Magnesia): 178 km
    - Livadi (Larissa): 154 km
    - Anatoli (Larissa): 148 km
- Based on Risk Per Capita (km/resident): These areas have few residents to manage a massive network.
    - Kokkinopilos (Larissa): 1.19 km per resident.
    - Elafos (Larissa): 0.83 km/resident.
    - Sklithro (Larissa): 0.82 km/resident.
    - Anatoli (Larissa): 0.72 km/resident.

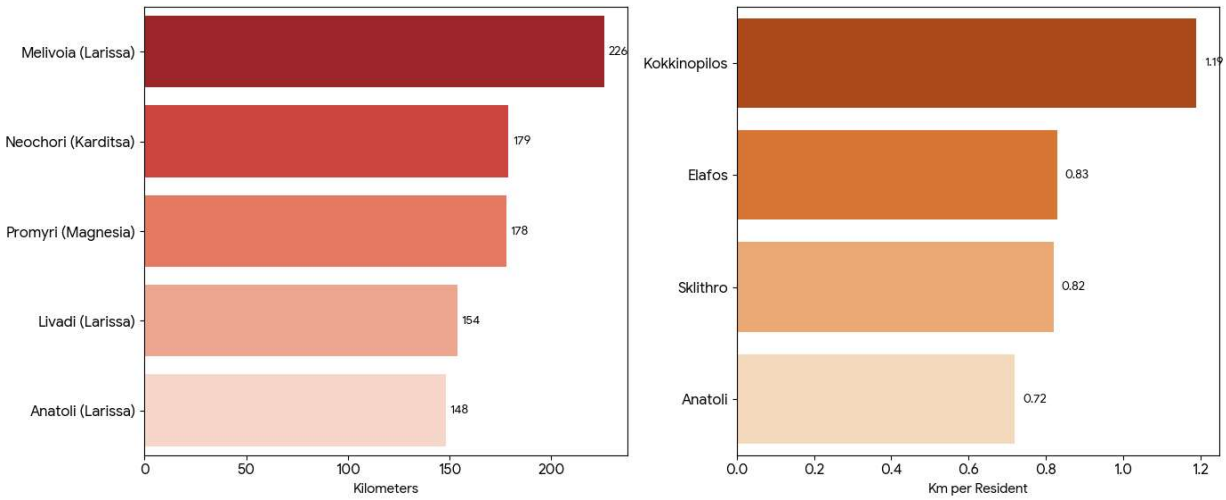

Figure 4. Municipal Communities - *Absolute Length of High-Risk Road Network (km)*

The interaction of road network wildfire risk with Protected Areas (Natura 2000). The analysis uncovered a troubling overlap between conservation and fire risk. In areas designated as both SCI (Sites of Community Importance) and SPA (Special Protection Areas), 53% of the road network falls into the "High" risk category, with another 11% in "Extremely High." By comparison, non-protected areas have only 17% of their roads in the "High" risk bracket (Grillakis et al., 2017).

Table 5: Road Network Risk Distribution in Protected Areas.

Natura 2000	**Low**		**Medium**		**High**		**Extremely high**		**Total**
	km	**%**	**km**	**%**	**km**	**%**	**km**	**%**	**km**
Non-Protected	1059	**3%**	23988	**78%**	5290	**17%**	350	**1%**	30688.
Natura SCI	56.	**1%**	3389	**64%**	1733	**33%**	143	**3%**	5322
Natura SCI & SPA	7	**2%**	141	**34%**	221	**53%**	45	**11%**	414
Natura SPA	139	**3%**	4375	**81%**	815	**15%**	44	**1%**	5374
Total	1262	**3.0%**	31893	**76.3%**	8059	**19.3%**	583	**1.4%**	41799

These statistics uncover the challenges that civil protection is facing in Thessaly. The most consequential finding is the quantitative confirmation of an "operational blind spot." The fact that 8.7% of the land requires "Extremely High" protection but effectively has almost no road access (1.4% of the network) created a severe capability gap. In tactical terms, this means that if a fire ignites in these blind spots, ground forces are essentially locked out during the initial attack phase. Without roads, there are no anchor points to establish containment lines and no safe routes for heavy machinery (Thompson et al., 2017). These zones effectively become "no-go" areas for ground crews, forcing a reliance on aerial suppression, which is fickle and dependent on daylight and weather.

The concentration of 44% of the high-risk network in the 300-800m altitude belt pinpoints the primary theater of operations. This isn't deep wilderness; it is the WUI - a patchwork of abandoned fields, shrubland, and homes. The risk here is driven by the continuity of fuels and the high probability of human ignition. Adaptive management must focus attention on this zone. Vegetation clearing and road hardening here act as a shield, buffering the inhabited plains from the mountain forests above (Modugno et al., 2016).

In Thessaly there is the Islands and costal Constraint. The data for Skopelos and South Pelion highlights a fragility unique to coastal and island environments. On the mainland plains of Trikala, if one road is blocked, there is usually another route. On an island like Skopelos or Skiathos, the network is finite and linear. With 80% of its roads in the danger zone, a single well-placed fire could sever the island's north-south axis, trapping residents and tourists. In this context, road management elevates from a forestry issue to a critical public safety imperative (Sakis et al., 2022).

The intense concentration of risk in Natura 2000 zones (53% High Risk) creates a policy dilemma. These areas need the most aggressive fuel management to prevent catastrophic biodiversity loss, yet they are shielded by environmental laws that often restrict mechanical clearing (Xofis, 2020). This "conservation paradox" demands a nuanced approach, such as "Bio-Diverse Fuel Breaks" where roadside management favors low-flammability native species rather than the "bare earth" clearing.

5. CONCLUSIONS

This study employed granular geospatial analysis to quantify the intersection of wildfire risk and infrastructure in Thessaly, revealing that risk distribution is highly heterogeneous and concentrated within the 300–800 m altitude belt. The findings demonstrate the inadequacy of uniform maintenance protocols, highlighting a critical "accessibility deficit" where the zones of highest flammability possess the lowest road density, effectively creating operational voids for ground suppression forces. Consequently, current resource allocation models predicated on traffic volume are rendered obsolete in the context of resilience; a transition to "Risk Per Capita" metrics is required to rectify the disproportionate exposure of "outlier" communities. Ultimately, effective mitigation requires a paradigm shift from static clearing to dynamic zoning, necessitating the transformation of key arterial routes into "fire-hardened corridors" capable of sustaining safe operational access during extreme fire behavior. Future research should look to integrate real-time traffic data and dynamic meteorological models to further refine the risk categorization of these road segments as the fire season evolves (Papakosta and Straub, 2017).

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CULTURAL AND SPORTS ASSOCIATIONS AND SUSTAINABLE DEVELOPMENT: INSIGHTS FROM AGRINIO, GREECE

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Abstract
The present paper examines the contribution of cultural and sports associations of the Municipality of Agrinio, located in the Regional Unit of Aitoloakarnania,prefecture of Western Greece, to its Sustainable Development. The municipality, with a population of approximately 89,691 inhabitants, hosts a notable number of cultural and sports associations whose role in local development has not been systematically studied to date. The study pursues three interconnected objectives: to map the associations operating within the municipality and document their activities; to identify hospitality and dining businesses located in proximity to association premises and to analyze existing survey data on residents' cultural engagement and participation patterns. The study employs a mixed-method approach, combining secondary analysis of survey data (Chalioris, 2023), spatial mapping techniques, and literature review.

The survey data reveals significant unmet demand for cultural participation: while residents express strong interest in theatre, nature hiking, and collective cultural activities of which actual participation rates remain low. A gender imbalance in respondents and a concentration of younger age groups is also noted. The findings further indicate that the economic potential of sports and cultural facilities remains largely unexploited, with the exception of the areas surrounding the Gymnastic Association of Agrinio and the G.F.S. Panetolikos, where business activity has visibly increased following recent municipal regeneration works. The paper concludes that, despite notable infrastructure deficits in both sports and cultural facilities, the foundations for sustainable cultural development are in place and could be significantly strengthened through targeted investment, improved programming, and closer collaboration between associations, local government, and the hospitality sector.

Keywords: sustainable development, cultural associations, sports associations, Agrinio, local development, cultural participation

1. Introduction and Research Context

The sustainable development of local communities has become one of the central challenges of contemporary governance, calling for approaches that go beyond purely economic metrics and integrate social, cultural, and environmental dimensions **(**UNESCO**,** 2022; UCLG, 2020)**.**. (In this context, cultural and sports associations occupy a distinctive position: they function simultaneously as agents of social cohesion, custodians of cultural heritage, and catalysts for local economic activity, yet their contribution to sustainable development remains insufficiently documented at the municipal level in Greece (Thymi, 2026).

The Municipality of Agrinio, the principal urban center of the Regional Unit of Aitoloakarnania in Western Greece, offers a particularly instructive case study in this regard. With a population of approximately 89,691 inhabitants and a rich associational landscape that includes both longstanding civic organizations and more recently established clubs, Agrinio is far from being a typical over-touristic Greek municipality. This creates both a challenge and an opportunity: the municipality cannot rely on mass tourism as a development driverand must instead cultivate endogenous resources - among which its cultural and sports associations are arguably the most underexploited.

The research problem addressed by this paper is therefore twofold. Firstly, there is a descriptive gap: no systematic mapping of cultural and sports associations in Agrinio, together with an assessment of their economic footprint in terms of nearby business activity, has previously been undertaken. Secondly, there is an analytical gap: the relationship between residents' cultural participation patterns and the sustainable development trajectory of the municipality has not been examined. Without understanding both the supply side (what associations exist and where) and the demand side (how residents engage with cultural life), it is impossible to formulate evidence-based policies for sustainable local development.

Against this background, the present paper pursues three main objectives: (a) to describe the geographical, demographic, economic and cultural context of the Municipality of Agrinio; (b) to catalogue and spatially map its cultural and sports associations alongside the hospitality and dining businesses located in their vicinity; and (c) to analyze residents' cultural engagement through secondary analysis of survey data, drawing on the work of Chalioris (2023), in order to identify both existing strengths and structural gaps that bear on the municipality's sustainable development prospects.

The paper is structured as follows: Chapter 1 provides a description of the Municipality of Agrinio, covering its geographical location, demographic profile, and economic, social and cultural characteristics. Chapters 2 and 3 catalogue the cultural and sports associations of the municipality, respectively. Chapter 4 presents a spatial map of associations and nearby hospitality businesses. Chapter 5 examines the business ecosystem that has developed around the most prominent association premises. Finally, Chapter 6 analyses the survey data on residents' cultural participation. The paper closes with a conclusion section that synthesizes the main findings and identifies priorities for future action.

2. Study Area: The Municipality of Agrinio

The Region of Western Greece comprises three Regional Units: Achaea, Ilia and Aitoloakarnania. Within the Regional Unit of Aitoloakarnania, the Municipality of Agrinio holds a dominant position. It consists of the Municipal Units of Agrinio, Aggelokastro, Thestia, Arakynthos, Makrynia, Stratos, Neapolis, Paravola, Panaitoliko and Parakampylia. According to official data, it covers an area of 1,246.65 km² and has a population of 89,691

inhabitants, according to the 2021 census. The seat of the municipality is the city of Agrinio, which is the largest city in the Regional Unit of Aitoloakarnania, and its morphological composition is predominantly flat with very little semi-mountainous terrain (Monioudi – Gavala, 2010).

Agrinio is located to the north-west of Lake Trichonida, with the Aetolian plain in front of it and Mount Panaitolikoat its background and it has been built at an altitude of approximately 90 meters.

The roots of the city of Agrinio can be traced back to antiquity, although not in the exact same location, bordering the Acheloos river, which has always been the natural boundary between Aetolia and Akarnania. It was at various times part of the Aetolian League and part of the Akarnanian League, until it was destroyed by Cassander in 314 BC. Archaeological excavations in the early 20th century uncovered remains of the ancient city outside modern Agrinio, as well as scattered antiquities within its built fabric (Papatrechas, 1991).

The historical reappearance of Agrinio came many centuries later, during the Ottoman period, under the name 'Vrachori'. Its inhabitants were mainly Turks, and in the early 18th century it became the administrative center of a broader region called 'Karleli', which roughly corresponds to the present-day boundaries of Aitoloakarnania. It was liberated on 11th June 1821 and was incorporated within the borders of the newly established Greek state in 1832 (Papatrechas, 1991). After liberation, the city was renamed Agrinio and began to develop rapidly, particularly in the late 19th and early 20th centuries, through the cultivation and trade of tobacco. Powerful families (Papastratos, Papapetros, and Panagopoulou) developed tobacco cultivation and commerce. The traces of this development are still visible today through the vast warehouses and tobacco processing factories that survive and are now used as cultural or other public buildings (Monioudi – Gavala, 2010). The expansion of tobacco cultivation came primarily after the Asia Minor Catastrophe, when many refugees arrived in the city, settled inthe area of Agios Constantinos and, with their knowledge and skills in such cultivation, contributed decisively to the growth of Agrinio and its establishment as a tobacco center. There was also an influx of population in Epirus and Evrytania (Monioudi – Gavala, 2010).

A defining element of sporting life in Agrinio is the local football Association Panetolikos, which was founded in 1926 as an educational organization and in subsequent years offered significant social benefits to the local community. The Panetolikos football team has become one of the most historic clubs in Greece and has maintained a steady presence in the top football league of Greek football in recent years.

Panetolikos also participates as a club in other popular sports such as volleyball, handball, basketball and Greco-Roman wrestling. Besides Panetolikos, other clubs have distinguished themselves in national championships, such as A.O. Agrinio, the Gymnastic Association of Agrinio (GEA) and PAS IonikosAgrinio.

Regarding sports facilities, a significant problem has been identified in the Agrinio area: there is a lack of substantial infrastructure capable of hosting the numerous clubs that exist (Mitsopoulou, 2016). Specifically, the available facilities include the 'Michalis Kousis' Municipal Athletic Centre, the Indoor Gymnasium in the main bridge area called 'Aerogefyra', the Panetolikos Stadium and the Emileon SportsCenter training facility (owned by the majority shareholder of Panetolikos and serving as the club's training center), several neighborhood pitches for amateur clubs and the municipality, and a few private facilities. The shortage of indoor gymnasiums in the city is evident, but the main problem is that the existing sports facilities are outdated and in need of immediate modernization

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3. Methodology

This study adopts a mixed-method approach combining secondary data analysis, spatial mapping, and literature review. The primary empirical basis of the research is the survey conducted by Chalioris (2023), which examines residents' cultural participation and perceptions. In addition, the study includes the mapping of cultural and sports associations within the Municipality of Agrinio, as well as the identification of nearby hospitality and dining businesses.

The methodological approach aims to capture both the supply side (associations and infrastructure) and the demand side (residents' cultural engagement), allowing for a more comprehensive assessment of the contribution of these actors to sustainable local development. A limitation of the study concerns the composition of the survey sample, which presents a gender imbalance and a higher representation of younger age groups.

4. Mapping Cultural Associations in the Municipality of Agrinio

Association	Description
GYMNASTIC ASSOCIATION OF AGRINIO (GEA)	Historic association with multifaceted activities
ASSOCIATION OF ASIA MINOR REFUGEES	Association of refugees from Asia Minor, who constituted a significant part of the Agrinio society
CULTURAL ASSOCIATION OF AGIOS KONSTANTINOS	Same background as the above
PAN-EPIROTIC ASSOCIATION	Association of internal migrants originating from Epirus
TRADITIONAL ARTS WORKSHOP	Important center for cultural activities
G.F.S. PANETOLIKOS	The oldest and largest association in Agrinio
HISTORICAL – ARCHAEOLOGICAL SOCIETY OF WESTERN GREECE	Organization with significant cultural activities
FRIENDS OF THE FOLKLORE MUSEUM	Small association supporting the Folklore Museum of Agrinio
FOLKLORE MUSEUM	Small museum housing significant preserved exhibits
TA MANOUSAKIS	Dance Association
CULTURAL ASSOCIATION OF DYO REMMATA	Association representing a local district of Agrinio
CULTURAL ASSOCIATION OF AHI VASILIOTIKON	Association representing a local district of Agrinio
CULTURAL – FOLKLORE CLUB OF AGRINIO ''OI MERAKLIDHES''	DanceAssociation
CULTURAL ASSOCIATION – AHI GIANNIS RIGANA	DanceAssociation

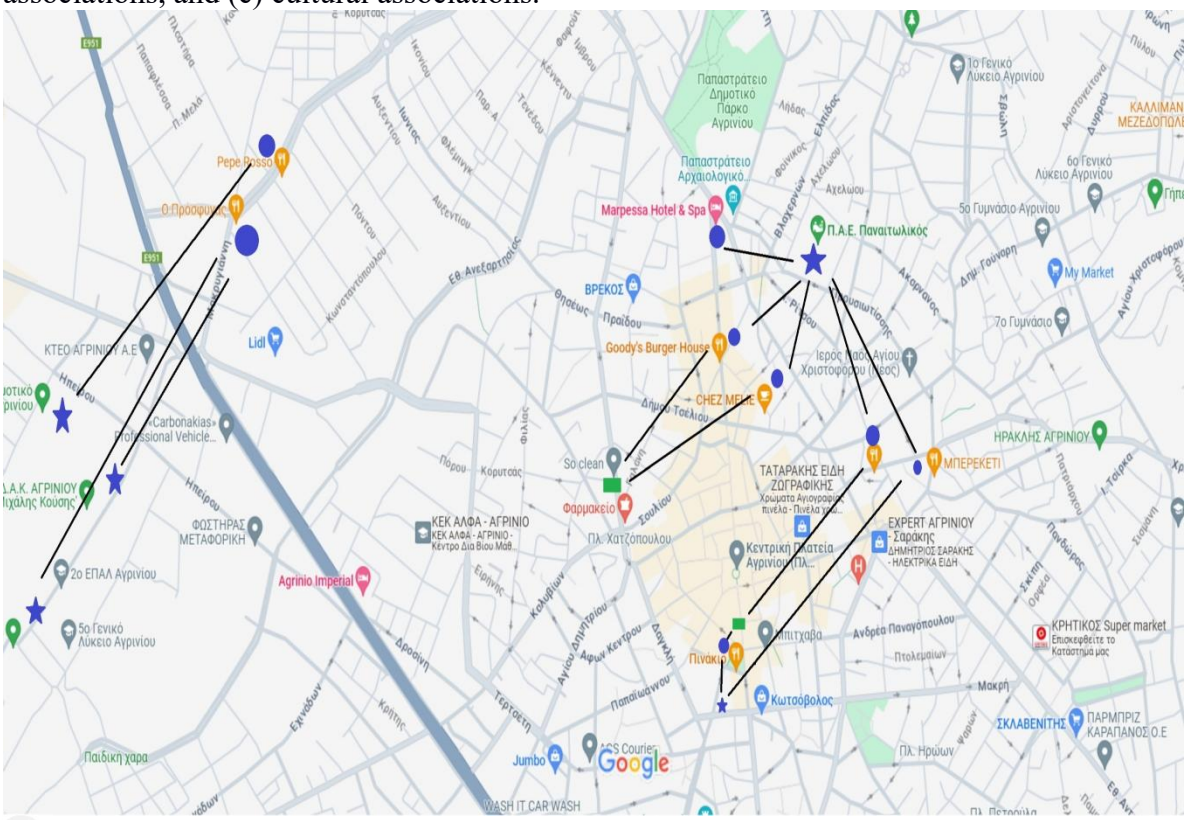
PAN-SOUMELI SPIRITUAL CENTRE OF ROUMELION	Association of internal migrants from Central Greece (Roumeli)
PAN-CRETAN ASSOCIATION OF AITOLOACARNANIA	DanceAssociation
''COMPANY WITH TRADITION''	Danceassociation
PAN-EVRYTANIAN ASSOCIATION OF AITOLOACARNANIA	Association of internal migrants from Evrytania
ASSOCIATION OF PONTIANS OF AITOLOACARNANIA – ''D. PSATHAS''	DanceAssociation
DANCE ASSOCIATION – ''ZORBAS''	DanceAssociation
AETOLIAN ENVIRONMENTAL SOCIETY	Association focused on the protection of Lake Trichonida
ASSOCIATION OF FRIENDS OF TRADITION ''THE ROOTS''	DanceAssociation

5. Mapping Sports Associations in the Municipality of Agrinio

Association	Description
1. G.E. AGRINIO	Athletic club with a wide range of sports
2. PANETOLIKOS G.F.S.	Historic athletic club with a wide range of sports
3. A.O. AGRINIO	Athletic club with a football section
4. P.A.S. IONIKOS 80	Athletic club with a football section
5. FI.MBA. PEGASOS	Athletic club with a basketball section
6. A.L.F.A. 93'	Athletic club with a basketball section
7. A.S. ARGONAUTS	Athletic club with a swimming section
8. PROODEYTIKI AGRINIO	Athletic club with a basketball section
9. A.S. PHOIVOS	Athletic club with a swimming section
10. AKARNAN AGRINIO – BEACH VOLLEY	Athletic club with a beach volleyball section
11. EUZIN	Small SportsClub
12. FOOTBALL COACHES ASSOCIATION	Association of football coaches in the broader theAitoloakarnania region

6. Spatial Analysis of Associations and Local Economic Activity

The following map illustrates the spatial distribution of cultural associations, sports associations, and hospitality and accommodation businesses in the Municipality of Agrinio. The legend distinguishes among: (a) hospitality and dining establishments, (b) sports associations, and (c) cultural associations.



hospitality and dining establishments

sports associations

cultural associations

The dense urban layout of Agrinio did not allow for the creation of sports and athletic spaces within the metropolitan fabric; instead, it compelled the authorities to establish such centers on the periphery of the city, relatively remote and detached from its core (Mitsopoulou, 2016). As a result, these peripheral areas show virtually no signs of business activity or hospitality services, which means that the economic potential of these spaces has not been properly harnessed and that a broader economic and entrepreneurial flourishing has not been materialized (Zarentis, 2018). Exceptions to this pattern are the headquarters of the 'Gymnastic Association of Agrinio and of the G.F.S. Panetolikos, both of which are located within the built fabric of the city and have in their own way shaped their surrounding areas, attracting diverse business activity from both the hospitality and retail sectors.

These areas have been regenerated by the Municipality of Agrinio in recent years, a development that has significantly boosted their commercial value and attracted new entrepreneurs. Around the premises of the 'Gymnastic Association of Agrinio' there are numerous restaurants and cafes, and its proximity to the central square of Agrinio, places it close to hotel units in the centerand to shopping facilities.

The same applies to the area surrounding the G.F.S. "Panetolikos"000000, which also hosts the refurbished Panetolikos Stadium. This area also benefits from ample parking, as it is not located in the actualcenter of the city. Its proximity to the Agriniopark, which has recently undergone significant improvement, seta different tonecompared to the heavily 'cemented' remainder of the city (Zarentis, 2018). The difference compared to the central area of the 'Gymnastic Association of Agrinio' is that there are no retail shops around.

Representative examples of dining and accommodation establishments in these two areas include the Marpessa and Leto hotels, as well as the restaurants Pinakio, Il Mondo di Mare, Marpessa Roof Garden, Sergio, Pizza Roma, and others.

7. Survey Results: Cultural Participation Patterns in MinicipalityAgrinio

Analyzing the results of the survey (Chalioris, 2023) conducted by researcher K. Chalioris on the contribution of cultural associations and local organizations to the preservation and promotion of the cultural heritage of an area (see Appendix), we observe that the proportion of respondents residing in the Municipality of Agrinio amounts to 9% (Q.1). The vast majority of these have lived in the Municipality of Agrinio for more than 10 years (Q.2), indicating that we are speaking of permanent residents of the area. The gender ratio is approximately 75% women to 24% men (Q.3), while the age groups are distributed evenly, with the largest proportion belonging to the 16–24 age group (Q.4).

With regards to the employment status of the survey sample, we observe an almost equal distribution between public sector and private sector employees (Q.5), while in terms of educational level, university education dominates, with an additional increase in percentage attributable to postgraduate studies (Q.6).

Following the demographic questions, the questionnaire moves on to questions about cultural life in Agrinio. Specifically, respondents indicate that the three most important places for cultural life in a neighborhood are: a) an arts or music school, b) an exhibition space or museum, and c) a theatre or concert venue (Q.12). These answers are unsurprising, as these three venues – together with the cinema – have become established as the primary centers of cultural production in Greece. In the following question, we see that the most common cultural activity among respondents is going out to dining establishments, with participation in traditional or folk collective activities coming in a close second (Q.13). Notably, respondents indicated they would prefer to have more time for the latter, as well as for walks in nature, as shown in the answers to question 14 (Q.14).

In Questions 15–21,we see the respondents;answersabout their cultural activities in the last six months. The responses show that a large percentagehave watched films or attended concerts infrequently, while it is noteworthy that there is a marked absence of participation in theatrical performances or dance shows (Q.15–21). This can be explained by the timing of the survey, since in Agrinio such cultural activities typically take place at the end of spring or at the beginning of summer.

In questions 22–24, participants indicate that they would like to participate in more cultural activities, showing a preference in the arts, walks in nature, and collective cultural activities, while also expressing an awareness of their limited engagement with dance performances, photography activities, and so on (Q.22–24).

The most prominent cultural activities among respondents are music (listening, singing, playing instruments, etc.) and theatre, according to their responses in questions 25–32. These activities are available within the Municipality of Agrinio, as there are several music schools, most notably the Municipal Philharmonic of Agrinio, and the historic Municipal Regional

Theatre (DIPETHEA) of Agrinio, which in recent years has managed to stage a number of interesting theatrical productions (Q.25–32).

Questions 33 and 34 reveal strong opposition among respondents to any downgrading of local cultural institutions (Q.33–34). There is a total rejection to the possibility of closing down a local library or a local cultural center.

In the section on the importance of education in culture (Q.35–41), survey participants express full agreement with statements such as 'The arts and culture are essential for society' and 'Visual arts, music and drama lessons are important for primary and secondary school pupils', among others (Q.35–41). Following on from the above, question 42 asks about respondents' intention to actively participate in cultural groups and associations (Q.42). The responses reflect an intention to join an artistic or cultural association or group (51%) and an intention to join a sports club or hiking group (20%), as well as other activities with lower percentages.

Regarding the importance of the family in cultural life (Q.43–44), respondents indicate that it was primarily their mother who had handicraft skills, while their father was involved in music or writing (articles and prose). The importance of musical activities within the family context is also reflected in questions 46–48, wheremost respondents indicate that they have both attended such activities themselves and have encouraged their children to do the same (Q.43–48).

Finally, in the concluding questions 51–54 on the importance of culture in entrepreneurship and regional development, respondents express a positive view that social enterprises providing sports or cultural services and activities make a significant contribution to the economic development of an area and act as a multiplier of social cohesion and economic well-being (Q.51–54).

Question	Topic / Categories	Percentages / Data
DemographicData		
Q.1	Residents of the Municipality of Agrinio in total sample	**9%**Residents of Agrinio
Q.2	Years of residence in the municipality	**81%** More than 10 years **9%** 4–9 years **6%** 1–3 years **4%** Less than 1 year
Q.3	Gender	**75%** Female **24%** Male **1%** Prefer not to say
Q.4	Agegroup	**33%** 16–24 years old **26%** 35–44 years old **20%** 25–34 years old **13%** 45–54 years old **4%** 55–64 years old **3%** 65 and over **1%**Noanswer
Q.5	Currentemployment status	**36%** Public sector employee **33%** Private sector employee **15%** Self-employed / Entrepreneur **6%** Homemaker **5%** Unemployed **3%** No answer **2%**Student

Question	Topic / Categories	Percentages / Data
Q.6	Highest level of education completed	**49%** University degree (Bachelor's / Diploma) **25%** Postgraduate studies (Master's) **23%** Compulsory education (primary / secondary) **1%** Doctoral degree **1%** Did not complete compulsory education **1%** No answer
Cultural Life&Activities (Q.12–14)		
Q.12	3 most important places for cultural life in a neighborhood (number of responses)	**~28** Arts or music school **~25** Exhibition space or museum **~23** Theatre or concert venue **~20** Cinema
Q.13	Cultural activities carried out in the last six months (number of responses)	**~28** Going out to restaurants / bars **~25** Traditional or folk collective events **~22** Walks in nature **~18** Visits to exhibitions & markets
Q.14	Would like to spend more time on... (number of responses)	**31** Walks in nature **25** Traditional / folk collective activities **24** Arts, crafts, traditional cooking etc. **19** Visits to exhibitions & markets **13** Team games / sports (non-professional) **8** Walks in the city **6** Going out to discos / clubs / dance halls **4** Going out to restaurants / bars **1** Visits to religious sites
Frequency of Participation in Cultural Activities in Last 6 Months (Q.15–21) — absolute values: 1=Never · 2=Sometimes · 3=Often/Very often		
Q.15	Concerts	**37** Never **60** Sometimes **37** Often / Very often
Q.16	Watching a film (cinema)	**32** Never **66** Sometimes **33** Often / Very often
Q.17	Danceperformances	**68** Never **38** Sometimes **16** Often / Very often
Q.18	Films (streaming / TV)	**20** Never **53** Sometimes **56** Often / Very often
Q.19	Theatricalperformances (asaudience)	**39** Never **64** Sometimes **23** Often / Very often
Q.20	Participation in theatricalproductions	**92** Never **14** Sometimes **6** Often / Very often
Overall Assessment of Participation & Intention (Q.22–24)		
Q.22–24	Would you participate in more cultural activities?	**114** Strongly agree **18** Do not know / No answer **1**Stronglydisagree
Importance of Cultural Infrastructure (Q.33–34)		
Q.33	Would it bother you if the local library	**116** Very much (yes)

Question	Topic / Categories	Percentages / Data
	closed?	**12** Do not know **6**Notatall (no)
Q.34	Would it bother you if the local cultural centre closed?	**117** Very much (yes) **11** Do not know **3**Notatall (no)
Intention to Join an Association (Q.42)		
Q.42	Which type of group / association would you join?	**51%** Artistic or cultural association / group **20%** Sports club or hiking group **13%** Other groups for joint activities **12%** Social association / NGO **4%**Spiritualorreligiousassociation
Culture & Entrepreneurship / Regional Development (Q.51–54)		
Q.51	Are you aware of social enterprises providing sports services in your area?	**106** Yes **27** No **0** Do not know
Q.52	Do they contribute to the economic development of the area? (sports)	**91** Yes **43** No **0** Do not know
Q.53	Are you aware of social enterprises providing cultural services in your area?	**66** Yes **37** Do not know **17** No
Q.54	Do they contribute to the economic development of the area? (culture)	**97** Yes **27** Do not know **7** No

Table 1. Survey Results — Municipality of Agrinio *Source: Chalioris (2023). For Q.12–14 and Q.15–21, absolute values (number of responses) are provided, as exact percentages are not explicitly stated in the original presentation.*

8. Conclusions and Policy Implications

Sustainable development of municipalities is a major issue in our time, and all stakeholders are seeking solutions that stand in contrast to the development pattern observed predominantly in island regions – development that does occur but is not sustainable, driven by overtourism and an exclusively economic orientation, resulting in the gradual degradation of both the place and its human dimension. The case of the Municipality of Agrinio is far from being characterized as over-touristic, which is not necessarily a disadvantage, as it opens wide the opportunities for its Sustainable Development. Despite significant shortcomings in both sports (pitches, teams, etc.) and cultural infrastructure (theatres, concert venues, etc.), the municipality nevertheless manages to sustain an undiminished sporting and cultural interest among its residents. The challenge is to link this sporting and cultural interest with hospitality businesses and broader economic activity so that appropriate revenues can be generated.

The survey conducted by K. Chalioris demonstrated the local community's 'thirst' for cultural activities. The foundations exist; there are many associations engaged in cultural activities, whether of a traditional nature (e.g., dance associations such as 'Ta Manousakia' or the 'Pan-Cretan Association of Aitoloakarnania') or of a more contemporary nature (e.g., tango lessons offered by the 'Traditional Arts Workshop'). What remains is for this foundation to be supported and expanded so that it can reach a wider audience.

According to the survey, there is a gap in engagement with theatre and nature hiking, but this can be addressed in the short term by the local community, with the support of the Municipality of Agrinio, since the necessary infrastructure is already in place – on the one hand, there is the DIPETHE (Municipal Regional Theatre) and other theatre groups, and on the other hand, there is a significant urban forest that can be used for hiking.

Strengthening synergies among cultural and sports associations, local authorities, and the private sector could play a pivotal role in unlocking the full potential of these actors for sustainable local development.

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PRE ORGANISED SPECIAL SESSION

"Islands in Transition: Innovation, Sustainability, Tourism and Climate Resilience"

Organised and Chaired by **Assoc Prof Maria P. Doumi, Assist Prof Ioanna Pagoni, Assist Prof Iason-Nikolais Koufodontis** and **Em Prof Angelis Vasilis**

THE VOLUNTARY LOCAL REVIEWS (VLRs) AS A TOOL FOR SUSTAINABLE GOVERNANCE IN CITIES: THE CASE OF SKIATHOS

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Abstract
In 2015, the UN adopted a new agenda entitled *Transforming our world for 2030. Agenda for sustainable development*, which sets 17 Sustainable Development Goals (SDGs). One of them, Goal 11 refers to the cities and the actions which should be taken to make them safe, resilient, sustainable and inclusive. Moreover, this goal interacts with almost all the others thus confirming the decisive contribution of the cities to the attainment of all the SDGs. Hence the next step was the *Localization of 2030 Agenda,* or in other words its adaptation to the local conditions, which focuses on the process of setting, implementing and monitoring goals and strategies at a local level compatible with the national ones. Moreover, a special innovative tool, known as Voluntary Local Review (VLR), has been developed for monitoring the local actions. Islands as vulnerable ecosystems with particular social, economic and environmental conditions are asked to draw up strategies combining resilience to climate crisis, sustainable tourism development and social cohesion. In this context the VLRs can play a key role. The present paper introduces the VLRs and presents their application to Skiathos, the first Greek Municipality which has used this tool.

Keywords: Sustainable Development Goals (SDGs), Sustainable Governance, Voluntary Local Review (VLR), Skiathos.

CULTURAL LANDSCAPE AND TOURISM. THE CASE OF THE STONE-BUILD ROADS IN CHIOS.

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Abstract
One of the main characteristics of most of the Greek Islands, which indeed differentiates them from other tourist destinations worldwide, is that their main attraction is the landscape. Moreover, following the pandemic there seems to be a shift to the global tourism trends, placing a particular emphasis on the landscape of the destinations. In this context, the landscape may have a key role as planning and management tool regarding the development of tourism in Greek islands. Furthermore, as all landscapes are in effect cultural, culture is central to landscape and inextricably linked with it. The present paper looks firstly into the concept of cultural landscape, its origins, development and delicate balance with tourism. At the second level it focuses on Chios and examines the case of its stone-built roads. After a brief introduction to these traditional roads, it presents the main findings of a relevant research which has been carried out. The research collects and analyzes the views of professional bodies related to tourism regarding their knowledge about these roads, the current state of their development, their future prospects as well as their potential contribution to the enhancement of the island's tourism product.

Keywords: Cultural Landscape, Tourism, Stone-Built Roads, Chios.

CIRCULAR ECONOMY AND SUSTAINABLE DEVELOPMENT. THE CASE OF GREEK ISLAND MUNICIPALITIES.

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Abstract
The environmental degradation, the excessive use of natural resources, the climate crisis as well as the social and economic inequalities are among the major threats facing the planet and ask for immediate action. The prevailing linear production and consumption model seems unable to provide the required solutions to these problems and hence the use of an alternative model, that of circular economy may offer a better way of addressing those issues. The present paper presents new trends in circular economy models, outlines their basic principles and highlights the potential benefits but also the possible pitfalls stemming from their application, At the second level it focuses on the Greek island Municipalities and presents the main findings of a relevant research which has been carried out. The research collects an analyzes the views of sixteen Greek island municipalities regarding the application of circular policies in them, the stakeholders involved, the main problems faced, the current state of development and the future prospects.

Keywords: Circular Economy, Sustainable Development, Greek Island Municipalities.

THE SECURITY OF DIGITAL PLATFORMS AS A SUSTAINABILITY FACTOR IN THE URBAN ENVIRONMENT OF CHIOS

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Abstract
The rapid growth of social media platforms has transformed communication, information exchange, and entertainment, but it has also generated critical concerns regarding user safety and wellbeing. Issues such as privacy breaches, online gambling, exposure to harmful or violent content, and incitement to hostility have been widely reported, with potential psychological, social, and behavioral consequences for users of all ages. These problems may be more acute in small towns in island regions, due to the restrictions and specificities that apply.

This study aims to examine the underlying dimensions of these risks and their collective influence on social media users. Using survey data and statistical analysis, factor analysis in SPSS was employed to identify latent constructs that explain the co-occurrence of problematic experiences on social platforms. The results highlight key factors that cluster around security vulnerabilities, addictive behaviors, and exposure to harmful content, demonstrating how these risks interact and amplify one another. The findings contribute to a deeper understanding of the structural relationships between diverse social media problems and provide valuable insights for policymakers, educators, and platform developers seeking to mitigate adverse impacts while promoting safer digital environments.

Keywords: digital platforms, social media, digital addiction, social problems, island regions

ISLAND SUSTAINABLE STRATEGY: FROM VULNERABILITY TO RESILIENCE

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Abstract
Demographic and productive shrinkage were the main impacts caused by the unique characteristics of insularity (small size, peripherality and isolation, uniqueness but high fragility of natural and cultural resources) under the pressure of the dominant economic model of mass production in the 20th century, placing them in a vulnerable position.

Tourism development in recent decades has changed the trend, as islands are considered worldwide as very attractive places to visit and tour. New incomes, often very high, have been created, as well as new jobs. This development has created new challenges and another type of vulnerability.

The most important goal on islands, as in every place in the world, is (a) to be attractive for both people and businesses and (b) to remain within the limits of sustainability. These goals can only be achieved in the different types of areas in the specific terms of each area (e.g. urban, mountainous, rural, island) respecting its specificities. The regeneration and diversification of the economy from tourism mono-culture is an even more difficult task.

Keywords: Insularity, tourism, sustainability, resilience

SUSTAINABLE ISLAND MOBILITY PLANS: PLANNING FOR PEOPLE, TOURISM, AND CLIMATE

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Abstract
This paper presents the Sustainable Island Mobility Plan (SIMP), an innovative framework in transport planning, specifically tailored to the environmental, economic, and social particularities of small and medium-sized Greek islands. These territories experience extreme seasonal fluctuations due to high tourism inflows, which significantly increase mobility demand, strain infrastructure capacity, and amplify environmental pressures. These challenges are further compounded by the islands' inherent characteristics, i.e. geographical isolation, limited space for transport infrastructure, sensitive ecosystems, and the co-existence of permanent and seasonal populations.

Such conditions necessitate a specialized, flexible approach to mobility planning, which addresses the above challenges while also integrating sustainable, climate-resilient and flexible mobility solutions. The SIMP framework, unlike traditional Sustainable Urban Mobility Plans (SUMPs), is designed to balance the year-round mobility needs of residents with the seasonal surges driven by tourism. The methodology is grounded in participatory planning, engaging local stakeholders—including public authorities, transport operators, and tourism actors—to co-develop mobility strategies that respond to both off-peak and high-demand conditions. The analysis is supported by relevant data on tourism arrivals, population patterns, and transport use. Finally, the paper highlights emerging practices in sustainable island mobility, such as electromobility, on-demand public transport, and active travel modes.

Keywords: Sustainable Island Mobility Plan, Greek islands, Sustainable Transport, Mobility planning

DIGITAL ECOSYSTEMS AND BUSINESS INNOVATION AS ACCELERATORS OF SUSTAINABLE TRANSITION IN ISLAND SMART CITIES

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Abstract
Smart cities are emerging as key models of sustainable urban development, particularly in island regions undergoing complex transitions due to socioeconomic pressures and climate challenges. This paper explores the role of digital ecosystems and business innovation as dual and complementary drivers in shaping resilient, participatory, and innovation-driven urban environments. Digital ecosystems—comprising interconnected platforms, data infrastructures, and collaborative networks—enhance interoperability between public and private actors, enabling more efficient resource management and citizen-centered service delivery. At the same time, business innovation facilitates the development of new value models, such as smart mobility and sustainable energy solutions, which strengthen economic diversification and quality of life in insular contexts. Special emphasis is placed on open innovation and cross-sector collaboration as catalysts for enhancing climate resilience and managing tourism-related pressures in vulnerable island territories. The study argues that the integration of technology, participatory governance, and entrepreneurial activity provides a functional model for sustainable transformation in island smart cities. It highlights the importance of ecosystem thinking in transitioning from traditional urban management to adaptive systems capable of addressing environmental, social, and economic challenges. Ultimately, this framework offers new pathways for reimagining islands as laboratories for inclusive and future-ready development.

Keywords: Smart Cities, Digital Ecosystems, Business Innovation, Island Resilience, Sustainable Transition

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The conference aims to present and disseminate research results related to the Sustainable Development of cities and regions at a global level.

The main subject is the presentation of relevant research in the field of Sustainable Development.

The conference is organized and structured on the four main pillars of Sustainable Development, which in fact are also the main pillars of Urban and Regional Development: Environment, Economy, Society and Culture. Each of these pillars includes its subcategories, which are detailed through the thematic sections related to the 17 Global Goals of Sustainable Development.

The conference brings together many distinguished researchers of Local and Regional Sustainable Development and Urban Reconstruction from many countries all over the world. Participants have the opportunity to present new research, exchange information, and discuss current issues.

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