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Contents

The articles published in SRDSJ Journal are in accordance with the approving dates by the anonymous reviewers.

Sustainable Regional Development Scientific Journal, Vol. III, (1), 2026
Editorial Note

In the first semester of 2026, the Sustainable Regional Development Scientific Journal (SRDSJ), published under the aegis of the Albanian Association of Regional Scientists (A.A.R.S), launched the first issue (1) of its third volume (Vol. III) since its first day of publication. The SRDSJ is an international, open-access, and peer-reviewed journal that publishes research on various topics related to Regional Science and Sustainability. The journal it acts as a platform for scholars, researchers, policymakers, and practitioners to exchange insights on sustainable regional development and its various aspects.

Since July 2024, the SRDSJ has published more than 30 articles, on a wide range of topics (such as Regional Economics and Development; Spatial Analysis and Econometrics; Economic Geography and Transportation Economics; Urban Planning and Development; Tourism Economics and Development; Urban and Regional Sustainability; Regional Analysis and Policy; etc.). Serving its broad multidisciplinary scope, SRDSJ provides publication opportunities to researchers from various disciplines and an open-access platform for communicating regional science research and making it accessible to a wider audience. Also, SRDSJ supports a reasonably timely review process, promoting the academic dialogue by making scientific research accessible to the researchers' community in time.

The journal is indexed in various scientific databases (RePEc, EconPapers, IDEAS, RSAI) and its contribution to scientific research is accredited by scientific associations (such as Regional Science Association International, Albanian Association of Regional Scientists). Further, the SRDSJ has the merit to include in its editorial board reputable academics from worldwide, who ensure that the published papers meet rigorous academic standards. The SRDSJ community thanks the Editor-in-Chief, the Editorial Board, its Reviewers, Authors, and Readership for this achievement. Dedicated to its high standards and values, SRDSJ will pursue improvement. Moreover, the SRDSJ systemically provides a forum for ideas exchange, news, and information, by covering topics of broader academic interest, such as events (conferences, workshops, and seminars), academic profiles (providing insights into the work and accomplishments of leading scholars in the field), and book reviews (offering a valuable service by summarizing and evaluating important publications). This broad academic framework enhances the value of SRDSJ as a resource for scholars and practitioners for readers interested in keeping up with the latest developments in Regional Science.

All these attributes and merits of SRDSJ have been so far fertile and promising for the journal's future path. Following this reputed heritage, the SRDSJ continues working hard toward providing a reputable and respected publication, along with a valuable platform for high-quality research for anyone interested in regional science, regional development, and related fields. This current issue (SRDSI, Vol. III, (1), 2026) presents 9 articles that were carefully selected to meet the journal's high standards. These articles cover traditional and contemporary topics in Regional Science, such as spatial disparities, regional demographics, inequalities, education, healthcare, marginalized areas, and comparative advantages in production, input-output models, direct investments and economic growth, financial economics, sustainability, climate change awareness and tourism, gas emissions, and waste management, and are described in brief as follows:

In brief, the first paper, titled "CHEMICAL AND MATERIAL STRATEGIES FOR ENERGY-POSITIVE BUILDINGS: A SUSTAINABILITY-ORIENTED REVIEW", authored by Gülşah ÇELIK GÜL, explores the pursuit of a promising way to reduce the impact of energy-positive buildings on the built environment is defined as reduced energy consumption. On the other hand, sustainability cannot be based solely on operational energy performance, as it is significantly influenced by material-related factors. This study is a comprehensive review of the chemical and material foundations of energy-positive buildings and a compilation of the long-term performance of material properties and degradation mechanisms. Data synthesis and literature selection were carried out using the PRISMA method. In light of the information obtained, parameters related to energy-intensive production, material stability, and life cycle impacts were addressed by considering key material groups, including cement-based systems, polymers, and bio-based materials. The findings show that degradation processes and limited circularity remain critical challenges. Therefore, achieving sustainable energy-positive buildings requires an integrated approach that simultaneously considers material chemistry, energy system performance, and life cycle assessment.

The second paper, titled "EXAMINING THE RELATIONSHIP BETWEEN SPATIAL DEMAND AND URBAN STREET ORGANIZATION: THE CASE OF KARDITSA CITY, GREECE", authored by Katerina KARALI and Dimitrios TSIOTAS, examines from a theoretical perspective, urban space is produced through the transformation of the natural environment into a structured built environment, giving rise to land-use patterns redefining existing forms of urban organization. In turn, these configurations attract population flows, thereby generating conditions for urban development and further transformations of the urban structure. Assuming that urban form's spatial organization reflects the socio-economic forces and processes that have shaped it over time, this paper builds on graph-theoretic modeling and on correlation analysis of network topology measures with land rent values and land-use indicators across the urban network, to examine the degree of urban spatial organization in relation to the demand for urban space. The analysis focuses on the road network of the city of Karditsa, Greece, and provides empirical insights into the connectivity, efficiency, and overall spatial organization of Karditsa's urban system, while also highlighting the extent to which the demand for urban space contributes to urban fabric's formation and evolution.

The third paper, titled "SUSTAINABILITY ACCOUNTING AND ITS APPLICATION IN ALBANIA" authored by Antoneta POLO, Enkela CACA, Ilirjana ZYBERI and Sara BIXHAKU**,** analyse the importance of sustainability accounting that focuses on measuring, reporting, and managing the social, environmental, and economic impacts of corporate activities. This form of accounting helps organizations monitor and assess their performance in relation to sustainability and communicate their commitment to sustainable development to stakeholders. Over time, sustainability accounting has become a key instrument for companies seeking to meet legal requirements, enhance their image, and increase opportunities for green investment. International frameworks such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) have provided guidance for reporting on Environmental, Social, and Governance (ESG) factors, allowing companies to measure and report their impacts in a comparable and reliable manner. Globally, the development of sustainability accounting has profoundly changed the way organizational financial and social performance is measured and evaluated. However, implementing these practices remains challenging, particularly in developing countries such as Albania, where a clear legal framework and institutional support are crucial for sustainable economic development. This paper explores the concept of sustainability accounting, the challenges and opportunities it presents, and its significance for global economies and businesses, with a special focus on its application in Albania.

The fourth paper, titled "CONTEMPORARY CHALLENGES OF ISLAND TOURISM DEVELOPMENT" authored by Josip HORVAT, Zvonimira SVERKO GRDIC and Filipos RUXHO, applies island tourism development increasingly shaped by challenges arising from pronounced seasonal concentration of tourism demand, pressure on communal infrastructure, and cumulative environmental stress in a mature island destination. These challenges are particularly pronounced in mature island destinations, where cumulative pressures require adaptive governance and context-specific policy responses. This paper explores the contemporary challenges of island tourism development through a qualitative case study of Mali Lošinj, one of Croatia's most developed island tourism destinations. The study adopts a qualitative case study approach based on document and discourse analysis of strategic and institutional materials related to tourism development in Mali Lošinj. Selected findings from a survey conducted among local residents in September 2025 are used as a supplementary source of evidence for triangulation purposes. The survey captures residents' perceptions of tourism-related pressures and sustainability-oriented policies but does not serve as the primary research method. The findings indicate that Mali Lošinj faces interconnected challenges related to seasonal tourism concentration, infrastructure capacity constraints, and cumulative pressure on the natural environment, including pronounced seasonality and governance-related implementation constraints. While sustainability is strongly embedded in institutional discourse and strategic planning, persistent development pressures highlight gaps between policy intentions and practical outcomes. Residents' perceptions largely align with institutional assessments regarding key challenges, although uncertainties remain concerning the effectiveness of sustainability measures. The paper contributes to the literature on island tourism development by illustrating how general sustainability challenges materialise in a mature island context.

The fifth paper, titled "CULTURAL AND SOCIO-CULTURAL DETERMINANTS OF ENTREPRENEURIAL MINDSET AND BEHAVIOR: A REVIEW AND ANALYSIS", authored by *Imelda SEJDINI, Ina SEJDINI and Ardita TODRI,* analyses the influence of cultural and socio-cultural factors on the development of entrepreneurial mindset and behavior across different regions worldwide. Analyzing existing literature, international reports, and recent statistics, it highlights how cultural dimensions such as individualism, collectivism, uncertainty avoidance, and long-

term orientation shape entrepreneurial attitudes and actions. The study underscores that countries with open, innovation-friendly cultures tend to exhibit higher rates of new venture creation, whereas more conservative societies display lower entrepreneurial activity. The role of education, social norms, and public policies in fostering entrepreneurial culture is emphasized as crucial for economic growth and social progress. Overall, the findings suggest that understanding and leveraging cultural values can significantly enhance entrepreneurial development, advocating for targeted strategies to cultivate an environment conducive to innovation, risk-taking, and social capital building across diverse cultural contexts.

The sixth paper, titled "RETHINKING OLIVE OIL PRODUCTION: PATHS TO SUSTAINABILITY", authored by Isabel JOAQUINA RAMOS, Conceição REGO, Maria da Conceição FREIRE and Lília FIDALGO explores the olive groves and olive oil production as part of rural landscapes in Portugal since ancient times. While their social and cultural relevance are rooted in the past, their economic role stands out today. However, the intensification of production has been putting at risk the balance between territory, landscape and production. The challenge is to revitalise rural areas without pressure on natural resources, ecosystems and their inevitable relation to local communities, meaning to improve agricultural practices and quality of life. Sustainability programs have emerged to address these concerns. This article reflects on some impacts of the intensification of olive groves and shares insights from the Olive Oil of Alentejo Sustainability Program (OASP), focusing on Human Communities, Landscape Management, and Biodiversity. It presents suggestions for improvements in these areas and concludes that initiatives like OASP are important complements to public policy instruments. Also highlights the importance of involving public and private actors, researchers, and communities to develop innovative and responsible solutions that values and respects landscapes, ecosystems, and communities.

The seventh paper, titled "THE IMPACT OF INFORMATION TECHNOLOGIES ON SOCIAL COMMUNICATION AS A CATALYST FOR BUSINESS MANAGEMENT EFFICIENCY", authored by, Kushtrim UKA, explains how the rapid development of information technologies has significantly transformed the way social communication is conducted within business organizations, directly influencing managerial processes and organizational efficiency. In the context of the digital economy, technology-mediated social communication has become a key factor in coordinating activities, supporting decision-making, and achieving strategic objectives. The main purpose of this article is to analyze the role of information technologies in social communication and their impact on enhancing the efficiency of business management. The study is based on a combined methodological approach, integrating a theoretical analysis of relevant literature with empirical data collected through appropriate research instruments. The findings indicate that the integration of information technologies improves the quality of organizational communication, increases transparency, facilitates decision-making processes, and contributes to the optimization of managerial performance. The contribution of this study lies in expanding the theoretical framework on the relationship between social communication and business management, as well as in providing practical implications for managers seeking to enhance organizational efficiency through digital transformation.

Last but not least, the eight paper, titled "TURNING KNOWLEDGE INTO CAPITAL: HOW ADULT EDUCATION AND RVCC UNLOCK COMMUNITY ENTREPRENEURSHIP IN RURAL TERRITORIES", authored by, Susana Soares Pinheiro Vieira PESCADA, Fernando José Calado e Silva Nunes TEIXEIRA and António Manuel Felício Espírito SANTO, examines how Adult Education and the Recognition, Validation and Certification of Competencies processes (RVCC) can be strategically mobilized to activate human capital, foster local entrepreneurship and promote sustainable development in Almodôvar, a low-density rural municipality in the Alentejo region of Portugal. Based on a qualitative and exploratory approach, supported by semi-structured interviews with 15 participants, including learners and programme promoters, and analysed through thematic analysis, the research repositions competency recognition as a strategic resource rather than merely an educational outcome.The findings show that structured learning pathways and the recognition of experiential knowledge function as catalysts for individual empowerment, increased employability and strengthened entrepreneurial confidence, generating human capital with relevance for local economic dynamics. At the community level, these initiatives reinforce trust-based cooperation networks and stimulate civic engagement, both essential for territorially rooted entrepreneurial ecosystems. However, structural barriers persist, including mobility constraints, scheduling rigidity and resource scarcity, which limit expansion, sustainability and overall impact.

All these interesting works are available on the next pages of the SRDSJ intending to promote the academic dialogue in Regional Science. Overall, the Editor in Chief, Associate Professor Filipos A. Ruxho, the Editorial Board, and the signatory of this Editorial Note welcome

the reader to the multidisciplinary journey of Sustainable Regional Development Scientific Journal that the current issue promises on its following pages.

On behalf of the Editorial Board
Professor **Kreshnik Bello**
Sustainable Regional Development Scientific Journal

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Articles

CHEMICAL AND MATERIAL STRATEGIES FOR ENERGY-POSITIVE BUILDINGS: A SUSTAINABILITY-ORIENTED REVIEW

Gülşah ÇELIK GÜL

Assoc. Prof. Dr., Savaştepe Vocational School, Balikesir University,
Renewable Energy Research and Application Center,
Balikesir University, Balikesir, Türkiye
gulsahcelik@balikesir.edu.tr

Abstract

The pursuit of a promising way to reduce the impact of energy-positive buildings on the built environment is defined as reduced energy consumption. On the other hand, sustainability cannot be based solely on operational energy performance, as it is significantly influenced by material-related factors. This study is a comprehensive review of the chemical and material foundations of energy-positive buildings and a compilation of the long-term performance of material properties and degradation mechanisms. Data synthesis and literature selection were carried out using the PRISMA method. In light of the information obtained, parameters related to energy-intensive production, material stability, and life cycle impacts were addressed by considering key material groups, including cement-based systems, polymers, and bio-based materials. The findings show that degradation processes and limited circularity remain critical challenges. Therefore, achieving sustainable energy-positive buildings requires an integrated approach that simultaneously considers material chemistry, energy system performance, and life cycle assessment.

Keywords: Energy-positive buildings, Embodied carbon, Material chemistry, Building materials.

JEL Classification: Q01, Q42, Q56, Q55

Citation: Gul Ç. G., 2026. “Chemical and material strategies for energy-positive buildings: a sustainability-oriented review”, Sustainable Regional Development Scientific Journal, Vol III. (1), pp.12-36

1. Introduction

Energy-positive buildings, that produce more energy than they consume, are key solution for sustainable construction. When buildings become more energy efficient, operational emissions decrease with embodied carbon emissions from material production, construction, and end-of-life stages can dominate the total footprint. Cement, steel, and polymer-based materials are major contributors. Therefore, material chemistry plays a critical role in this problem. Material properties define thermal behavior, durability, and environmental interactions with the parameters such as thermal conductivity, heat capacity, and chemical stability. At the same time, degradation processes with influence maintenance needs, service life, and total emissions can change material properties.

On the other hand, advanced materials have both opportunities and risks: polymer-based insulation, bio-based materials, and phase change materials improve energy performance; but, they also raise concerns about toxicity, durability, and end-of-life management. In practice, recycling, reuse, and design approaches have serious limitations such as material heterogeneity, contamination, and degradation. As a result, theoretical recycle is often not achieved in real systems.

This review examines energy-positive buildings through the view of material chemistry. The aim of the study is to connect molecular design, material performance, and system-level outcomes. With this point of view, the study provides a clearer understanding of how buildings perform over their full lifecycle with a realistic pathway. It also highlights that true sustainability requires more than energy positivity.

2. Methodological Framework

The methodological framework of this review is designed to connect what is known about energy-positive buildings, the chemical foundations of sustainability, and the tools required to assess them. It pre-planning the integration of literature selection, data synthesis, and normalization (Caldeira et al. 2024). With this integration, the framework supports cross-disciplinary synthesis that aggregates insights from energy systems analysis, green and sustainable chemistry, and life cycle assessment to yield a view of how chemical design, material choices, and building energy performance interact throughout a building's life cycle (Blinova et al. 2023).

2.1. Literature Search and Selection Strategy

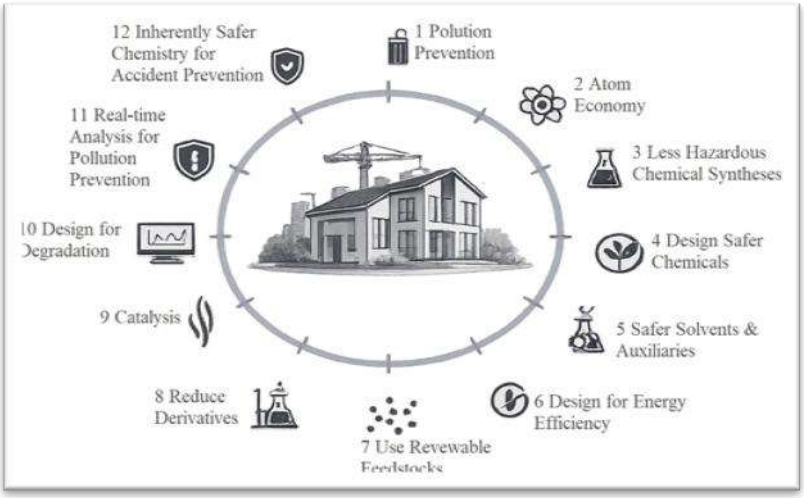
This review follows a PRISMA-inspired strategy to ensure transparent and reproducible study for the topic "Energy-Positive Buildings and the Chemical Foundations of Sustainability". I defined a comprehensive search protocol within two major databases, Scopus and Web of Science. This approach is consistent with PRISMA principles of explicit reporting of search strategies, database sources, and search terms as decribed in the literature (Soloveichik 2011).

3. Chemical Foundations of Energy-Positive Buildings

3.1. Green Chemistry in the Built Environment

Green chemistry (fig.1) provides a chemical foundations looks for rethinking construction materials and building systems over operational energy, guiding material choices, processing, and end-of-life pathways toward lower embodied harm. Key principles such as waste prevention, safer chemicals, energy efficiency, and the use of renewable feedstocks reform into the built environment emphasize designing systems that minimize waste and emissions at the cradle-to-grave scale, curtail toxic exposures, and reduce demand for virgin resources. In practice, this translates to formulating binders and coatings with lower embodied energy and toxicity. These employing processes that avoid waste streams, and prioritizing materials whose production, use, and disposal enact a net environmental benefit when evaluated across the life cycle (Goh and Ng 2016).

Figure 1. Twelve Principles of Green Chemistry to construction materials



Material chemistry shapes sustainability when operational energy is controlled. Embodied carbon, toxicity, and resource efficiency arise as material-level constraints. As a critical view, despite promising life-cycle analyses, the adoption of new chemicals is tempered by durability and compatibility (Vijayan et al. 2023). Overall, green chemistry offers a route to decarbonize the built environment, but its realization depends on material innovations with lifecycle performance, safety, and systemic integration within the construction sector (Booth and Jankovic 2022).

3.2. Material Safety, Toxicity and Indoor Chemistry

Building materials are active determinants of indoor chemical environments, leading to the sustained release of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), gas emissions from adhesives and resins, and secondary chemical reactions (Coffaro and Weisel 2022). While low-emission materials and source-control strategies can reduce primary VOC loads, there remains substantial uncertainty about long-term exposure to a broad, evolving mix of emissions and reaction products. Reviews emphasize that while reducing VOC emissions and employing materials with documented low emissions is beneficial, it does not automatically translate to safer indoor environmentsThis reality reveals that material selection must be shaped by consideration of indoor air quality guidelines, adequate ventilation design, and indoor chemical reactivity in order to achieve truly energy-positive results (C. W. Yu and Kim 2012).

3.3. Carbon Intensity of Material Production

Carbon intensity in construction materials (fig.2) is the mass of greenhouse gases emitted per unit of material or area, commonly expressed as kg CO_2-eq per kg of material over the material's life cycle. This metric captures embodied emissions from material production, processing, and delivery, distinct from operational energy performance during the building's use phase (Lobaccaro et al. 2018). In many building materials, embodied carbon is determined by the material product stages (A1-A3), which generally account for the largest share due to cement and steel-based systems, clinker production, high-temperature processing, and complex supply chains (Nath et al. 2018a). Hybrid and process-based life cycle analyses reveal significant differences in embodied carbon between materials and regions, depending on factors such as energy tariffs, upstream frontier selections, and data completeness. Nevertheless, cement, concrete, and steel consistently stand out as the primary carbon sources when comparing typical high-rise and solid wood structures (Wan Mohd Sabki Wan Omar et al. 2014). These patterns underscore the importance of up-front material choices in carbon accounting, even when a building achieves low operational energy.

Figure 2. Representative proportional contribution of primary construction materials to embodied carbon in building assemblies.

3.4. Distinctions and Material Comparisons

Efficient envelopes or systems reduce operating emissions, but materials with high embodied carbon may dominate lifecycle emissions, particularly if operational energy reductions are modest or offset by long lifespans and end-of-life dynamics. Several studies show that low-energy buildings can still accrue high lifecycle emissions if embodied intensities are high or if biogenic or recycled content is not effectively accounted for; thus the overall carbon performance hinges on material selection as much as on efficiency measures during use (Lausselet et al. 2019; Nordby and Shea 2013). Representative cradle-to-gate embodied CO_2 ranges for conventional mineral-based materials and selected recyclable or composite alternatives are summarised in Table 1. These indicative ranges illustrate that carbon intensity is strongly pathway-dependent and cannot be interpreted independently of processing temperature, feedstock origin, and recyclability potential. When comparing material categories, mineral-based systems generally exhibit higher carbon content per unit area than wood-based or bio-based alternatives. However, advancements in low-clinker cements, recycled steel, and cross-laminated timber may shift this balance. Mass timber designs often act as biogenic carbon sinks and can achieve positive lifecycle footprints, particularly when considering carbon absorbed during growth and carbon sequestration at the end of its life cycle (Chen et al. 2020; Felmer et al. 2022). The literature consistently warns that it is incorrect to assume that any single material category guarantees low life-cycle emissions, and a holistic assessment including A1-A5 and beyond, potential biogenic storage, and end-of-life pathways is required for robust comparisons (Lausselet et al. 2019).

Table 1. Indicative Embodied CO2 Ranges for Conventional and Recyclable/Composite Construction Materials

Material Category	Indicator (Typical Basis)	Embodied CO2 Range (kg CO2e / kg)	Notes
Concrete (normal strength, mix-dependent)	Mass-based	~0.07 – 0.15	Strongly dependent on cement content, SCM substitution, and regional energy mix (Hammond et al. 2011).
Structural steel	Mass-based	~1.3 – 2.5	Sensitive to recycled scrap ratio and electricity carbon intensity (Hammond et al. 2011).

Material Category	Indicator (Typical Basis)	Embodied CO_2 Range (kg CO_2e / kg)	Notes
Aluminum (primary-dominant production)	Mass-based	~8 – 16	Primary smelting is highly energy-intensive; recycled content reduces intensity (Hammond et al. 2011).
GFRP (glass fiber–reinforced polymer composites)	Mass-based	~1.8 – 4.6	Varies with resin system, fiber fraction, and manufacturing route (Alrehaili et al. 2025).
CFRP composite (virgin carbon fiber)	Mass-based	~50 – 60	Carbon fiber production is energy-intensive; values depend on precursor and curing method (Ramachandran et al. 2023).
Recycled carbon fiber (rCF)	Mass-based	~20 – 25	Dependent on recovery technology; significant reduction compared to virgin CF (Urruzola et al. 2025).
Engineered timber (biogenic carbon accounted)	Sequestration-adjusted	~−1.6 kg CO_2e/kg (biogenic storage basis)	Biogenic accounting depends on system boundaries and end-of-life assumptions (Orr et al. 2020).

3.5. From Molecular Design to System-Level Sustainability

With current advancements in molecular-scale design, performance criteria are being defined in classical building structures. By optimizing chemical composition, molecular architecture, and reactive pathways, scientists are able to shape properties such as ion transport, interface stability, and thermal behavior, which determine energy consumption, durability, and safety in buildings (Sharma et al. 2025). The integration of AI-assisted design and preliminary chemistry enables multi-scale mapping, from structure-property-performance relationships to system-level outcomes, and reveals how molecular-level metrics can translate into various gains in terms of energy efficiency and durability (Vu et al. 2025).

Creating energy-positive buildings of the targeted scale requires integrating materials science with building energy system design, which can only be achieved through the simultaneous optimization of building facade materials, heat storage, and active/passive HVAC strategies (Lee et al. 2025).

4. Carbon Footprint and Life Cycle Assessment

4.1. Cement and Mineral-Based Materials

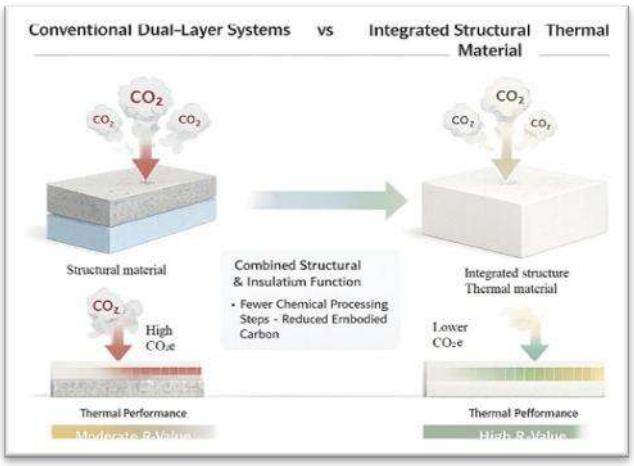
Cement and mineral-based materials are central to the embodied carbon of buildings, because cementitious binders underpin the vast majority of concrete and precast elements that constitute most structures. The high-temperature clinker production step, and specifically limestone calcination, is the dominant source of process emissions in cement manufacture, while energy use for pyroprocessing contributes a substantial portion of lifecycle emissions (Reis et al. 2021). The combination of calcination-derived CO_2 release (the chemical part) and fossil-fuel combustion for kiln heat underpins why cement-based materials are frequently identified as hard-to-abate sectors in built environment decarbonization pathways (Reis et al. 2021). Beyond clinker production, the cement-to-concrete chain also modulates emissions through the clinker-to-cement ratio and the parceling of supplementary cementitious materials (SCMs), which reduce reliance on Portland cement and thereby lower the process- and energy-related footprints of the binder system (Scrivener et al. 2018). These dynamics are echoed in cross-cutting analyses of demand- and supply-side decarbonization, where SCMs, alternative binders, and carbonation concepts are foregrounded as practical levers for near-term mitigation (Pamenter and Myers 2021; Watari et al. 2022). Overall, the literature emphasizes that decarbonization is not the

result of a single technology, but rather a portfolio of interdependent actions, each of which has significant impacts on structural performance, lifecycle resilience, and the ability to be implemented on a large scale across various markets (Arvizu-Montes et al. 2025).

4.2. Polymers in Insulation and Coatings

Polymer-based materials, with their superior thermal insulation and durable protective coating properties, are among the fundamental research areas of our time for reducing operating energy in buildings. In insulation, polymer foams and aerogels, generally derived from fossil-based polyols and isocyanates or alternative bio-based monomers, are used, which have low thermal conductivity (Dove et al. 2019). Throughout the life cycle (Figure 3), the need arises to evaluate the energy-performance advantages of polymers in an integrated manner with material selection, considering how various materials affect both operational energy use and the energy contained within the building cladding system (Iwuanyanwu et al. 2024).

Figure 3. Conceptual comparison between conventional dual-layer envelope systems and integrated structural–thermal materials.



Therefore, a needs assessment requires striking a balance between higher energy performance and environmental and health impacts. This encourages research into bio-based polymers and low-toxicity formulations that improve both insulation performance and lifecycle sustainability. Some of the emerging alternatives, such as bio-based binders, natural fibers, and closed-loop design concepts, show promise in terms of reducing carbon footprint while maintaining hygrothermal performance (Nasr et al. 2023; Raja et al. 2023). In this context, the development of bio-based insulation materials and low-toxicity coatings is consistent with the logic of circular building; however, careful life cycle assessment is required to ensure that their use, operation, and tangible benefits are realized throughout the process (Marín-Calvo et al. 2023).

4.3. Bio-Based Materials: Limits and Trade-offs

The construction industry is turning to bio-based materials due to limited fossil fuels, potential carbon sequestration, and regulations aimed at reducing energy consumption in building structures. However, the literature emphasizes that bio-based materials do not necessarily have entirely low-carbon or sustainable performance. Environmental benefits can be determined depending on the life cycle context, end-of-life options, and the durability of the materials during use. In conclusion, bio-based materials do not guarantee a lower carbon footprint or better life cycle performance. To achieve the targeted sustainability, their standardization should be supported through integrated design choices, protective surface treatments, and compatible matrices (Maraveas 2020).

4.4. Strengths and Limitations of LCA Methods

Life cycle assessment (LCA) is a holistic approach to evaluating the environmental performance of buildings throughout their entire life cycle (Cai et al. 2021). In the context of energy-positive buildings, Life Cycle Analysis (LCA) enables direct comparison of materials and systems, leading to lower-carbon configurations (Cabeza et al. 2021; Cai et al. 2021; Ramakrishna et al. 2021). However, LCA results are highly sensitive to methodological preferences and information gaps, and can significantly shape conclusions about a building's sustainability performance (Andersen et al. 2021). The main limitations include variability in system boundaries (A1–A5, B, C, D scopes) and allocation rules, which can lead to different energy and carbon emission outcomes for similar designs (Kayan et al. 2016). Table 2 provides a comparative qualitative assessment of integrated structural-thermal systems in terms of carbon sensitivity, recyclability, and service life durability risk.

Table 2. Comparative Qualitative Assessment of Integrated Structural–Thermal Systems Including Durability Risk

System Type	Structural Capacity	Thermal Conductivity Potential	Recyclability Potential	Embodied Carbon Sensitivity	Service-Life Durability Risk
Autoclaved Aerated Concrete (AAC)	Moderate	Moderate	Limited	High (cement chemistry dependent)	Moderate (moisture sensitivity, carbonation) (Ramamurthy et al. 2009)
Foamed Geopolymer Systems	Moderate (research-stage structural grades)	Moderate–Good	Moderate	Medium–High (activation route dependent)	Moderate–High (long-term durability still under study) (Tolun 2022)
Insulated Concrete Forms (ICF)	High	Good	Low	High (dual production pathways)	Moderate (polymer aging + concrete cracking) (Aci 2001)
Structural Insulated Panels (SIPs)	High	Good	Low–Moderate	Medium–High	Moderate–High (adhesive degradation, moisture ingress) (Straube and Burnett 2005)

System Type	Structural Capacity	Thermal Conductivity Potential	Recyclability Potential	Embodied Carbon Sensitivity	Service-Life Durability Risk
VIP-based Composite Panels	Low–Moderate	Very High	Low	Medium–High (processing energy sensitive)	High (vacuum loss, puncture sensitivity) (Simmler et al. 2005)
Thermoplastic Composite Sandwich Systems	Moderate –High	Good	High (mechanically separable)	Medium (electricity/fibre dependent)	Moderate (creep, UV sensitivity; matrix dependent) (Real 2023)

5. Energy Systems and Thermochemical Integration

5.1. Photovoltaic Materials and Degradation

Photovoltaic materials are a cornerstone of energy-positive buildings, enabling on-site electricity generation and complementing high-performance building facades and demand reduction strategies. In building-integrated approaches, photovoltaics (PV) play a dual role: firstly, providing clean electrical energy to meet part or all of the building's load; and secondly, enabling architectural strategies that reduce cooling and heating demands through shading and daylight interactions. In this context, bi-sided, translucent, and PV-thermal configurations have various advantages and disadvantages depending on the climate, orientation, and building use (Bošnjaković et al. 2023; Kong et al. 2023).

Degradation and aging mechanisms are of critical importance in achieving long-term performance and lifecycle energy targets. In all photovoltaic technologies, degradation results from thermal stress, prolonged UV exposure, moisture ingress, and mechanical and/or environmental aging (Maghrabie et al. 2021). In summary, the literature consistently demonstrates that uncertainty regarding the breakdown of photovoltaic technologies and installation strategies has a significant impact on achievable long-term energy efficiency (Reddy et al. 2024).

5.2. Thermal Energy Storage (PCM Systems)

Phase change materials (PCMs) enable latent heat storage in building facades and mechanical systems by absorbing or releasing large amounts of energy at nearly constant temperatures during phase transitions, thus stabilizing indoor temperatures and reducing high heating and cooling loads (Huang et al. 2021). Comparative studies show that organic phase change materials (paraffins, fatty acids) offer favorable chemical stability, non-corrosiveness, negligible phase separation, and minimal supercooling, but are inherently limited by low thermal conductivity and, in some cases, flammability. On the other hand, inorganic phase change materials (salt hydrates, hydrated salts) provide higher internal heat densities and better conductivity, but have disadvantages such as phase separation and supercooling (Huang et al. 2021). Eutectic phase change material (PCM) systems, including organic-organic, inorganic-inorganic, or organic-inorganic mixtures, can often be specifically designed to achieve target melting points and overcome some of these drawbacks; however, they also have various stabilization problems (Zhang et al. 2018).

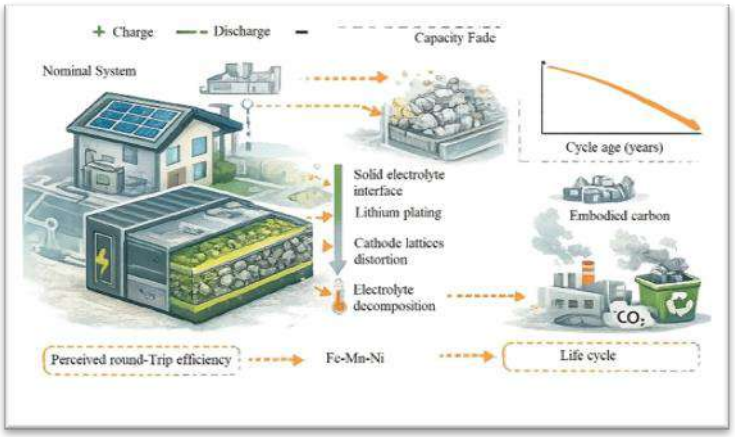
Overall, the literature on PCM systems agrees on a consistent view: while they provide significant reductions in heating and cooling loads when designed as stabilized composites with improved conductivity, various formulations can be developed considering phase stability, leakage problems, and life cycle effects in material selection. This offers promising new options for reliable and scalable building thermal energy storage solutions

(Wang et al. 2017).

5.3. Electrochemical Storage Systems

Electrochemical energy storage (ESS) systems play a central role in transforming energy-positive buildings from mere ideal concepts into practical and resilient infrastructures. Numerous studies have shown that ESS-equipped buildings enhance renewable energy integration, enable load shifting, and reduce grid emissions and stabilize on-site power profiles by increasing self-consumption (Jones et al. 2019). From an application perspective, round-trip efficiency, charge status management, and appropriately sized storage capacity determine the degree to which energy is converted into usable energy for daily operations in on-site production. Simultaneously, lifecycle considerations shape whether a storage investment will deliver net carbon and cost benefits over time (Gao et al. 2023). As shown in Figure 4, electrochemical storage systems exhibit time-dependent degradation mechanisms that directly affect the long-term energy balance of buildings.

Figure 4. Degradation pathways in building-integrated lithium-ion storage and their influence on long-term capacity and lifecycle emissions.



Sustainability considerations at the material level are of undeniable importance for long-term building performance. Critical raw materials, electrolyte formulations, and degradation pathways shape not only environmental footprints but also safety and maintenance requirements within building contexts. End-of-life management and recycling emerge as crucial levers for closing material cycles. Recent research strongly underscores the need for harmonized lifecycle analyses, standardized functional units, and open data to obtain reliable benchmarks and policy-relevant conclusions for building applications (Titirici et al. 2024).

5.4. Hydrogen-Integrated Building Systems

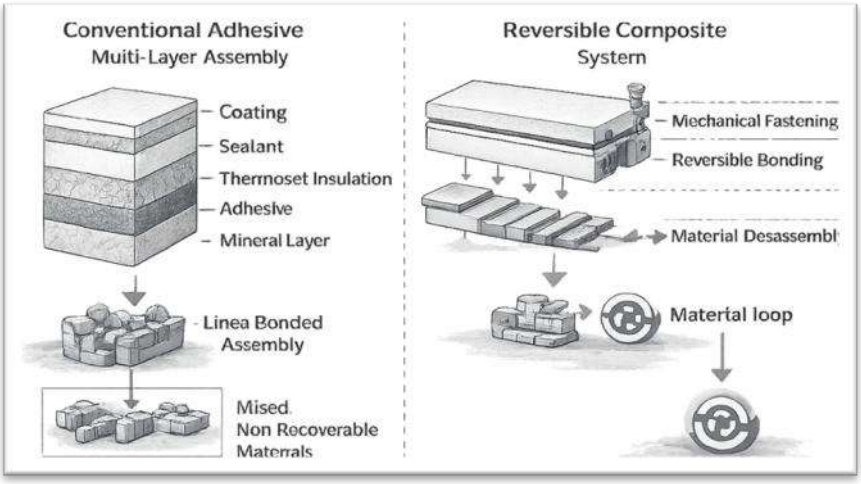
Hydrogen is increasingly being explored as a cross-sector unifying element for energy-positive buildings and a long-term energy storage medium, offering a pathway to deeper decarbonization beyond direct electrification (Cheekatamarla 2024). In this context, buildings can host a small- to medium-scale hydrogen energy system that couples electricity, heating, and potentially mobility. Oppositely, literature reports a spectrum of limitations and uncertainties. Efficiency losses arise from electrolysis, hydrogen compression, storage, and then conversion back through fuel cells or hydrogen turbines, which reduces round-trip efficiency relative to direct electricity storage technologies (Cheekatamarla 2024). Overall, studies show that while hydrogen remains an attractive option, the literature consistently highlights the need to develop infrastructure, policies, and technologies to overcome current limitations on its widespread adoption in energy-positive configurations at the building scale (Kirk 2022).

6. Material Durability and Performance Gap

6.1. Chemical Ageing Mechanisms

Extensive studies have shown that chemical aging in building materials results from fundamental processes such as oxidation, hydrolysis, carbonation, and polymer degradation. Mineral-based materials (e.g., cementitious matrices, geopolymers, and natural clays) primarily age through various pathways such as hydration/dehydration dynamics, dissolution-precipitation equilibria, and silica-alumina polymerization in response to moisture, temperature, and aggressive species (Thissen et al. 2024). Fig. 5 illustrates how bonding chemistry governs dismantlability of conventional adhesive and reversible composite. Conventional multi-layer assemblies rely on irreversible cross-linking and heterogeneous interfaces that prevent selective separation. In contrast, composite systems designed with thermoplastic matrices or reversible bonding mechanisms enable material recovery with lower thermodynamic input.

Figure 5. Conceptual comparison of conventional bonded multi-layer envelope systems and chemically reversible composite assemblies illustrating their implications for end-of-life recoverability



6.2. Moisture-Induced Degradation

Moisture moves through building materials via absorption, diffusion, and capillary action. In mineral-based systems, capillary rise and diffusion lead to slower transport through gels and microstructural pores. This dual system governs the timing and extent of moisture-induced chemical changes and salt transport in concrete and stone. In polymer-based matrices, moisture can soften polymers, alter free volume, and accelerate damage by facilitating diffusion across interfaces. In composites, moisture is due to interface quality and the presence of hygroscopic fillers or natural fibers. Bio-based materials increase moisture sensitivity due to the natural hygroscopicity of lignocellulose components. Thus, moisture absorption not only swells the fibers but also increases micropore transport towards the matrix, accelerating hydrolysis and biodegradation. Moisture transport, which links deterioration due to humidity to durability and indoor air quality, affects not only structural integrity but also the health of building occupants. Increased absorption and delayed drying raise indoor humidity, promote microbial growth, and affect pollutant transport, impacting energy performance and the sustainability of energy-positive buildings (Akarken et al. 2025).

6.3. Photodegradation Processes

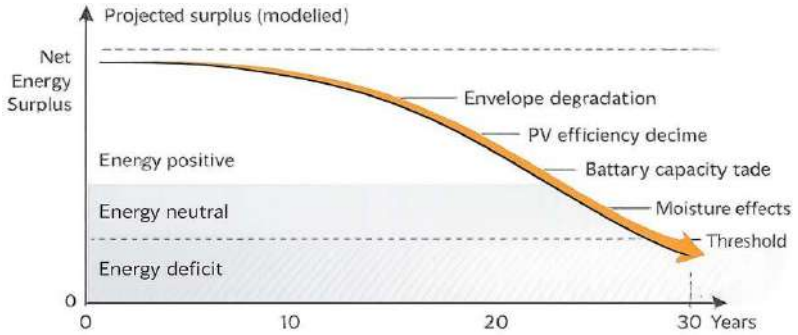
Building exterior materials are exposed to sunlight, triggering photochemical reactions initiated by UV photons absorbed by various types of chromophores. In polymeric systems, photostimulation produces radical processes manifesting as chain breaking, cross-linking, and oxidation of carbonyl groups, leading to optical discoloration accompanied by brittleness and surface cracking. These changes are associated with decreased mechanical performance

and deterioration of aesthetics (Wolf 2008). In photovoltaic (PV) materials, encapsulation and barrier layers can prevent photodegradation by limiting oxygen and moisture access. However, photoinduced oxidation of active layers and interfacial degradation remain the dominant loss mechanisms. These can be most effectively mitigated through targeted encapsulation strategies rather than simply making changes to the material itself (D. Kim et al. 2024).

6.4. Long-Term Stability of Advanced Materials

Material stability is a crucial constraint in the real-world performance of energy-positive buildings, as laboratory measurements often overestimate durability after materials have been subjected to all environmental stressors encountered during service. A consistent synthesis across polymeric composites, coatings, and nanostructured systems demonstrates that long-term stability arises from the interplay of chemical aging, moisture transport, and photodegradation (Andrady et al. 2023). In fiber-reinforced and nano-enhanced coatings, the presence of UV and moisture accelerates interfacial debonding, nanoparticle migration, and matrix cracking, suggesting that long-term reliability hinges on robust interfacial adhesion and well-designed UV stabilization strategies that persist under damp-heat cycling (Jacobs et al. 2016). Moreover, the literature on self-healing and nanocomposite coatings indicates a trade-off: while embedded nanomaterials and adaptive coatings can impede early-stage degradation and offer self-repair, they can also introduce new pathways for nanoparticle release or altered aging kinetics under sustained weathering, necessitating comprehensive life-cycle risk assessments (Jacobs et al. 2016). As conceptually illustrated in Fig. 6, projected energy surplus may gradually decline as degradation mechanisms accumulate across envelope materials, photovoltaic systems, and electrochemical storage. Energy-positive status is therefore a time-dependent condition rather than a fixed design attribute.

Figure 6. Conceptual representation of time-dependent reduction in projected energy-positive margin due to material degradation, PV efficiency decline, and storage capacity fade.



Across material classes, discrepancies between short-term lab performance and field durability are pronounced and attributed to the complexity of real climates and multi-factor aging. Laboratory tests that isolate a single stressor (e.g., UV or humidity) can misrepresent long-term trajectories where synergistic interactions (photodegradation coupled with moisture ingress, thermal cycling, and environmental pollutants) govern degradation rates. For example, photostabilizers and nanocoatings can dampen visible property loss in laboratory protocols but may still fail to maintain performance under realistic UV–moisture cycling or salt-rich atmospheres, leading to unforeseen maintenance demands and higher lifecycle carbon footprints (Andrady et al. 2023). The durability of high-performance polymers and hybrid systems is thus highly contingent on the balance between intrinsic material resilience and extrinsic exposure conditions, with implications for maintenance frequency, embodied energy, and retrofit timing in energy-positive building envelopes (Berdahl et al. 2008). This synthesis underscores that achieving durable, low-carbon buildings requires explicitly accounting for long-term stability in material selection, accelerated aging interpretation, and regulatory frameworks that align short-term lab results

with decades-long service expectations (Rana et al. 2025).

7. Circularity and End-of-Life Chemistry

7.1. Polymer Recycling Challenges

Recent literature across mechanical and chemical recycling of polymer-based construction materials—including insulation, coatings, and fiber-reinforced composites—highlights a persistent gap between theoretical recyclability and real-world circularity. A central theme is material heterogeneity: multilayer films, composites, and blended insulation systems comprise incompatible polymers, additives, and interfacial layers that frustrate straightforward recycling recipes (Adam et al. 2025). Even when individual components are, in principle, recyclable, the presence of tie layers, fillers, inks, adhesives, and moisture residues compromises recyclate purity and mechanical performance, limiting end-use options and often relegating streams to downcycling rather than closed-loop reuse (Adam et al. 2025). In construction waste, the same challenge manifests in insulation composites and protective coatings where diverse resin matrices and reinforcing fibers co-exist, generating immiscible blends that deteriorate as-recycled material properties and hinder uniform processing in subsequent manufacturing cycles (Peti et al. 2025).

Comparative assessment of mechanical versus chemical recycling reveals complementary strengths but also critical limitations in practice. Mechanical recycling is energy-efficient and capital-friendly but suffers progressive polymer degradation (molecular weight, crystallinity, and tack) and strong sensitivity to contamination, leading to property decline after each cycle and often restricting recyclates to applications of lower value or shorter lifespans (Younis et al. 2024). Chemical recycling—depoymerization, dissolution-based separations, pyrolysis, and gasification—promises higher purity and the potential to valorize mixed or multilayer streams, including thermosets and composites; however, it remains energy-intensive, technologically complex, and frequently hampered by high pre-sorting requirements and uncertain techno-economic viability at scale (Srivastava 2025). A pragmatic view emerging from systems-level analyses documents that no single recycling pathway suffices for the broad spectrum of polymer waste generated by buildings; instead, a tiered, hybrid approach—combining dissolution or selective delamination for separation, followed by targeted chemical or mechanical routes—offers the best potential for maintaining material quality across cycles while reducing lifecycle carbon (McGuire et al. 2025). The literature also notes a behavioral and policy gap: current recycling rates fall far short of theoretical recyclability, with persistent barriers including feedstock contamination, nonuniform material design, and fragmented collection, which collectively constrain circularity and limit lifecycle carbon benefits in energy-positive buildings (McGuire et al. 2025).

In sum, advancing the circularity of polymer-based construction materials requires (i) explicit design-for-recycling strategies that reduce heterogeneity and remove non-recyclable tie layers and additives; (ii) scalable, integrated recycling workflows that leverage the strengths and compensate for the weaknesses of both mechanical and chemical routes; and (iii) robust data, standardization, and policy frames to translate theoretical recyclability into real-world rates and lifecycle carbon savings. The gap between ideal recyclability and observed recovery rates remains a major bottleneck for achieving low-carbon, energy-positive buildings, underscoring the need for coordinated advances in material design, processing technologies, and circular economy governance (Adam et al. 2025; McGuire et al. 2025).

7.2. Secondary Raw Materials from Demolition Waste

Demolition waste harbors substantial potential as a feedstock for secondary raw materials, with multiple studies showing that material streams such as recycled aggregates, mineral fractions, metals, glass, and recovered polymers can substitute primary materials in construction. Comparative analyses across case studies and regional contexts indicate that recycled aggregates (RAs) and RCA/RFA fractions can replace conventional coarse and fine aggregates in concrete and road base, albeit with performance constraints tied to particle quality, contamination, and the presence of mortar or ceramics (Shufrin et al. 2023). Metals

recovered from structural steel, aluminum, copper, and ferrous alloys consistently demonstrate high recycling rates and embodied-energy benefits when properly segregated, while glass cullet and post-consumer polymers offer potential for asphalt, concrete, and composite applications, provided sorting and cleaning advances accompany collection (Keyhani et al. 2023a). Across these streams, several analyses converge on the notion that end-of-life material streams can close material loops, contributing to resource efficiency and circular economy goals when embedded in design decisions that anticipate deconstruction and material passports (Hussain and Kamal 2015).

Crucially, the literature reveals persistent barriers that limit the realization of lower-embodied-carbon outcomes from demolition-derived secondary materials. Contamination with pre-existing mortars, bricks, plaster, gypsum, and non-target polymers reduces material quality and performance, while mixed waste streams, heterogeneous composition, and variable on-site sorting capabilities hinder assurance of consistent material standards (Baiani and Altamura 2022). Regulatory constraints and the absence of harmonized EPDs or material passports further impede uptake by increasing uncertainty and transaction costs for designers and contractors (Keyhani et al. 2023a). Several studies underscore that while recycling can reduce embodied carbon by avoiding virgin material production, this does not automatically translate into lower lifecycle impacts: the processing energy, transportation, and end-of-life treatment can offset gains if recycling rates are suboptimal or if secondary materials fail to perform adequately and require overdesign or additional substitutes (Vidal et al. 2019). The net climate performance thus hinges on system-level choices—designing for disassembly, incorporating high-recovery pathways, and aligning regulatory and market incentives to sustain quality sorting and validated supply chains (Hussain and Kamal 2015).

In the context of energy-positive buildings and sustainability foundations, secondary materials contribute to circular economy trajectories and resource efficiency by reducing primary material demand and associated embodied carbon, but only when integrated with appropriate governance, validation of material quality, and robust life-cycle accounting. Several studies emphasize that generic labeling of recycled content is insufficient; the carbon and energy benefits depend on concrete performance, end-of-life pathways, and accurate accounting of C3 and D-stage contributions in LCA frameworks. This nuance is highlighted in cross-comparative assessments that compare recycling strategies, energy payback, and lifecycle emissions across materials and regions, illustrating that recycled content must be coupled with strategic design for reuse, disassembly, and credible EPD data to achieve genuine climate-positive outcomes (Keyhani et al. 2023a; Shufrin et al. 2023).

7.3. Design for Disassembly

Design for Disassembly (DfD) is a lifecycle-oriented design discipline that foregrounds end-of-life recoverability by enabling orderly separation of building components and materials for repair, reuse, remanufacturing, or recycling. The literature consistently frames DfD as a critical enabler of circular building practice, linking its success to modular architectures, standardized connections, and careful material compatibility that preserve value across multiple life cycles (Roxas et al. 2023) . Empirical work in the construction sector shows that reversible or demountable connections (bolts, clips, plug-and-play interfaces) and modular subdivision of assemblies substantially lower disassembly effort and material damage, thereby enhancing reuse potential and reducing embodied carbon when compared with conventional, linearly demolished components (Roxas et al. 2023). Case studies of prefabricated envelopes and timber-based systems quantify embodied-carbon reductions and highlight that multi-cycle reuse outcomes hinge on the reversibility of connections and the ability to maintain material condition during recovery (Bergmans et al. 2023). However, several studies emphasize that the climate and circular benefits of DfD are contingent on real-world recovery rates and life-cycle performance, with economic and policy constraints shaping outcomes (e.g., up to 50% embodied-carbon reductions in favorable cases, and clear thresholds where downcycling diminishes climate benefits) (Bergmans et al. 2023).

Material selection, connections, and system integration emerge as the linchpins of disassembly performance. Material compatibility across interfaces—favoring non-toxic, non-composite, and standardizable materials—facilitates off-site management and

downstream reuse, while modular design aggregates functions into discrete, interchangeable units that can be disassembled with minimal collateral damage (Roxas et al. 2023). Yet the literature uniformly acknowledges practical limitations: higher initial design complexity and cost, scarcity of standardized DfD guidelines for diverse building systems, and fragmentation in policy uptake and industry practice hinder broad adoption (Roxas et al. 2023). Notably, several analyses connect DfD to the circular economy and lifecycle carbon reduction by demonstrating that modular, reversible connections and strategic material choices enable material banks, multi-life service, and enhanced recovery pathways, underscoring the need for early-stage design decisions and alignment with circular-design metrics (e.g., circularity indicators and Level(s)–compatible assessments) to translate theoretical gains into tangible performance (Roxas et al. 2023). Where governance and standards lag, potential benefits are curtailed, and the literature calls for harmonized criteria, repeatable disassembly workflows, and industry-scale demonstrations to close the gap between design ideals and practice (Roxas et al. 2023).

7.4. Life Cycle Carbon Beyond Operational Balance

Operational carbon and embodied carbon denote distinct portions of a building's total climate impact. Operational carbon arises from energy consumed during use (heating, cooling, lighting, equipment), whereas embodied carbon encompasses emissions from material production, construction, maintenance, and end-of-life across the building's life cycle (Curmi et al. 2022). Across multiple studies, as operational energy intensity falls with high-performance envelopes and on-site renewables, the share of embodied carbon in total life-cycle emissions rises and can dominate the footprint in NZEB/NZCB contexts; e.g., analyses of net-zero or beyond-net-zero designs show embodied emissions can constitute substantial or even majority shares when operating energy is minimized (often 26–74% in low-energy to net-zero scenarios, and up to 74–100% in some net-zero cases) (Keyhani et al. 2023b). Kneifel et al. demonstrate that pursuing net-zero operating performance can trigger a pronounced increase in embodied flows (over 40%), offsetting some operating gains, though total life-cycle emissions still decline relative to code-built baselines; this finding is echoed by systematic reviews noting the growing prominence of EC as OC improves (Keyhani et al. 2023b). More advanced LC-ZCB frameworks explicitly optimize for both OC and EC, sometimes achieving negative life-cycle embodied values when biobased or carbon-storing materials are deployed, but such outcomes hinge on material choice, supply chains, and end-of-life assumptions (Gomes 2025).

Current approaches that focus predominantly on operational energy metrics risk obscuring where most emissions accumulate, particularly during material production, construction, and end-of-life phases. Several studies emphasize the need to integrate embodied flows into policy and practice; policy reviews and practitioner guides argue for whole-life carbon accounting (WLCA) to guide design decisions, material selection, and demolition versus refurbishment pathways, noting wide cross-country variation in methodologies and definitions of net-zero that can undercount EC if boundaries are poorly defined (Loveday et al. 2022; F. Yu et al. 2022). In practice, refurbishment and reuse can outperform new construction when embedded emissions and end-of-life scenarios are properly accounted for, sometimes yielding lower life-cycle carbon than demolition-rebuild options even under aggressive OC reductions, underscoring the necessity of urban-scale, dynamic LCA approaches and benchmarking to move beyond operational-centric targets (Hu 2021). Collectively, the literature argues for a holistic design paradigm that couples aggressive operational strategies with aggressive embodied-carbon mitigation—through material substitution, circular design for disassembly, and end-of-life strategies—to realize true low or net-zero life-cycle carbon, rather than assuming that zero or near-zero operating energy automatically delivers low lifecycle emissions (Gomes 2025).

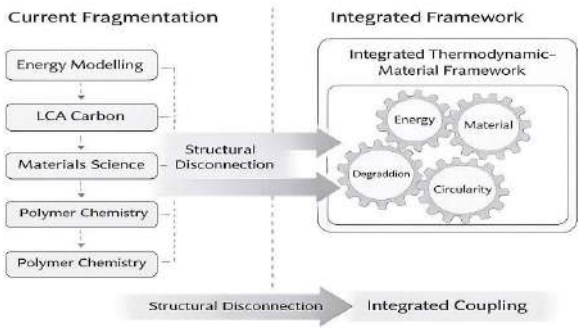
8. Research Gaps and Future Directions

8.1. Integrated Energy–Material Modelling

Integrated Energy–Material Modelling: A forward-looking synthesis is needed because current energy-performance assessments for energy-positive buildings treat materials as

static inputs rather than chemically and electrochemically responsive systems, leaving a critical gap between building energy models and the molecular- to microstructural properties that govern material performance and degradation under real service conditions (Ding et al. 2022). The lack of coupling between energy simulations and material-level chemical properties undermines the predictive fidelity of sustainability assessments, since changes in material chemistry, microstructure, hydration, degradation pathways, diffusion, and interfacial reactions directly alter thermal conductivity, moisture transport, heat capacity, durability, and embodied energy over the building's life cycle (Q. Ma et al. 2023). A robust framework is required to couple energy simulations with material degradation models, transport phenomena, and interface chemistry to forecast long-term energy performance, repair needs, and end-of-life trajectories; such integration would enable dynamic LCA/LCA-like life-cycle energy accounting that accounts for evolving material states, facilitating design choices that optimize both operational energy and material sustainability across decades (Costa 2025). While some reviews address LCA, durability modelling, or advanced energy-material systems in isolation, there is no consensus on standardized coupling methodologies or data-sharing practices, and harmonized multi-scale, multi-physics approaches are urgently needed to move from static assumptions to predictive, integrated, and auditable assessments for future energy-positive buildings (Nath et al. 2018b). In this direction, future work should emphasize open, interoperable pipelines that link process-level chemistry, degradation kinetics, and microstructure-informed transport with building-scale energy models, supported by validated, scalable simulations and enhanced data transparency to close the loop from material design to lifetime energy performance (Sbahieh et al. 2023). As illustrated in Fig. 7, current research architectures treat energy modelling and materials chemistry as parallel domains. Future frameworks must integrate these into a unified thermodynamic-material system.

Figure 7. Structural contrast between current disciplinary fragmentation and an integrated energy–material–degradation–circularity framework in energy-positive building research.



8.2. Exergy-Based Carbon Evaluation

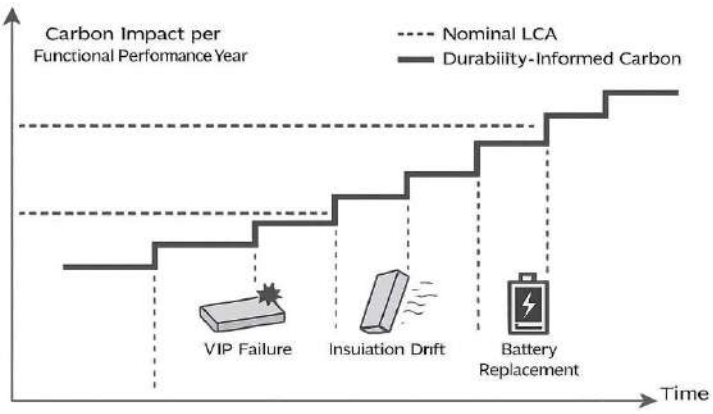
Exergy-based carbon evaluation offers a critical lens to overcome the well-known limitations of energy-based carbon accounting, which conflates energy quantity with environmental impact and often underrepresents the quality of energy flows, irreversibilities, and the ambient conditions under which energy is exchanged; exergy, by quantifying the maximum useful work potential relative to the environment, reveals that two systems with identical energy consumption can have markedly different environmental burdens due to differences in energy quality, transfer losses, and irreversibility (M. Ma et al. 2021), a point reinforced in exergy-LCA integrations that highlight its capacity to unify material, energetic, and environmental dimensions into a common unit and to expose hidden inefficiencies in resource use (M. Ma et al. 2021). Despite this theoretical appeal, the application of exergy-based approaches to building-scale sustainability remains disproportionately underdeveloped, with most exergy work concentrated in civil infrastructure and industrial processes rather than in single buildings or built-environment districts, thereby missing scale- and boundary-specific dynamics such as occupancy-driven load profiles, embodied exergy in

materials, and end-of-life couplings that shape long-term resilience and retrofit potential (M. Ma et al. 2021). Consequently, the exergy perspective invites targeted research directions: (i) developing standardized building exergy assessment frameworks that coherently integrate operational, embodied, and end-of-life exergy destruction across lifecycle stages; (ii) coupling exergy metrics with dynamic building energy simulations under climate-change scenarios to capture quality-adjusted demand and supply mismatches; (iii) advancing exergoeconomic and exergoenvironmental analyses for buildings to inform cost-optimized decarbonization pathways; and (iv) designing pilot demonstrations of exergy-based decision-support tools at the neighborhood and district scales to reveal synergies between building design, grid interactions, and circular material strategies, thereby bridging the current gap between exergy theory and practical, energy-positive building outcomes (M. Ma et al. 2021). Annotated bibliography follows.

8.3. Durability-Based Carbon Modelling

Current carbon modelling in built environments largely treats materials and assemblies as static end-states, neglecting how ageing, degradation, and refurbishment reshape embodied and operational emissions over the building lifetime; this gap undermines the reliability of lifecycle carbon estimates and can misinform decarbonization strategies (Kang et al. 2019). Material degradation drives evolving emissions profiles: degradation mechanisms, maintenance, component replacement, and end-of-life recycling loops alter the timing, magnitude, and composition of embodied carbon, often amplifying recurring emissions through more frequent refurbishments even as newer materials promise lower standby footprints (Kang et al. 2019). Consequently, integrating ageing and lifetime into carbon assessments is essential to capture the full spectrum of future emissions, including how future decarbonization of electricity, circular material strategies, and disassembly/reuse pathways interact with aging stocks to modulate long-run carbon outcomes (Moomaw et al. 2020). A forward-looking framework that embeds time-dependent material performance,Stock turnover, and dynamic refurbishment scenarios within LCA/LCC paradigms is therefore needed to produce robust, policy-relevant insights for energy-positive buildings and the chemical foundations of sustainability (Stephan et al. 2022). In doing so, researchers should explicitly address the trade-offs between durability, embodied carbon, and operational carbon, and leverage cross-scale, multistage modeling to anticipate how lifetime extension and material substitution reshape whole-life carbon trajectories under evolving energy systems (Moomaw et al. 2020). As conceptually illustrated in Fig. 8, static life-cycle carbon accounting assumes constant performance over time, whereas durability-informed modelling reflects capacity drift, envelope degradation, and component replacement cycles.

Figure 8. Illustration of divergence between static life-cycle carbon assessment and time-corrected carbon modelling incorporating material degradation and replacement cycles.



8.4. Advanced Polymer Design for Circularity

Advanced Polymer Design for Circularity: The energy-positive trajectory of buildings

hinges not only on material performance but on truly circular polymers whose end-of-life is an integral design parameter. Current recyclability and circularity remain hampered by mixed-polymer streams, irreversible crosslinks, and energy-intensive depolymerization pathways that degrade material properties across cycles (Balu et al. 2022). To move beyond this linearity, polymers must be conceived with closed-loop end-of-life in mind—incorporating degradable or recyclable backbones, dynamic covalent networks, and modular architectures that enable property-tunable end-of-life handling without sacrificing performance in service (Mah et al. 2025). Emerging approaches—recyclable thermosets and vitrimers, covalent adaptable networks, and depolymerization/upcycling strategies—offer routes to recover monomers or convert waste into value-added materials while preserving or enhancing functionality (Balu et al. 2022; Ellis et al. 2021; Habets et al. 2023; H. J. Kim 2023; Y. Ma et al. 2022). Realization will require design principles that balance mechanical resilience with controllable bond exchange kinetics, renewable-sourced monomers, and compatible processing to support energy-positive buildings under a cradle-to-cradle paradigm (Y. Ma et al. 2022; Mah et al. 2025). While challenges persist—such as achieving selective depolymerization in mixed waste streams and scaling dynamic chemistries to industrial volumes—a concerted emphasis on end-of-life design and integrated lifecycle thinking will enable a future where building polymers contribute to sustained energy efficiency, resource security, and environmental regeneration (Shahriari and Kim 2025).

8.5. Material Constraints in Hydrogen Systems

Material constraints in hydrogen systems are a primary bottleneck to the energy-positive buildings vision, as material choices govern the safety, durability, and economic viability of electrolysis, storage, and fuel cells that underpin building-scale hydrogen integration; in electrolysis, durable, cost-effective electrodes and membranes must withstand aggressive operating environments across alkaline, PEM, AEM, and solid-oxide platforms, while catalyst scarcity and degradation under repeated cycling threaten overall efficiency and system life, signaling a need for alternative materials, catalysts, and protective coatings (Guan et al. 2023); in storage, high-pressure tanks, cryogenic or solid-state storage, and potential regenerative or LOHC approaches expose embrittlement risks, thermal-management challenges, and weight/material cost trade-offs that constrain volumetric energy density and safety standards essential for building applications, with material compatibility and long-term aging modeling becoming critical for predictable performance (Ahad et al. 2023); in fuel cells, membrane durability, catalyst loss, and stack integration remain cost and lifetime bottlenecks that impede rapid deployment in building envelopes or campus-scale microgrids, underscoring the imperative for cross-cutting materials research—novel catalysts, membranes with lower precious-metal loading, advanced heat and mass transfer architectures, and integrative designs that harmonize electrolyzer, storage, and fuel-cell subsystems within the building energy continuum (Hassan et al. 2023). Collectively, these material challenges demand targeted, building-scale research into robust, safe, and cost-competitive materials that enable reliable, continuous hydrogen production, storage, and utilization in energy-positive buildings, while recognizing that technoeconomic constraints and safety governance may intensify as system complexity and scale increase (Kiani et al. 2025).

8.6. Integrated Thermodynamic–Material Design

To advance energy-positive buildings, it is essential to fuse rigorous thermodynamic analysis with materials design, ensuring that high-level system optimization is grounded in feasible, low-level material constraints and failure modes; without this integration, system gains can be severely undermined by exergy losses, material degradations, or incompatible interfaces that erode overall performance (Demirel et al. 2019). A persistent gap remains between architecture-level objectives—such as minimizing exergy destruction and maximizing energy throughput within circular economy constraints—and the realities of material selection, processing limits, and durability under varied climatic and load conditions, which can skew or invalidate optimized solutions when unconstrained by material realities (Weber et al. 2022). We propose a forward-looking framework that couples multi-scale process synthesis and heat–energy integration with materials-intrinsic models

through a unified, constraint-aware platform: (i) a modular, building-block representation that spans chemistry, kinetics, exergy, and thermodynamics at the material level; (ii) a system-level optimizer that informs material criteria (e.g., degradability, recyclability, exergy efficiency) via integrated exergy accounting and circularity metrics; and (iii) an iterative design loop wherein material discovery, property prediction (thermodynamic and kinetic), and process integration co-evolve under shared objective functions, enabling rapid convergence to solutions that are both thermodynamically optimal and practically realizable in energy-positive buildings. This blended paradigm harnesses digital-twin–driven simulations, multiscale modeling, and data-enabled decision frameworks to move beyond isolated optimizations toward resilient, scalable, and sustainable building systems (Liu et al. 2025). By explicitly aligning system- and material-level perspectives, future work can close the gap between holistic performance and material constraints, enabling integrated thermodynamic–material design that accelerates the deployment of truly energy-positive buildings.

9. Conclusions

The findings of this review demonstrate that the sustainability of energy-positive buildings cannot be adequately evaluated through operational energy performance alone. Across the literature synthesized here, a consistent pattern emerges: while advances in building energy systems—particularly photovoltaics, electrochemical storage, and hydrogen integrationenable substantial reductions in operational emissions, material-related factors increasingly dominate lifecycle outcomes. Embodied carbon associated with material production, especially in cementitious and polymer-based systems, remains a critical determinant of total environmental impact, often offsetting gains achieved through improved operational efficiency. As operational energy demand declines, the relative importance of embodied emissions rises, underscoring the need to move beyond energy-centric performance metrics toward comprehensive lifecycle-based assessments.

A central insight emerging from this synthesis is that material chemistry fundamentally shapes building sustainability over time. The interplay between molecular design, material composition, and system-level performance reveals that micro-scale properties—such as thermal behavior, chemical stability, and transport characteristics—directly influence macro-scale outcomes, including energy demand, durability, and carbon footprint. This relationship is evident across material categories: from cement systems constrained by calcination emissions, to polymer-based insulation balancing energy efficiency with toxicity and end-of-life challenges, and bio-based materials offering potential benefits but limited by durability and environmental trade-offs. Collectively, the literature highlights that no single material pathway guarantees sustainability; instead, performance depends on context-specific integration across the full lifecycle.

Durability and degradation processes further complicate the sustainability narrative by introducing time-dependent variability into building performance. Chemical ageing, moisture-induced degradation, and photodegradation collectively alter material properties, often accelerating performance decline and increasing maintenance or replacement requirements. These processes directly influence lifecycle carbon by shortening service life and amplifying embodied emissions through repeated interventions. Importantly, discrepancies between laboratory performance and real-world behavior highlight a critical limitation in current assessment approaches, where simplified or isolated testing conditions fail to capture the synergistic effects of environmental exposure. This gap reinforces the need to explicitly incorporate long-term material stability into both design and lifecycle evaluation frameworks.

Circularity and end-of-life considerations represent another key dimension shaping the sustainability of energy-positive buildings. While recycling, secondary material use, and design for disassembly offer pathways to reduce embodied carbon, the literature consistently reveals a gap between theoretical potential and practical implementation. Material heterogeneity, contamination, degradation, and insufficient standardization limit effective recycling and reuse, particularly for polymer-based systems. Similarly, the benefits of secondary raw materials and disassembly-oriented design depend strongly on recovery rates,

material quality, and system-level integration. These findings indicate that circularity cannot be treated as an add-on strategy but must be embedded in material selection, design, and lifecycle planning from the outset.

Taken together, the evidence points toward a fundamental need for integration across scales and disciplines. Current approaches remain fragmented, often separating material science, energy systems, and lifecycle assessment into parallel domains. However, the synthesis presented in this review demonstrates that meaningful sustainability gains require a unified framework in which material design, degradation behavior, energy system performance, and lifecycle carbon are considered simultaneously. This integration is particularly critical for emerging technologies such as advanced polymers, thermal storage materials, electrochemical systems, and hydrogen-based infrastructures, where material constraints and system performance are tightly coupled.

Ultimately, the transition toward truly sustainable energy-positive buildings requires a paradigm shift from performance-based evaluation to integrated, multi-scale design thinking. Rather than optimizing individual components in isolation, future building systems must be conceived as interconnected material–energy systems, where chemical design, durability, circularity, and energy performance are co-optimized over the full lifecycle. In this context, sustainability is not solely a function of energy balance, but the outcome of coordinated decisions spanning molecular structure, material systems, and building-scale operation. Only through such an integrated perspective can energy-positive buildings evolve from a promising concept into a robust and genuinely low-carbon solution for the built environment.

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EXAMINING THE RELATIONSHIP BETWEEN SPATIAL DEMAND AND URBAN STREET ORGANIZATION: THE CASE OF KARDITSA CITY, GREECE

Katerina KARALI
Researcher, Department of Planning and Regional Development,
University of Thessaly, Volos, Greece,
kathykarali@gmail.com

Dimitrios TSIOTAS
Associate Professor, Department of Regional and Economic Development
Agricultural University of Athens, Greece,
tsiotas@aua.gr
(Corresponding Author)

Abstract

Social structures, economic organization, and the spatial configuration of urban space have long been understood as being shaped through a complex and symbiotic relationship. From a theoretical perspective, urban space is produced through the transformation of the natural environment into a structured built environment, giving rise to land-use patterns redefining existing forms of urban organization. In turn, these configurations attract population flows, thereby generating conditions for urban development and further transformations of the urban structure. Assuming that urban form's spatial organization reflects the socio-economic forces and processes that have shaped it over time, this paper builds on graph-theoretic modeling and on correlation analysis of network topology measures with land rent values and land-use indicators across the urban network, to examine the degree of urban spatial organization in relation to the demand for urban space. The analysis focuses on the road network of the city of Karditsa, Greece, and provides empirical insights into the connectivity, efficiency, and overall spatial organization of Karditsa's urban system, while also highlighting the extent to which the demand for urban space contributes to urban fabric's formation and evolution.

Keywords: urban development; land uses; rent values; network central nodes; urban centers.

JEL Classification: R12, R14, O18, P25.

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1. Introduction

The spatial distribution of economic activities and land use within cities has been a central topic in urban economics and geography since the beginning of the previous century (Capello, 2016; Polyzos, 2023). Classical approaches have established the theoretical basis for analyzing how transport networks and urban form jointly shape spatial demand (Polyzos, 2019), consistently demonstrating that road networks are not neutral infrastructures but active determinants of the spatial distribution of economic activity and land values. For instance, von Thünen's (1826) land rent theory provides a foundational framework for understanding how distance from a central point and transportation costs shape land values and determine agricultural and urban uses' allocation. Building on this rationale, Christaller's (1933) central place theory emphasized urban hierarchy and the role of accessibility, introducing the notion of "economic distance" as a key determinant of centrality and service provision. Losch's (1940) extended this framework with the configuration of a demand cone highlighting the interaction between accessibility, profit maximization, and consumer costs. Further contributions from urban economics' theories refine this understanding by explicitly addressing internal city structure. For instance, Burgess' (1925) concentric zone model proposed that urban land uses are arranged in rings radiating from the city center, reflecting processes of urban expansion and restructuring. Beyond linear development, Hoyt's (1939) sector model suggested that land uses are forming wedge-shaped sectors that reflect the influence of accessibility on land rents and urban growth dynamics. Subsequently, Harris and Ullman's (1945) multiple nuclei model provided a polycentric view of the city, where multiple centers (commercial, industrial, or residential) jointly structure land use patterns and urban demand.

In parallel, contemporary research has increasingly emphasized the quantitative analysis of urban systems through network-based approaches, applying graph theory (Diestel, 2005) and the network paradigm (Albert and Barabasi, 2002; Barthelemy, 2011; Tsiotas, 2019) to represent road systems as graphs, enabling the measurement of topological attributes, such as connectivity, centrality, and accessibility (Barthelemy, 2011; Osman, 2014; Tsiotas and Polyzos, 2018; Arif and Gupta, 2020). In transport geography, relevant studies (Rodrigue et al., 2023; Tsiotas and Ducruet, 2021; Tsiotas and Kallioras, 2025) have shown that nodes configuration, graph density, and overall network topology directly influence mobility patterns as well as land value distribution. Spatial networks analysis (Barthelemy, 20111 Tsiotas and Polyzos, 2018) further provides a ground for linking urban form to economic outcomes (Polyzos, 2023), demonstrating that highly connected areas tend to exhibit higher land demand, whereas poorly connected locations are often associated with underutilization. These approaches allow for the empirical assessment of how network efficiency (Capello, 2000; Barthelemy, 2011), node importance (Xue et al., 2017), and network resilience (Barthelemy, 2011; Tsekeris and Tsiotas, 2026) relate to rent levels (Andersson et al., 2006; Porta et al., 2006) and land-use patterns (Li et al., 2019; Zhao et al., 2022; Feng et al., 2026). Empirical literature (Benjamin and Sirmans, 1996; Porta et al., 2006; Safaralizadeh et al., 2024) further confirms that proximity to main roads, measures of network centrality, and accessibility to urban amenities significantly affect residential and commercial property values. At the same time, there is empirical evidence (Acheampong and Silva, 2015; Zeng et al., 2020; Tsiotas, 2021; Silva and Hurtubia, 2025) of a bidirectional relationship between transport infrastructure and urban development, where roads both respond to and shape underlying economic demand. In this context, areas with higher land demand tend to attract more intensive connectivity (Polyzos, 2019, 2023), while network design itself can either enable or constrain urban expansion (Tsiotas, 2017; Polyzos, 2023). Nevertheless,

medium-sized cities remain relatively underexplored in the literature, as most studies focus on large metropolitan areas (Porta et al., 2006; Barthelemy, 2011; Boeing, 2017, 2019), leaving important gaps in understanding how these mechanisms operate in smaller urban systems.

Overall, relevant literature establishes a strong and consistent link between urban road network structure, land-use patterns, and spatial demand. Classical urban economic theories (Burgess, 1925; Christaller, 1933; Lösch, 1940; Alonso, 1967) provide the conceptual foundation, while modern network analysis and empirical studies (Porta et al., 2006; Barthelemy, 2011; Tsiotas and Polyzos, 2017; Tsiotas et al., 2017; Tsiotas, 2021) offer the methodological tools to measure and model these relationships in a quantitative context. Building on this framework, this paper examines the topological features of the road network of Karditsa, Greece –a medium-sized city of approximately 50,000 inhabitants (Polyzos, 2019, 2023)– in relation to rent levels, to explore how urban connectivity and accessibility shape the spatial distribution of demand. Karditsa's urban road network is modeled as an undirected, distance-weighted graph, allowing for an assessment of network efficiency and connectivity while also revealing how the spatial attractiveness of specific areas contributes to the formation of the urban fabric. The overall approach aims to provide a quantitative foundation for urban planning and policy, bridging traditional urban economics with contemporary spatial network analysis.

2. Data and Methods

Assuming that the spatial form of urban organization is shaped by spatial demand (Bento et al., 2005; Clifton et al., 2008; Polyzos, 2019, 2023), this study addresses the research question of whether the structural properties of Karditsa's major urban network (conceptualized as determinants of spatial organization) and rent prices (used as a proxy for spatial demand) are related. The study area is the Municipality of Karditsa (Tsiotas, 2017), for which primary data on geographic location, land use, and rent levels were collected from online sources (Spitogatos, 2024; YPEN, 2024). The methodological approach employs complex network analysis (Albert and Barabasi, 2002, Barthelemy, 2011; Tsiotas and Polyzos, 2018) to examine the structure and centrality of the urban road network and unveil how these spatial patterns relate to land value formation. In particular, the analysis seeks to identify the relationship between economic centers (Polyzos, 2023) and their corresponding topological centers (Koschutzki et al., Tsiotas, 2017) within the urban system. In technical terms, in the first stage, all nodes of the study area were mapped based on their geographical coordinates (x, y) in the WGS84 reference system (NIMA, 2000). Each node is uniquely defined, and a set of basic network measures was computed for all nodes using the Gephi (Bastian et al., 2009) software. A complementary database of rental prices was also constructed using data retrieved from a Greek rental search web platform (Spitogatos, 2024). Following this, institutionalized land-use categories were assigned to each spatial unit according to their building block's registry based on the General Urban Plan (GUP) of the expanded Municipality of Karditsa (Hellenic Republic, 2016; YPEN, 2024). The resulting integrated dataset was used for correlation analysis conducted in IBM SPSS (George and Mallery, 2024), where the variables included in the empirical analysis are summarized in Table 1.

Table 1: Variables included in the analysis

Variable	Description
LONG	Longitude (x).
LAT	Latitude (y).
Land Rent	Land Use Prices, per square meter (€/m^2).
Land Use: Residence	General Residential Land Use.
Land Use: Green Space	Green Spaces.
Land Use: Local Center	Land Use of Local Centers – Distinct Neighborhood Area.

Variable	Description
District	
Land Use: Tourism Areas	Tourism and Recreation Land Uses.
Land Use: Specific Land Uses	Specific Land Uses (e.g., industrial parks, sports complexes, schools, hospitals, protected urban spaces, etc.).
Land Use: Urban Center Area	Land Use for Urban Centers and Central Functions.
(Node) Degree	The number of graph edges being adjacent to a given node *i*. It expresses the communication potential of a node.
Weighted Degree	The sum of weights of the links being adjacent to a given node.
Eccentricity	The longest shortest path originating from a given node.
Closeness centrality	The average path lengths originating from a given node to all other nodes in the network. It is a measure of accessibility.
Clustering Coefficient	The probability a node to have neighbours connected. It is computed on the number of triangles configured by node to the number of the total triplets shaped by this node.
Betweenness Centrality	The proportion that is defined by shortest-paths passing through a given node to the total shortest-paths in the network. It expresses intermediacy.

Table 1 brings together a coherent set of variables operationalizing the relationship between spatial position, land-use structure, and urban network topology, thereby providing an integrated empirical framework for examining how spatial demand is reflected in both land values and network configuration. In this context, the null hypothesis (H_0) in this research assumes that topological centers are not associated with economic centers, whereas the alternative hypothesis (H_1) posits that there is a statistically significant relationship between network topology and urban morphology, aiming to to assess the extent to which the topological structure of urban space influences rent levels as an expression of spatial demand. In detail, the geographic coordinate variables (*LONG*, *LAT*) provide the foundational spatial reference system of the analysis, enabling the precise localization of each node within the urban fabric of Karditsa. In parallel, the *Land Rent* variable captures the economic dimension of spatial demand, expressed through rental prices per square meter, and serves as a direct proxy for land value formation within the city. The *Land-Use* variables introduce a functional layer to the analysis by distinguishing between key categories of urban activity, including *Residential areas*, *Green Spaces*, *Local Center District*, *Tourism and Recreational Areas*, *Specific Land Uses*, and *Urban Central Areas*. This classification allows for a structured interpretation of how institutionalized and de facto land-use patterns interact with both accessibility and economic valuation. Finally, the set of network topology varaibles (*Degree*, *Weighted Degree*, *Eccentricity*, *Closeness Centrality*, *Clustering Coefficient*, and *Betweenness Centrality*) provides a multidimensional characterization of each node's structural position within the urban road network. Collectively, these measures of network topology capture different aspects of connectivity, accessibility, and intermediary potential (Tsiotas and Polyzos, 2018; Tsiotas, 2019), which are central to understanding how spatial structure conditions movement, interaction, and, ultimately, urban economic outcomes. Taken together, the variables in Table 1 form an operational bridge between urban economic theory and spatial network analysis, enabling the empirical testing of whether topologically central locations correspond to economically central areas, thereby linking the structural properties of the urban network to patterns of land value and spatial demand.

3. Results and Discussion

3.1. Correlation of rental values with centrality measures

The results of the bivariate correlation analysis are shown in Table 2, complemented by some corresponding spatial distribution layouts and boxplots shown in Figures 1, 2 and 3. Beginning with Figure 1, the boxplots examination indicates that rent prices vary across different levels of network degree. In particular, the boxplot corresponding to degree $k = 2$

exhibits a higher average rent value compared to the other categories, while degree $k = 4$ also shows relatively elevated values compared to other degree cases ($k = 1$, 3, and 5). However, inspection of the mean-value trajectory across degree classes suggests that higher network degree does not systematically correspond to higher rent levels. This pattern indicates a non-linear and non-monotonic relationship between network connectivity and land values, rather than a simple positive gradient. More broadly, the observed distribution in Figure 1 points to an urban structure characterized by polycentric tendencies, where spatial demand and land value formation are not exclusively concentrated at the most highly connected nodes. This interpretation is further supported by the presence of designated local center and neighborhood-scale land-use areas within Karditsa's urban fabric, which reinforce a multi-nodal configuration of economic activity and spatial demand.

Table 2: Measures of GTN's network topology across different levels of link filtering

		Pearson Correlation	Sig. (2-tailed)	N
Value/sqrm	Land Rent	1		1291
	LONG	.034	.216	1291
	LAT	.230**	.000	1291
	Degree	.191**	.000	1291
	Weighted Degree	-.015	.597	1291
	Eccentricity	-.162**	.000	1291
	Closness Centrality	.434**	.000	1291
	Clustering	-.012	.678	1291
	Betweeness Centrality	.079**	.005	1291

(Own elaboration)

In general, an urban center is defined as the spatial concentration of economic activities and urban functions (Tsiotas, 2017; Yu et al., 2021; Polyzos, 2023). Contemporary large cities are increasingly understood as polycentric systems, characterized by the emergence of multiple centers that redistribute functions across peripheral and intermediate zones (Polyzos, 2023). In line with von Thünen's (1826) model, increases in distance from the urban center are associated with declining land values, ceteris paribus, while the relocation of economic activity toward central locations implies a higher land rent gradient due to increased accessibility and competition for space (Polyzos, 2023). Within this theoretical framework, urban land values are determined not by a single central point, but by a network of interacting nodes that jointly structure spatial accessibility and economic attractiveness. The analysis of the topological layout in Figure 1 supports this interpretation. Nodes with higher degree values are predominantly concentrated in the central areas of the network. In particular, nodes corresponding to higher connectivity classes (notably degree 4) are primarily located within the urban core, while lower-degree nodes (1–3) are more frequently distributed toward the periphery of the urban fabric. This spatial pattern suggests that peripheral areas are characterized by reduced connectivity and fewer direct interactions within the network structure.

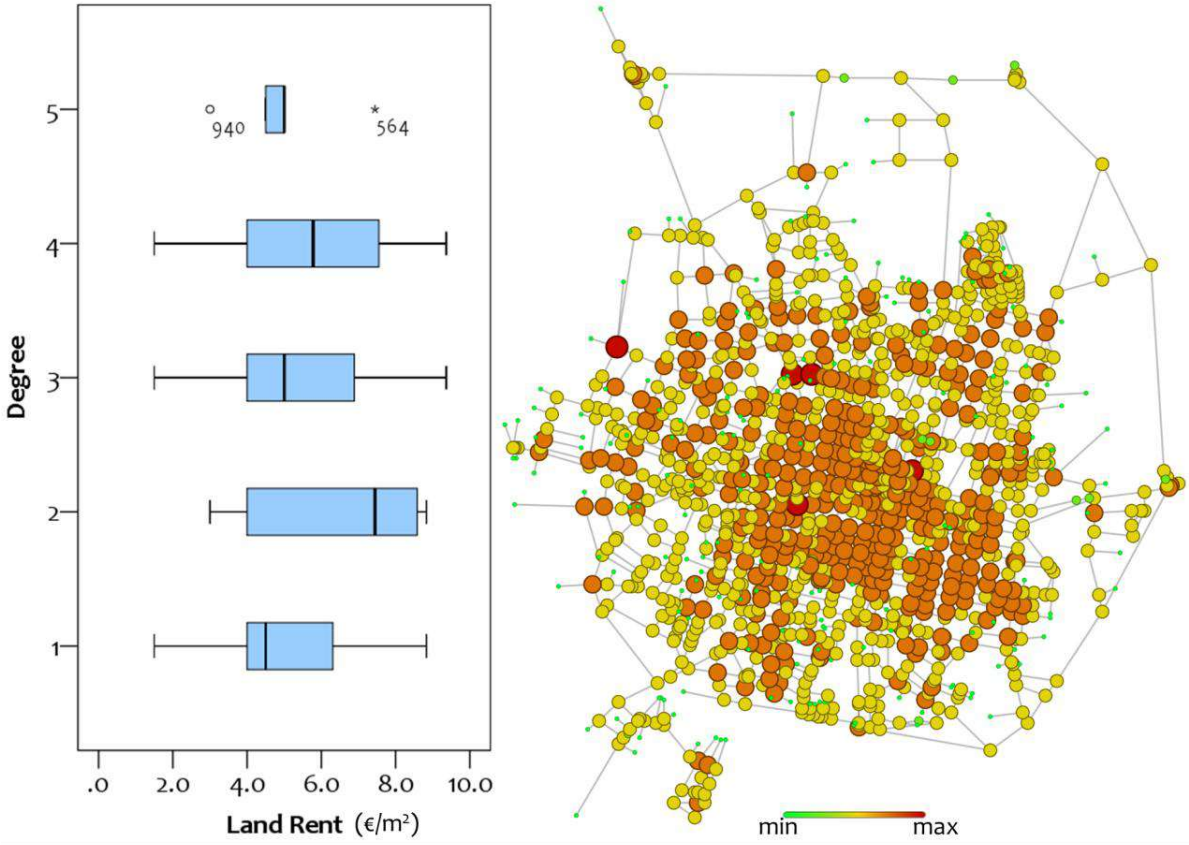

Figure 1. (Left) Correlation (box) plot of the variables Land Rent and node Degree and (right) the geo-referenced layout of the node degree's spatial distribution (red colored and larger in size nodes corresponds to higher values of node degree).

The correlation analysis reported in Table 2 further reveals a positive, albeit moderate, relationship between closeness centrality and rent levels, describing that nodes occupying more central positions within the network tend to be associated with higher land rents. This result is consistent with von Thünen's (1826) bid-rent framework, according to which urban space is allocated according to the ability of agents to pay for accessibility advantages. It also aligns with the Central Business District (CBD) concept (Burgess, 1925), which emphasizes the role of central locations in minimizing transport costs and maximizing accessibility, thereby attracting activities with higher bid-rent capacities, particularly commercial uses. In this context, centrality exerts a clear influence on land values, as centrally located areas offer superior access to goods, services, and interactions (Polyzos, 2023), which is reflected in higher rent levels. Nevertheless, such concentration pressures may also generate diseconomies that limit further centralization. For the case of Karditsa, the results suggest that average rent increases with closeness centrality, thus reinforcing the interpretation that topological centrality is a key determinant of spatial variation in land values within the urban system. Moreover, the topological layout in Figure 2 indicates that most nodes exhibiting high closeness centrality (depicted in dark red and larger in size nodes) are concentrated in the municipal core of Karditsa. This spatial pattern suggests that the urban center operates as the principal accessibility hub within the network, comprising nodes that can reach all other parts of the system through shorter average path lengths. In contrast, peripheral areas of the municipality display a considerably lower concentration of highly central nodes, implying weaker integration into the overall network structure and longer travel distances to other

locations within the system.

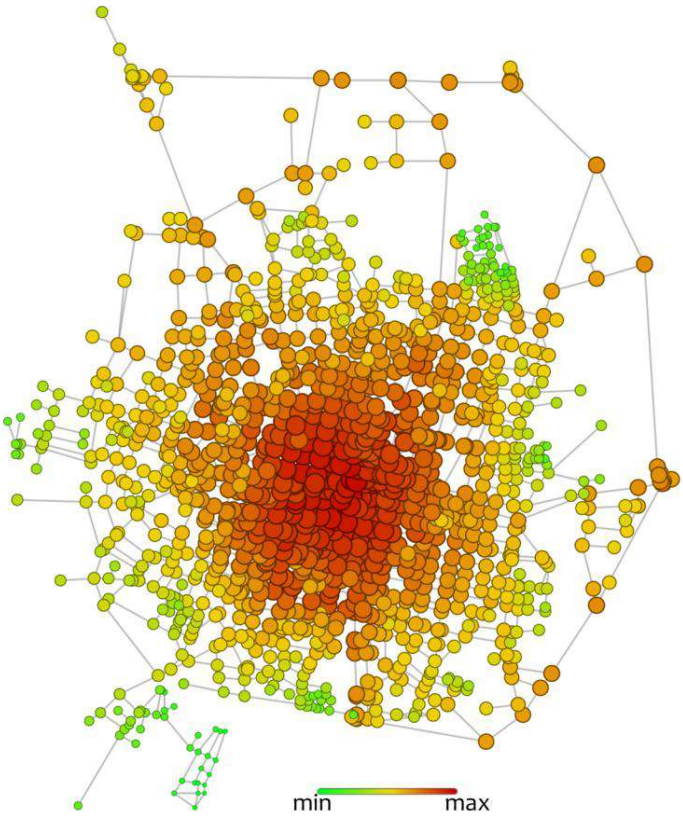

Figure 2. The geo-referenced layout of Closeness Centrality's spatial distribution (red colored and larger in size nodes corresponds to higher values of closeness centrality).

Next, Figure 3 shows boxplots capturing the relationship between land rent (value/m^2) and node eccentricity, which is a fundamental measure in network analysis for centrality (Tsiotas and Tselios, 2022) assessment. Eccentricity $e(v)$ of a node v in a connected graph G is defined as the maximum shortest-path distance $d(v,u)$ between v and any other node u in the network (Hage and Harary, 1995; Koschutzki et al., 2005; Tsiotas and Tselios, 2022), where $d(v,u)$ denotes the length of the geodesic path connecting the two nodes. Within this framework, higher eccentricity values indicate more peripheral and less accessible positions in the network structure. The results in Figure 3 suggest that increases in land rent are associated with decreases in eccentricity, indicating that higher-value locations tend to occupy more central and accessible positions within the urban network. This relationship is further supported by the Pearson's correlation coefficient (−0.162) and the associated p-value (0.0) shown in Table 2, which confirm a statistically significant, albeit weak, negative correlation between the two variables. The mean values' trend across eccentricity classes further illustrates variation in rent distribution, with the highest average rents observed at the lowest eccentricity levels (32, 33, 34). Beyond these values, average rents remain generally lower and do not exhibit a consistent monotonic pattern. Overall, the rents' distribution across eccentricity's levels does not follow a strictly linear or uniform trend, highlighting the multivariable nature of urban land valuation processes. This suggests that while network centrality plays a measurable role in shaping rent gradients, it interacts with additional spatial, functional, and institutional factors that jointly determine the observed heterogeneity in land prices.

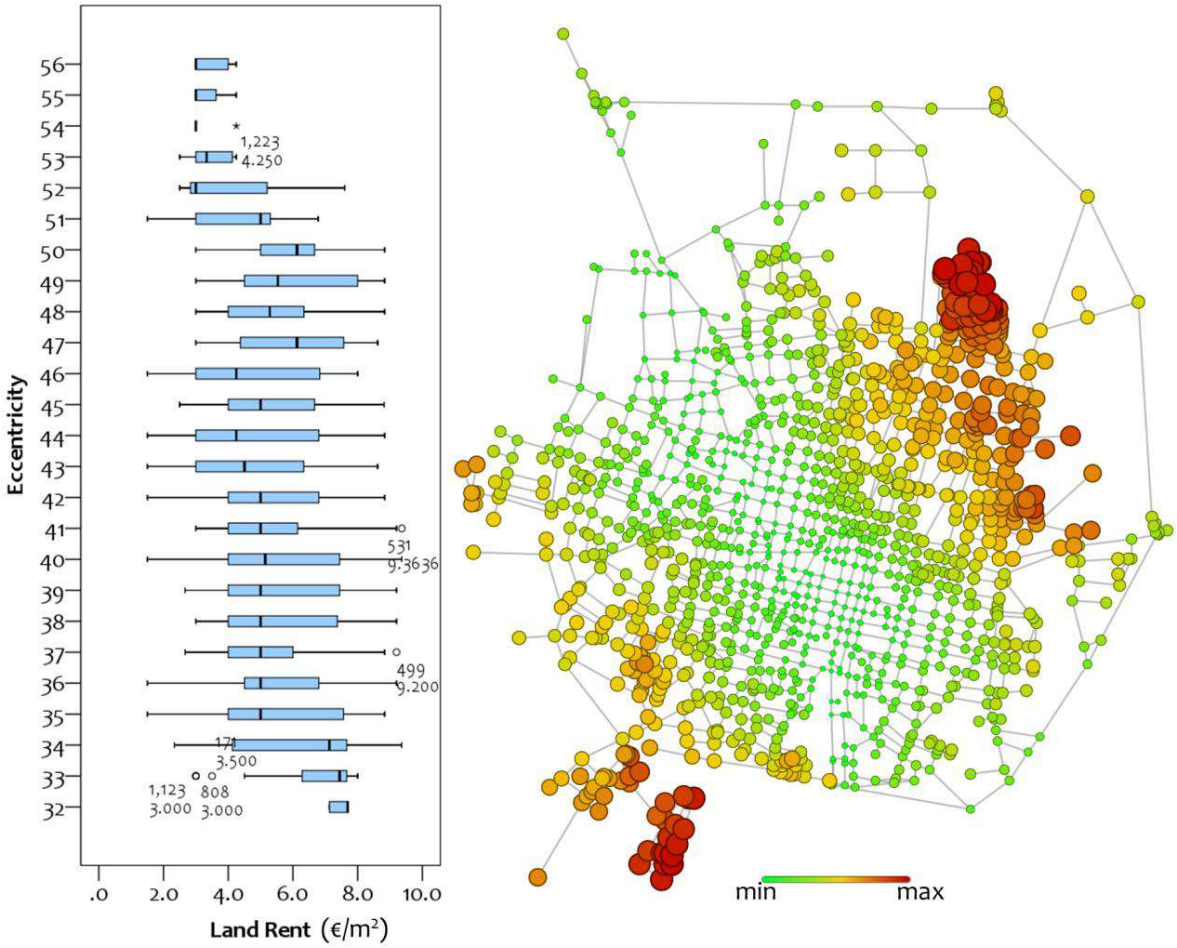

Figure 3. (Left) Correlation (box) plot of the variables Land Rent and Eccentricity and (right) the geo-referenced layout of eccentricity's spatial distribution (red colored and larger in size nodes corresponds to higher values of eccentricity).

Further, the eccentricity's spatial distribution in Figure 3 depicts the structural asymmetry of nodes within the urban network of Karditsa. Provided that eccentricity can be seen as a measure of a node's relative peripherality (Tsiotas and Tselios, 2022) within the network, the observed spatial pattern in Figure 2 reveals a clear zonal formation, where the most central nodes configure a contiguous core area illustrated in small-sized green nodes corresponding to eccentricity values between 30 and 39. This zone occupies the structural center of the network and reflects the highest accessibility levels in terms of maximum network distance. Surrounding this core, an intermediate ring of nodes (depicted in larger in size green colored nodes), exhibits eccentricity values between 40 and 49. These nodes are less centrally integrated but still maintain relatively moderate maximum distances to all other nodes in the system. Finally, nodes with the highest eccentricity values (50 and above), shown in red color, are predominantly located at the periphery of the urban fabric, indicating weaker integration and greater remoteness from the network core. Overall, the results in Figure 3 highlight a pronounced spatial clustering of nodes according to eccentricity levels, with a clear gradient of decreasing centrality from the urban core toward the outskirts.

Moving on path centrality, the spatial layout of betweenness centrality in Figure 4 illustrates the complex topological procedure of betweenness centrality, which measures the extent to which a node acts as an intermediary in the flow of shortest paths (Koschutzki et al., 2005; Newman, 2010), capturing its bridge role (intermediacy) over network connectivity. In

general, nodes with high betweenness values typically occupy strategic positions within the network (Barthelemy, 2011), such that their removal would substantially alter a large number of shortest paths and disrupt overall connectivity. In the case of Karditsa, Figure 4 illustrates that the majority of high betweenness centrality nodes (shown in orange and red on the map) are concentrated in the center and the ring road of the municipality. This suggests that the most central nodes play the most important role in connecting the entire network highlighting at the same time the importance of a ring road for the urban fabric's connectivity.

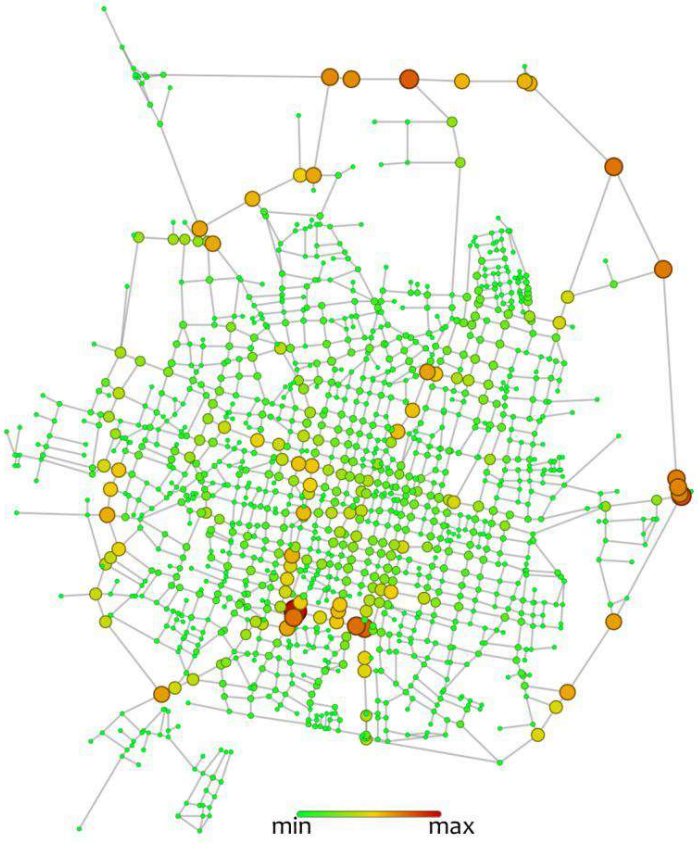

Figure 4. The geo-referenced layout of Betweenness Centrality's spatial distribution (red colored and larger in size nodes corresponds to higher values of betweenness centrality).

In computational terms, the betweenness centrality results in Table 2 indicate a positive, albeit weak, correlation between land rent (price per square meter) and betweenness centrality. This suggests that nodes with higher intermediary importance tend, on average, to be associated with higher rental values. However, provided that ring-road positions do not exhibit high land rent values, the correlation shown in Table 2 does not imply a strictly monotonic relationship. This observation describes that betweenness alone does not fully account for variations in land prices and pointing to the influence of additional spatial, functional, and institutional determinants of urban rent formation beyond purely topological centrality.

3.2. Correlation of centrality measures with land uses

The error bars in Figure 5 illustrate the variation in average Degree across different land-use categories, computed under a 95% confidence interval. The results indicate that Degree Centrality is not uniformly distributed across land uses, but instead exhibits systematic variation depending on functional urban specialization. In particular, nodes associated with

the identified land-use categories (category 1) tend to have average Degree values of approximately 3.05 connections and above, whereas nodes not assigned to a land-use category (category 0) tend exhibit lower average values, generally below 3.00 connections. These results suggest that functionally defined urban areas are more strongly integrated within the road network, reflecting higher levels of connectivity and interaction potential. In terms of interpretation, they support the assumption that land-use specialization is closely linked to the structural properties of the urban network, with more active or strategically located functions tending to occupy nodes with greater topological importance.

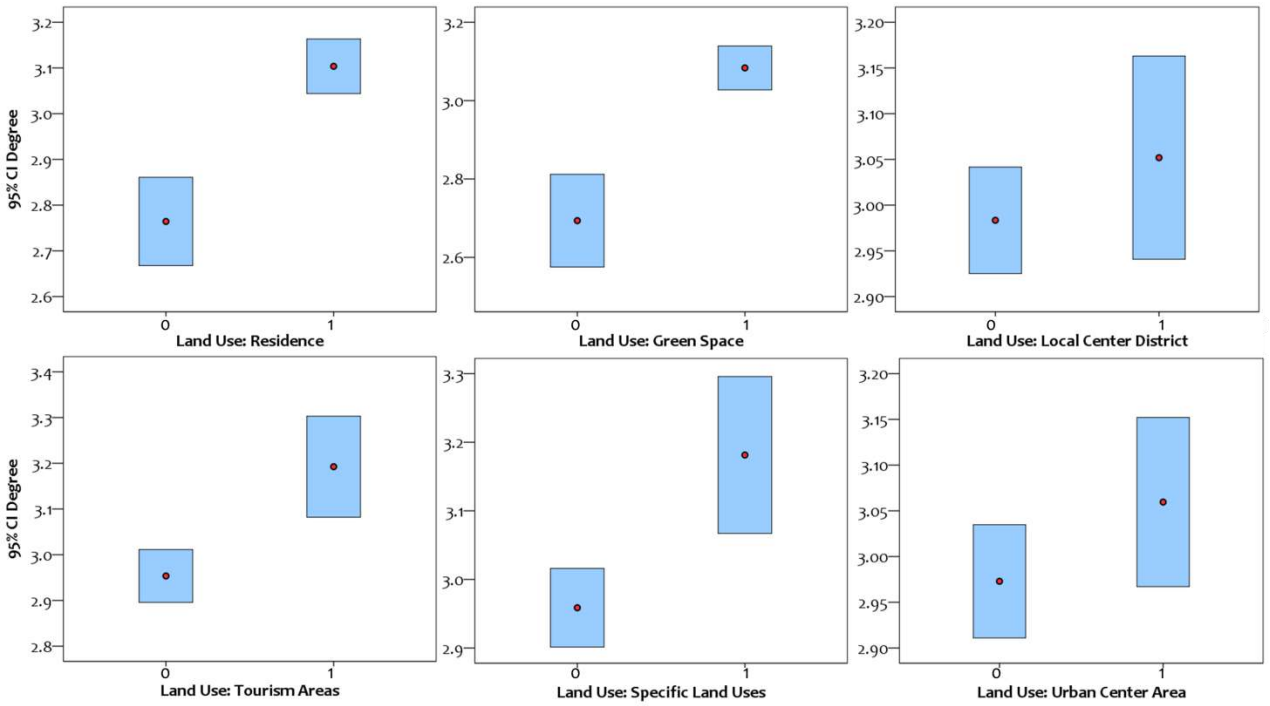

Figure 5. Error bars of 95% CIs for degree by land uses.

Next, the results presented in Figure 6 indicate that betweenness centrality varies across land-use categories in a broadly consistent manner. In general, nodes with high betweenness centrality are structurally important, as they frequently mediate flows between different parts of the network and can significantly influence overall accessibility (Wang et al., 2011), while those with low betweenness centrality appear less frequently on shortest paths and therefore play a more marginal role in network connectivity. In particular, nodes associated with a land use exhibit higher average betweenness values compared to those without a land-use classification, suggesting that functionally defined urban locations tend –on average– to occupy more intermediary positions within the network structure. At a first-order level of interpretation, these findings imply that nodes associated with land uses are more likely to serve as connectors within the urban system, facilitating movement and interaction across different city compartments. Secondarily, these findings reinforces the view that land-use specialization is not only associated with higher levels of activity, but also with increased structural importance in terms of network flow and spatial integration.

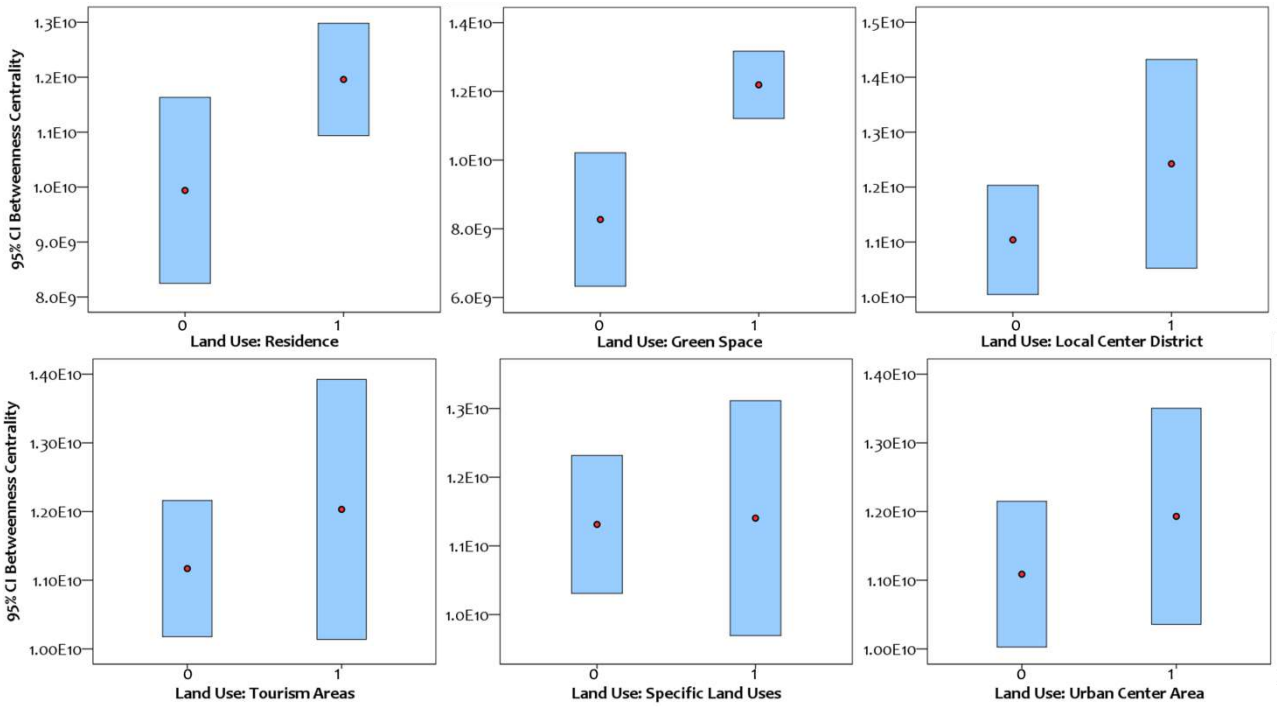

Figure 6. Error bars of 95% CIs for betweenness centrality by land uses.

According to the error bars in Figure 7, the total range of Eccentricity values for all land uses ranges from 40.25 to 41. However, for the "specific land uses" and "urban center-central functions" cases, the average Eccentricity of nodes associated with a land use is higher than those not assigned to a land-use, while for other cases of land uses this relationship appears reversed. This finding indicates either a trend towards decentralization of these land uses or the existence of more than one center within the urban fabric, therefore reinforcing the understanding of the complexity of the spatial organization of the Municipality of Karditsa. Next, closeness centrality is defined as the inverse of the total binary distance calculated on the shortest paths starting from a given node with destinations to all other nodes in the network (Tsiotas, 2021), expressing a node's accessibility in terms of steps of separation. The error bars in this case (Figure 8) indicate that all land uses are centrally located in the network and that the distance between nodes does not differ significantly, suggesting a homogeneous and accessible network in terms of main land uses.

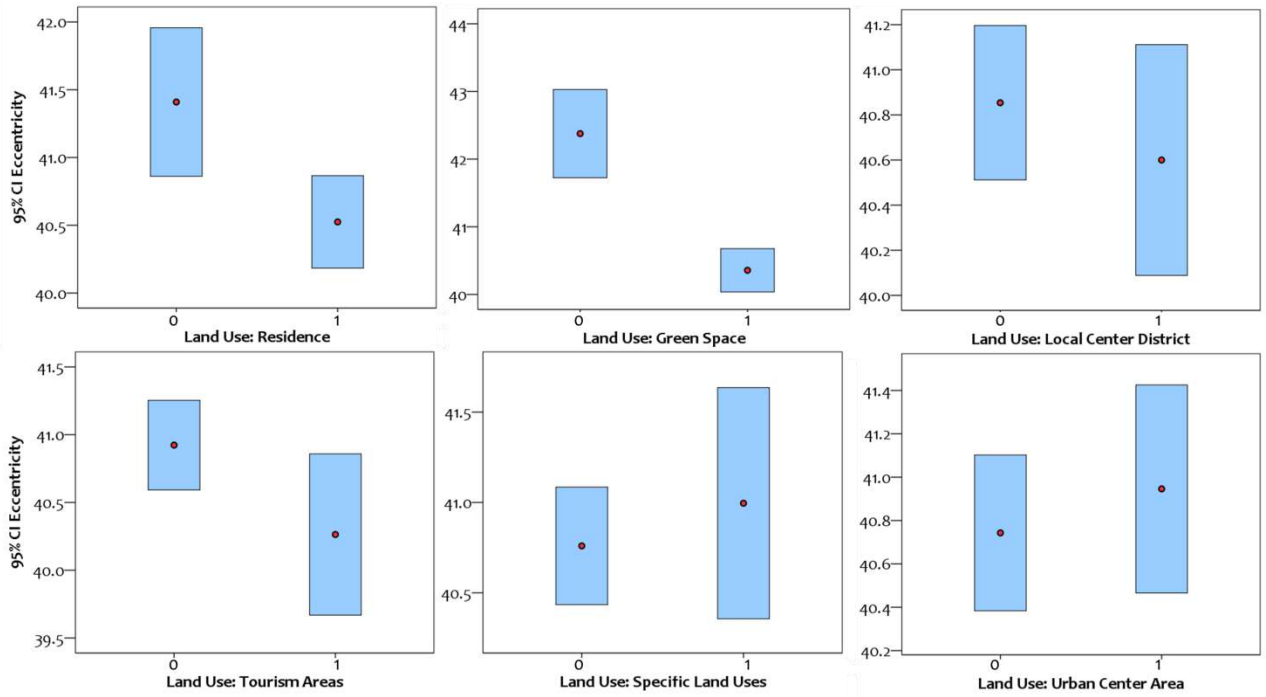

Figure 7. Error bars of 95% CIs for eccentricity by land uses.

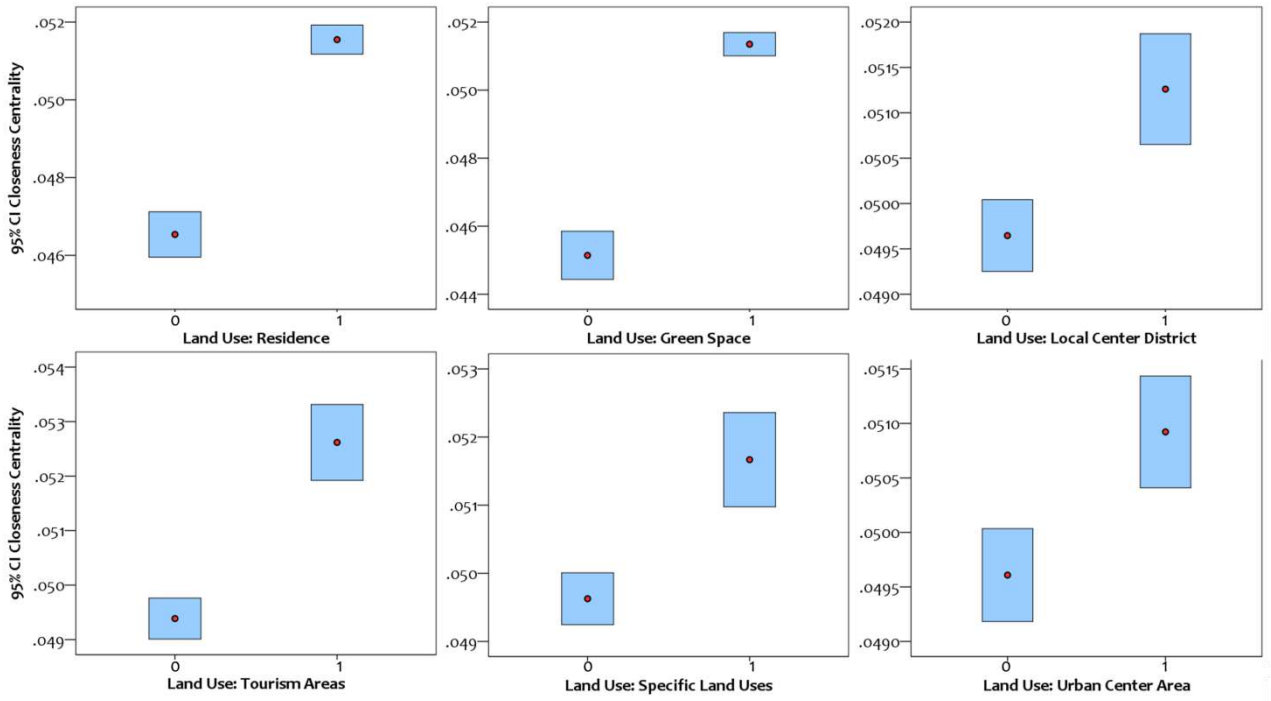

Figure 8. Error bars of 95% CIs for closeness centrality by land uses.

Finally, the clustering coefficient expresses the degree to which nodes tend to cluster together (Wang et al., 2011; Tsiotas, 2019), capturing the degree of mutual connectivity between a node's neighbors. Higher clustering coefficient values indicate denser mutual neighborhood connectivity and consequently cluster formation. In this context, Figure 9 shows that specific land uses, tourism-recreation, and urban center-central functions have the highest values of the basic measure, illustrating in general that geographically located land uses are more likely to form clusters.

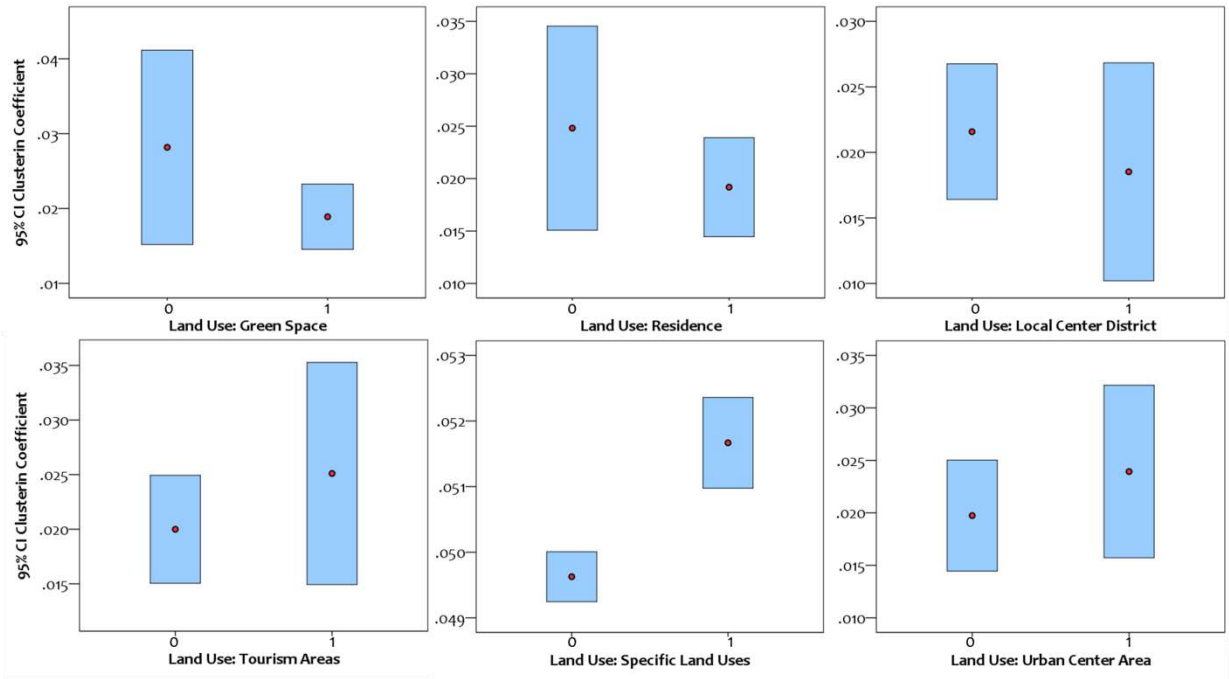

Figure 9. Error bars of 95% CIs for clustering coefficient by land uses.

The lack of an integrated policy in Greece on land use in recent years has significantly shaped urban, peri-urban, and rural areas (Petrakos and Psycharis, 2016; Polyzos, 2019). This has resulted in the creation of areas with mixed land uses, a phenomenon that has both positive and negative effects on the urban fabric and its inhabitants (Stefanou and Mitoula, 2006), where a typical example of a city with mixed land uses suggests the city of Karditsa. In particular, tourism and recreation land use's layout in Figure 10 shows scattered nodes within the urban center, indicating that this is not a common land use. This phenomenon may be due to two main factors: firstly, the fact that urban tourism has not developed to a high degree in Karditsa, and secondly, that tourism and recreation is incompatible with other dominant land uses, such as general residential use. Next, the distribution of general residential land use in the urban fabric of Karditsa, combined with the historical background of urban planning in Greece (Polyzos, 2023), implies that residential areas do not constitute a distinct zone in the city. General residential land use is part of an urban fabric with mixed land uses, in contrast to many European cities that apply "strict" land use zones (Stefanou and Mitoula, 2006). The case of mixed land use has both positive and negative outcomes. On the one hand, mixed land use can offer a more vibrant and dynamic urban environment, while, on the other hand, the incompatibility between certain uses (e.g., industry and housing) often leads to functional and environmental problems.

Figure 10. The geo-referenced layouts of the land use variables

From the urban green space layout (Figure 10), it can be observed that green areas are predominantly concentrated in the northwestern and southwestern sectors of the urban fabric. At the same time, a substantial share of the city's surface is occupied by green infrastructure, including parks, squares, and other recreational open spaces. This spatial configuration suggests a relatively well-developed system of urban green amenities embedded within the fabric of Karditsa. Provided that urban green space constitutes a key determinant of environmental quality and is widely recognized in the literature as positively affecting property values (Safaralizadeh et al., 2024), empirical studies further confirm that parks and forested areas exert a significant positive impact on residential prices, particularly when accessibility and proximity are taken into account. For instance, spatial econometric evidence (Panasolo et al., 2020) indicates that dwellings located in close proximity to urban parks tend to command higher prices, with this premium diminishing as distance increases. Within this framework, the spatial distribution of green areas in Karditsa may be interpreted as a factor contributing to localized variations in land value formation.

Next, the neighbourhood (local center) land-use category (Figure 10) represents a structured and functionally integrated urban unit operating as an intermediate scale between the household and the broader city center. It is characterized by a combination of social, infrastructural, and environmental functions, and is designed to accommodate the basic daily needs of residents, including education, retail activity, services, and leisure (Polyzos, 2023). In this paper's analysis, the spatial distribution of this land use reveals the existence of

localized sub-centers, which contribute to the formation of smaller-scale neighborhood units within the wider urban system. This pattern is consistent with a polycentric urban structure, where basic services are partially decentralized, thereby enhancing the functional autonomy and internal cohesion of local urban units. Finally, the distribution of urban center and central function land uses (Figure 10) exhibits two main clusters: a highly concentrated core in the city center and a secondary, less dense cluster within the wider central area. The observed pattern of polycentricity in Karditsa may therefore be partly explained by the functional incompatibility between certain land-use categories, which encourages spatial clustering and differentiation of activities. A characteristic example is the spatial concentration of offices and retail establishments within central areas, both of which fall under institutionalized central uses defined by planning regulations. Their co-location in the urban core underscores the continued importance of centrality for commercial and professional functions, despite emerging decentralizing tendencies. Overall, the land-use distribution analysis suggests that most functions remain concentrated in or near the urban center, while also exhibiting elements of functional mixing across the urban fabric, indicating an absence of strong land-use segregation and points toward a mixed-use urban environment. Such mixed-use configurations are widely regarded in the literature as more sustainable (Kweon et al., 2010), as they enhance accessibility, reduce travel demand, and support more efficient urban form.

4. Conclusions

Rapid urban development and population growth in cities have been dominant phenomena over the last century, leading to significant changes in urban areas. This development is taking place at different rates in different countries around the world, but it raises one of the most fundamental concerns: *the direct impact on land prices and rents in relation to spatial forms and organization*. The constant need for housing and the coverage of human activities make space a mediating commodity where land uses are developed and the needs for both housing and economic activities are met. Understanding the mechanisms of urban development and fluctuations in rental prices enables the effective implementation of housing policies, the subdivision of urban centers, the improvement of spatial planning, and the uniform distribution of public infrastructure.

The analysis of urban networks is a methodological approach which, through graph modeling and measures of network topology calculation contributes to the identification of the central elements and topological characteristics of the network. At the same time, urban development theories provide a ground for interpreting the economic dimension of these centers. The correlation between centers with different dimensions (topological and economic) was investigated in this paper revealing that land uses are mainly concentrated in the topological center of the urban center of Karditsa, Thessaly, Greece. General residential land use and green spaces occupy the majority of nodes, while the remaining categories are sparsely scattered throughout the city. In the urban network of Karditsa prices do not show large deviations, but fluctuations are noticeable between the more central points and the points on the outskirts of the urban fabric. The correlation of major topological measures with land use documents the variation in rents per square meter between central nodes. Finally, it is important to emphasize that every urban society is unique, with its own particular characteristics and challenges to address. Sustainable urban development requires a tailored approach that takes into account the adoption of basic design principles and the implementation of measures to improve conditions in the city. It is important to address the specificities of each urban fabric through methods and tools, and to develop strategies that focus on people, society, and the environment, with the aim of eliminating the “mistakes” of

the past and creating new prospects for cities.

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SUSTAINABILITY ACCOUNTING AND ITS APPLICATION IN ALBANIA

Antoneta POLO
Associate Professor, "Eqrem Çabej" University, Gjirokastra, Albania
neta_polo@yahoo.com

Enkela CACA
Associate Professor, "Eqrem Çabej" University, Gjirokastra, Albania
ebabaramo@yahoo.com

Ilirjana ZYBERI
Associate Professor, "Eqrem Çabej" University, Gjirokastra, Albania
izyberi@yahoo.com

Sara BIXHAKU
MSc., "Eqrem Çabej" University, Gjirokastra, Albania
sarabixhaku@gmail.com

Abstract

Sustainability accounting is an emerging and evolving field of accounting that focuses on measuring, reporting, and managing the social, environmental, and economic impacts of corporate activities. This form of accounting helps organizations monitor and assess their performance in relation to sustainability and communicate their commitment to sustainable development to stakeholders. Over time, sustainability accounting has become a key instrument for companies seeking to meet legal requirements, enhance their image, and increase opportunities for green investment. International frameworks such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) have provided guidance for reporting on Environmental, Social, and Governance (ESG) factors, allowing companies to measure and report their impacts in a comparable and reliable manner. Globally, the development of sustainability accounting has profoundly changed the way organizational financial and social performance is measured and evaluated.
However, implementing these practices remains challenging, particularly in developing countries such as Albania, where a clear legal framework and institutional support are crucial for sustainable economic development. This paper explores the concept of sustainability accounting, the challenges and opportunities it presents, and its significance for global economies and businesses, with a special focus on its application in Albania.

Keywords: Sustainability accounting, environment, society, economy, financial reporting.

JEL Classification: M41, Q56, G32, O13.

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1. Introduction

Sustainability accounting is a relatively new field of accounting that has gained significant importance in recent decades due to the need to address global challenges related to the environment, society, and economic development. This type of accounting focuses on measuring and reporting the impacts companies have on the three main pillars of sustainability — the environmental, social, and economic aspects — also known as the Triple Bottom Line (TBL).

Unlike traditional accounting, which primarily focuses on financial performance, sustainability accounting prioritizes information related to the use of natural resources, employee treatment, community engagement, and the management of environmental risks.

Within this framework, the concept has also gained increasing importance in government policies and in countries striving for sustainable development. For Albania, as a developing nation, the implementation of sustainability accounting provides significant opportunities to improve the performance of various economic sectors and to align with international standards for environmental protection and social development.

The purpose of this paper is to examine and analyze the concept of sustainability accounting and its relevance to businesses and global economies, with a special emphasis on the application of this concept in Albania. The study aims to provide a detailed overview of international sustainability accounting frameworks and standards, including GRI and SASB, and to explore how these standards can be applied and adapted within the Albanian context.

Through the analysis of international practices and case studies, the paper identifies the opportunities and challenges that Albania may face during the implementation of sustainability accounting, emphasizing the importance of developing a clear legal framework and institutional support. Moreover, it discusses how sustainability accounting can contribute to enhancing investor confidence, improving corporate reputation, and creating opportunities for green investments in Albania.

Finally, the paper aims to offer recommendations for improving sustainability accounting practices in Albania and highlight the importance of integrating such practices into corporate management strategies to ensure sustainable development and promote social and environmental responsibility.

2. Structure of the Paper

This paper will include a theoretical analysis of sustainability accounting, an overview of international practices, a review of the current situation in Albania, as well as an assessment of the challenges and opportunities facing Albanian businesses.

3. Literature Review

Sustainability accounting is a discipline concerned with the measurement, monitoring, and reporting of an organization's environmental, social, and governance (ESG) impacts. This type of accounting is closely linked to the concept of the Triple Bottom Line (TBL), which has been a fundamental model in sustainability management literature and encompasses performance measurement across economic, social, and environmental dimensions (Elkington, 1997). Sustainability accounting serves as a powerful tool for ensuring that companies contribute to sustainable development and meet the expectations of various stakeholders, including investors, consumers, and regulators. One of the major developments in the field of sustainability accounting has been the creation of international standards that support ESG reporting. The Global Reporting Initiative (GRI) is one of the leading organizations that has developed frameworks and standards for sustainability reporting. GRI has promoted transparent reporting of environmental and social impacts and has been widely adopted by global companies to ensure sustainability in their operations (GRI, 2016). This methodology has also been used to assess the effects of corporate interventions on the environment, society, and the economy.

According to Epstein and Buhovac (2014), sustainability accounting practices also help enhance corporate reputation and can lead to increased opportunities for green investment, as companies benefit from supportive government and regulatory policies for sustainable activities. Elkington (1997) emphasizes that the TBL concept is a key element in

sustainability measurement, providing a framework for integrating factors such as natural resource management, improved working conditions, and greater social engagement by companies. Another well-recognized framework is the Sustainability Accounting Standards Board (SASB), which provides industry-specific standards to help companies report their environmental and social impacts in a measurable and comparable manner (SASB, 2021). The International Financial Reporting Standards (IFRS) have also played an essential role in the implementation of international standards for both financial and sustainability reporting, making it easier to compare the financial and environmental performance of companies globally (IASB, 2019). In many developing countries, the implementation of sustainability accounting is still in its early stages. Studies such as Almeida and Ferreira (2012) in Portugal suggest that the application of sustainability accounting can enhance company performance by enabling more efficient use of natural resources and reducing negative environmental impacts. However, in most cases, sustainability practices remain voluntary rather than mandatory, and their implementation largely depends on government and regulatory support.

In Albania, sustainability accounting is still a relatively new concept, but it has begun to gain attention due to European Union (EU) policies and the need to meet international standards for environmental protection and social development. The report "Albania and Sustainable Development" (2019) by the Ministry of Environment indicates that the Albanian government has taken significant steps to promote sustainable development and provide support for sectors that contribute to renewable energy and sustainable use of natural resources. Albania has substantial opportunities to utilize sustainability accounting practices to promote green investment and sustainable development. According to the World Bank (2021), countries investing in sustainable development can achieve long-term economic benefits, such as increased employment and the growth of emerging sectors, including renewable energy and clean technologies. Similarly, the European Bank for Reconstruction and Development (EBRD, 2020) highlights Albania's potential in fostering sustainable investments, including support for companies that adopt sustainability accounting practices. One of the main challenges remains the lack of a clear legal and regulatory framework for sustainability accounting. The Institute of Certified Auditors of Albania (ICAA, 2020) suggests that Albania needs a dedicated law on sustainability reporting to ensure that its accounting practices align with those of the European Union and international standards. The literature further suggests that an important intervention would be the development of a national strategy to promote sustainability accounting in Albania, including support for the education and training of accounting and management professionals. Kolk and Mauser (2002) emphasize the importance of the engagement of professionals and governments to ensure that sustainability accounting practices are effectively implemented and produce positive outcomes for both businesses and society.

Additionally, it is crucial to encourage companies to report their environmental and social impacts transparently and to adopt international frameworks and standards to ensure credibility and cross-country comparability. Sullivan and Mackenzie (2007) argue that the implementation of these standards can strengthen investor confidence and improve corporate performance in global markets. Sustainability accounting is a discipline concerned with the measurement, monitoring, and reporting of an organization's environmental, social, and governance (ESG) impacts. This type of accounting is closely linked to the concept of the Triple Bottom Line (TBL), which has been a fundamental model in sustainability management literature and encompasses performance measurement across economic, social, and environmental dimensions (Elkington, 1997). Sustainability accounting serves as a powerful tool for ensuring that companies contribute to sustainable development and meet the expectations of various stakeholders, including investors, consumers, and regulators. One of the major developments in the field of sustainability accounting has been the creation of international standards that support ESG reporting. The Global Reporting Initiative (GRI) is one of the leading organizations that has developed frameworks and standards for sustainability reporting. GRI has promoted transparent reporting of environmental and social impacts and has been widely adopted by global companies to ensure sustainability in their operations (GRI, 2016). This methodology has also been used to assess the effects of corporate interventions on the environment, society, and the economy.

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4. Aspects of Sustainability Accounting

Sustainability accounting encompasses three fundamental aspects that represent its core pillars and are closely linked to environmental, social, and economic sustainability. These dimensions are essential for understanding the impact of a company's activities on the environment, society, and the economy, as well as for assessing performance in these areas.

4.1. The Environmental Aspect

The environmental aspect focuses on the impact that a company has on the natural environment and its use of natural resources. It involves monitoring, measuring, and reporting

environmental effects, as well as evaluating corporate practices aimed at minimizing negative environmental impacts.
Environmental issues are increasingly significant, as addressing climate change and protecting natural resources are critical for achieving sustainable development.
Key indicators and areas of focus under the environmental dimension include:

- Greenhouse gas (GHG) emissions and their reduction strategies.
- Waste management and recycling, including how waste is handled and the efficiency of recycling practices.
- Reduction of energy consumption and transition to renewable energy sources.
- Management of natural resources, such as water, energy, and raw materials, to ensure sustainable use.
- Biodiversity protection and prevention of harmful effects on local and global ecosystems.

The main objective of the environmental aspect is to ensure a balance between economic growth and environmental preservation, making the company more responsible and sustainable over time.

4.2. The Social Aspect

The social aspect of sustainability accounting focuses on a company's impact on society and individuals, including employees, local communities, and other stakeholders. It encompasses corporate responsibilities in areas such as labor rights, gender equality, occupational health and safety, and community development.
This dimension is crucial to ensuring a fair and inclusive society, where all individuals are respected and supported.
Key indicators and focus areas under the social dimension include:

- Working conditions and employee treatment, ensuring safe and fair work environments, equitable pay, and opportunities for professional growth.
- Diversity and inclusion, by creating equal opportunities for all social groups and strengthening gender and racial equality.
- Corporate social responsibility (CSR), through investment in local communities and socially sustainable development.
- Human rights protection, ensuring that business operations respect human rights and do not contribute to their violation.
- Health and safety at work, by providing safe workplaces and promoting employee well-being.

The goal of the social aspect is to ensure that corporate activities support societal development while maintaining and improving the well-being of individuals and communities.

4.3. The Economic Aspect

The economic aspect of sustainability accounting focuses on a company's financial performance and long-term viability. This is a critical issue since no organization can be sustainable in social and environmental terms without a solid economic foundation.
It involves strategies for resource and risk management, as well as for creating new opportunities for growth and innovation.
Key indicators and focus areas under the economic dimension include:

- Profitability and financial performance, by measuring profits, revenues, and long-term financial stability.
- Commitment to sustainable investment that supports innovation and technology over the long term.
- Compliance with financial and tax regulations to ensure legal and ethical business operations.
- Sustainable returns for shareholders, considering both risks and opportunities associated with sustainable growth.
- Cost reduction and resource efficiency, to create long-term economic benefits.

The goal of the economic aspect is to ensure economic development that supports the company's sustainable growth, guaranteeing financial success and long-term stability.

A successful integration of these three aspects, environmental, social, and economic, is key to achieving sustainability within an economic entity.
Organizations that effectively manage their impacts across these dimensions are better positioned to maintain a long-term competitive advantage and to contribute positively to both society and the environment.
This process promotes sustainable economic development for individuals and communities, reduces negative impacts on the planet through better management practices and sustainability-oriented infrastructure, and improves quality of life and opportunities for employees and communities through strong social inclusion and fair treatment.
Sustainability accounting thus serves as a powerful tool for ensuring that companies operate in a manner that is sustainable for all stakeholders — from investors and shareholders to employees and society at large.

4. International Case Studies on Sustainability Accounting

International case studies are essential for understanding how sustainability accounting is applied globally and how companies manage their environmental, social, and economic impacts. These cases provide valuable insights into the practice of sustainability accounting and serve as examples of how different frameworks and reporting standards can be implemented in real-world corporate contexts.
Below are selected international case studies based on existing literature, illustrating the application of sustainability accounting and its impact on corporate performance.

4.1. Unilever

Unilever is one of the world's largest fast-moving consumer goods companies and a global leader in implementing sustainability strategies. The company has integrated sustainability into its business model and adopted a comprehensive reporting system to manage and monitor its social and environmental impacts.
Unilever has applied an integrated approach that links sustainability with financial performance by adopting international standards such as GRI and SASB for reporting on environmental and social factors. The company's sustainability strategy focuses on sourcing renewable materials, reducing waste, and minimizing environmental footprints throughout its supply chain. A study conducted by The European Business Review (2020) analyzed Unilever's efforts to integrate sustainability into its management and reporting processes. The findings indicate that implementing a sustainability strategy has enhanced the company's corporate image, fostered innovation, and strengthened competitiveness in the global market. Unilever has significantly improved its environmental performance by reducing CO_2 emissions and lowering water consumption. The company has also supported its suppliers in improving sustainability practices, contributing to the development of local communities. By adopting international sustainability accounting standards, Unilever has achieved greater transparency and credibility in its reporting, reinforcing stakeholder trust and long-term value creation.

4.2. IKEA

IKEA, a global leader in furniture design and retail, has embraced sustainability as a core component of its business strategy. The company has implemented numerous initiatives to reduce environmental impacts while promoting social responsibility and employee welfare. IKEA uses the GRI and Task Force on Climate-related Financial Disclosures (TCFD) frameworks to ensure transparency regarding its environmental and social performance. It has prioritized reducing the use of harmful materials, improving supply chain sustainability, and transitioning toward renewable energy sources. A study published in Harvard Business Review (2019) examined how IKEA's sustainability strategy has influenced risk management and financial performance. The company has continuously measured and reported the social and environmental impacts of its processes, fostering accountability across its global operations. IKEA also supports its suppliers in adopting better sustainability practices by emphasizing the use of renewable resources and reducing carbon emissions (CO_2). Through its focus on sustainability, IKEA has developed innovative eco-friendly products, such as furniture made from recycled materials. This strategy has strengthened customer trust,

enhanced brand loyalty, and attracted investors seeking companies with strong sustainability credentials.

4.3. Patagonia

Patagonia, a globally recognized brand specializing in outdoor clothing and gear, has made sustainability an integral part of its business model. The company is well known for its strong environmental advocacy and commitment to using organic and recycled materials in its products. Patagonia follows GRI and SASB standards to ensure accuracy and transparency in sustainability reporting. It monitors resource usage and discloses detailed information about its environmental impacts, including efforts to use renewable energy and promote sustainable production processes. A study in the Journal of Business Ethics (2020) examined the role of sustainability accounting in Patagonia's marketing strategy and how it strengthened the company's brand identity and customer loyalty. Patagonia's detailed reporting on resource recycling and CO_2 emission reduction has positioned it as an industry leader in sustainability. The company's commitment to sustainability has helped drive sales growth and attract environmentally conscious consumers. Patagonia's investments in renewable energy and reduced use of non-recyclable materials demonstrate its contribution to global environmental protection. The above case studies show that adopting sustainability accounting has a significant impact on managing the social, environmental, and financial performance of companies. Firms that implement international standards and frameworks such as GRI, SASB, and TCFD achieve measurable improvements across multiple dimensions of their operations. Moreover, these companies foster stronger consumer and investor confidence, enhance long-term competitiveness, and contribute meaningfully to sustainable development. They provide valuable examples for other organizations worldwide seeking to integrate sustainability into their business and accounting practices.

5. Sustainability Accounting in Albania: Legal and Regulatory Framework

In Albania, sustainability accounting has begun to evolve in recent years, driven by global trends toward greater transparency and social and environmental accountability among businesses. Although the country is still in the early stages of developing sustainability accounting practices, several legal and regulatory frameworks—many inspired by international standards—play a crucial role in shaping this emerging field.

To better understand the state of sustainability accounting in Albania, it is important to examine the legal and institutional structures that support its development. One of the most important areas where sustainability accounting has gained ground in Albania is through the implementation of the International Financial Reporting Standards (IFRS). These standards are vital for ensuring the reliability of both financial and environmental information disclosed by companies. The IFRS framework requires companies to provide detailed information on the environmental and social impacts of their activities, including the risks and opportunities related to sustainability. These standards have been integrated into Albanian legislation and form an essential foundation for reporting and measuring performance related to sustainable development.

Companies operating in Albania that are required to follow IFRS must therefore also report on their sustainability practices and manage sustainability-related risks and opportunities. This approach facilitates the integration of environmental and social considerations into financial reporting and strengthens the connection between financial performance and sustainable outcomes. However, Albania's sustainability reporting legislation remains under development. Alignment with European Union (EU) legislation has been one of the main driving forces behind efforts to promote sustainability accounting in the country. For instance, the EU Corporate Sustainability Reporting Directive (CSRD)—which mandates companies to disclose information about their environmental, social, and governance (ESG) performance—is expected to directly influence Albania, especially since many Albanian companies operate within or are connected to EU markets. As a result, several Albanian companies with regional or European operations are beginning to recognize the importance of transparency and sustainability in their accounting and management practices.

Another relevant legal and institutional actor is the National Environmental Cleaning Agency, which monitors and promotes sustainable practices among companies and individuals whose activities may negatively affect the environment. Part of this framework includes environmental performance reporting, which obliges companies to monitor and disclose potential impacts such as pollution, greenhouse gas (GHG) emissions, and natural resource use. In addition, the Institute of Certified Auditors of Albania (ICAA) and the Association of Certified Accountants of Albania play important roles in promoting sustainability accounting practices. These organizations provide training and support to professionals engaged in the preparation of financial and sustainability reports, helping to ensure alignment with both national regulations and international standards. Albanian accountants and financial experts are encouraged to apply sustainability reporting principles that comply with global best practices, thereby enhancing the credibility and comparability of sustainability data. A particularly important sector for sustainability accounting in Albania is energy. The country possesses significant hydropower potential and a strong capacity for developing renewable energy sources. Albanian legislation has increasingly incorporated measures to monitor energy use and ensure that energy companies adopt sustainable practices in production and distribution. The EU Taxonomy for Sustainable Activities is another vital instrument that helps define which economic activities qualify as sustainable and are therefore eligible for green financing. Albania is currently working to align its national legislation with this framework, aiming to encourage investment and support long-term sustainable economic growth. Companies operating in Albania, especially those involved in the environmental and energy sectors, can benefit from this system by identifying and reporting sustainable activities, thereby gaining access to greater funding opportunities and investor support. In summary, although Albania's legal and regulatory framework for sustainability accounting is still evolving, there are clear and encouraging efforts to develop a more transparent and responsible reporting environment. The integration of international reporting standards such as IFRS and CSRD, as well as the promotion of sustainability practices in key sectors such as energy and environmental management, represent important steps toward ensuring sustainable growth and accountability.

6. Opportunities and Benefits for Albania from Sustainability Accounting

The implementation and development of sustainability accounting in Albania offer a wide range of opportunities and benefits for companies, economic sectors, and the national economy as a whole. By focusing on improving social, environmental, and financial performance, sustainability accounting can contribute to sustainable development and strengthen Albania's position in international markets. One of the main benefits of sustainability accounting is the enhancement of environmental and social performance across companies and economic sectors. By linking environmental and social outcomes with financial performance, businesses can reduce pollution, optimize the use of natural resources, and contribute to environmental preservation and sustainable growth. Through sustainability accounting, companies can also maximize the use of renewable energy, particularly in the energy sector, where Albania has substantial potential for diversification of energy sources. Another major benefit is the improvement of working conditions by promoting equality and opportunities for sustainable professional development among employees and communities. This contributes to creating a fairer labor environment and supports long-term social cohesion. In this way, Albania has the potential to become a successful model of sustainable development in the Western Balkans, helping to fulfill international commitments toward environmental protection and social progress. Sustainability accounting also creates opportunities for attracting green investments and increasing Albania's ability to participate in international financial markets. Investors are increasingly interested in companies that adopt sustainable practices and comply with environmental, social, and governance (ESG) principles. One of the most significant benefits for Albania is the increase in access to sustainable financing from international investors and financial institutions that seek to support projects with a positive environmental and social impact. Additionally, Albania could benefit from European Union (EU) subsidies and financial support programs, many of which are oriented toward promoting sustainability initiatives—especially in energy, environmental

protection, and rural development. This would allow Albania to create a favorable environment for the growth of sustainable industries and to strengthen its competitiveness in the global investment market. In an era when consumers are becoming more aware of the environmental and social implications of their purchases, sustainability accounting provides an opportunity for Albanian companies to improve their reputation and attract socially conscious customers. This can lead to increased customer loyalty, as modern consumers increasingly favor brands committed to sustainability and ethical values. Consequently, Albanian businesses can expand their market segments and benefit from a consumer base that values environmental and social responsibility. Sustainability accounting also offers an opportunity to strengthen local capacities and expertise in the fields of finance, accounting, and sustainability management. This can be achieved through professional training and education for accountants, auditors, and managers, enabling them to apply international sustainability reporting standards effectively. Capacity development at the institutional level—such as enhancing knowledge and practices related to sustainability management within government bodies and organizations—is equally important. Moreover, sustainability accounting presents significant opportunities for improving Albania's energy sector and green infrastructure, steering the economy toward the use of renewable resources.

Some of the key potential benefits include:

- Development of renewable energy projects, with investments in solar, wind, and hydropower, positioning Albania as a regional leader in renewable energy.
- Improvement of urban and rural infrastructure, through investments in sustainable energy systems, water management, and eco-friendly transport solutions.
- Advancement of the green economy, creating jobs and supporting long-term economic resilience.

By integrating sustainability accounting practices, Albania can also increase transparency in resource management and corporate performance. This would enhance trust in the private sector and ensure that businesses are committed to reporting accurate and reliable information regarding their environmental and social impacts.

Overall, sustainability accounting provides Albania with a pathway to achieving economic modernization, environmental responsibility, and social progress—three pillars essential for sustainable development and for aligning with European and global standards.

7. Conclusions and Recommendations for Sustainability Accounting in Albania

7.1 Conclusions

Sustainability accounting has begun to emerge as an important field for companies and economic sectors in Albania, although there is still room for improvement and development. Both companies and the public sector are starting to adopt better reporting practices concerning environmental, social, and governance (ESG) impacts. Most of the development in this field remains at an early stage and requires further commitment from all stakeholders. The implementation of International Financial Reporting Standards (IFRS) represents a significant step toward enhancing transparency and accountability. Although Albania has begun to adopt these standards, more effort and support are needed to ensure that sustainability accounting practices are properly implemented and aligned with international requirements. Albania has the potential to attract green investments and develop sustainable sectors, including renewable energy, agriculture, and infrastructure. The use of a clear framework for sustainability accounting could bring significant benefits by increasing opportunities for financing and sustainable development. There is a pronounced need in Albania to develop the capacities of accounting professionals and managers who can support the implementation of sustainability practices. Improving skills and providing training for these professionals would be an important step toward enhancing Albania's capacity to adopt and implement such practices effectively. The country also requires a clearer and more advanced legal and regulatory framework for sustainability reporting, including the potential establishment of a law on sustainability reporting aligned with European Union directives and international best practices.

7.2 Recommendations

Albania should continue improving its legal and regulatory framework to support the practice of sustainability accounting. This may include the establishment of a dedicated sustainability reporting law aligned with EU directives and requirements (such as the CSRD). Additionally, it is important to provide a clear framework for reporting ESG factors, making it mandatory for large companies and those operating in key economic sectors. Support for education and professional training is a critical area that requires ongoing programs to develop the capacities of accounting professionals and managers who can facilitate the implementation of sustainability reporting. Courses and training programs should be organized to provide in-depth knowledge of international sustainability reporting standards. Collaboration with international organizations and universities is also essential to develop educational programs that incorporate best practices in sustainability accounting. Albania should enhance conditions for attracting green investments, including the establishment of fiscal incentive systems for projects contributing to renewable energy development and the sustainable use of natural resources. Supporting the growth of emerging sectors such as solar, wind, and bioenergy is equally important to create opportunities for increased investment and sustainable employment. Companies should engage in ESG reporting to enhance transparency and business credibility. To this end, the implementation of best reporting practices, including the use of sustainability reporting systems, is recommended to ensure that information on environmental and social impacts is accurate and reliable. Mandatory sustainability reporting levels should also be established for large companies and those operating in key sectors such as construction, energy, and agriculture.

Small and medium-sized enterprises (SMEs) should be encouraged to implement sustainability practices. This can be achieved by providing financial and technical support to help them adopt sustainability standards. Developing policies that facilitate the implementation of sustainability practices for SMEs—by providing training and resources—is a particularly important recommendation. Sustainability accounting in Albania has the potential to contribute to the development of a sustainable economy and to enhance the transparency, credibility, and efficiency of Albanian companies. Despite the progress made so far, Albania needs to further improve its legal and regulatory framework, support the education and skills development of professionals, and encourage green investments and sustainable sector development. With coordinated commitment and an appropriate legal framework, Albania can leverage the opportunities offered by sustainability accounting to achieve sustainable development and benefit from global trends.

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CONTEMPORARY CHALLENGES OF ISLAND TOURISM DEVELOPMENT

Josip HORVAT
PhDc., Faculty of Tourism and Hospitality Management,
University of Rijeka, Croatia
e-mail: josiphorvat85@gmail.com

Zvonimira SVERKO GRDIC
Full Professor, Faculty of Tourism and Hospitality Management,
University of Rijeka, Croatia
e-mail: zgrdic@fthm.hr

Filipos RUXHO
Assistant Professor, Department of Business and Management
Universum College, Prishtina, Kosovo
e-mail: filip.ruxho@universum-ks.org
(Corresponding Author)

Abstract
Island tourism development is increasingly shaped by challenges arising from pronounced seasonal concentration of tourism demand, pressure on communal infrastructure, and cumulative environmental stress in a mature island destination. These challenges are particularly pronounced in mature island destinations, where cumulative pressures require adaptive governance and context-specific policy responses. This paper explores the contemporary challenges of island tourism development through a qualitative case study of Mali Lošinj, one of Croatia's most developed island tourism destinations. The study adopts a qualitative case study approach based on document and discourse analysis of strategic and institutional materials related to tourism development in Mali Lošinj. Selected findings from a survey conducted among local residents in September 2025 are used as a supplementary source of evidence for triangulation purposes. The survey captures residents' perceptions of tourism-related pressures and sustainability-oriented policies but does not serve as the primary research method. The findings indicate that Mali Lošinj faces interconnected challenges related to seasonal tourism concentration, infrastructure capacity constraints, and cumulative pressure on the natural environment, including pronounced seasonality and governance-related implementation constraints. While sustainability is strongly embedded in institutional discourse and strategic planning, persistent development pressures highlight gaps between policy intentions and practical outcomes. Residents' perceptions largely align with institutional assessments regarding key challenges, although uncertainties remain concerning the effectiveness of sustainability measures. The paper contributes to the literature on island tourism development by illustrating how general sustainability challenges materialise in a mature island context.

Keywords: Island tourism; sustainable tourism development; island destinations; tourism governance; Mali Losinj

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1. Introduction

Island destinations occupy a distinctive position within contemporary tourism development due to their spatial isolation, limited resource base, and heightened sensitivity to external pressures. Uneven spatial development of tourist destinations affects the economy, society, and the environment and represents an important factor in shaping sustainable development strategies (Krabokoukis, Polyzos, 2022). Tourism often represents a dominant economic activity on islands, generating income and employment while simultaneously intensifying environmental, infrastructural, and socio-economic pressures (Dłużewska and Giampiccoli 2021). As a result, island tourism development is frequently characterised by a structural tension between economic dependence on seasonal tourism revenues and the capacity of local infrastructure and ecosystems to absorb peak tourism demand. In recent decades, these tensions have become increasingly visible through pronounced seasonality, pressure on carrying capacity, environmental degradation, and growing concerns among local residents regarding the balance between tourism benefits and social costs (Gkarane et al. 2025). Consequently, the concept of sustainable tourism has gained relevance in island contexts, not merely as a normative development goal but as a practical necessity for maintaining the long-term viability of island destinations. However, translating sustainability principles into effective local policies and governance arrangements remains a persistent challenge, especially in mature destinations where tourism intensity is already high (Mihalic 2020). Within this broader context, the Croatian islands provide a particularly relevant setting for examining contemporary tourism challenges. As predominantly small and medium-sized islands with a strong orientation towards tourism, they face many structural vulnerabilities such as seasonal demand fluctuations, limited infrastructure capacity, and high sensitivity of coastal and marine environments. At the same time, differences in development trajectories and governance responses suggest that sustainability challenges are not uniform across islands but instead manifest in place-specific ways (Connell 2018). Mali Lošinj represents a distinctive case within Croatian island tourism. As one of the country's most developed island destinations, it has a long tourism tradition and a strong positioning in health, wellness, and nature-based tourism. At the same time, high tourism intensity, seasonal concentration of demand, and reliance on a fragile island environment raise critical questions regarding the long-term sustainability of its development model. These characteristics make Mali Lošinj a suitable case for examining how general challenges of island tourism development materialise at the local level. The objective of this paper is to identify and analyse contemporary challenges of island tourism development through a qualitative case study of Mali Lošinj. The study adopts an exploratory and interpretative approach, focusing on sustainability-related challenges specific to the local context. The analysis is based on qualitative examination of strategic documents, institutional reports, and policy frameworks, complemented by selected findings from a survey conducted among local residents, used as a supplementary source of evidence for triangulation purposes (Nunkoo and Ramkissoon 2011). This paper argues that sustainability is strongly embedded in the strategic and institutional framework of tourism development in Mali Lošinj, but that its practical implementation is constrained by pronounced seasonality and the infrastructural limits of a mature island destination.

Accordingly, the paper addresses the following research questions (RQ):

- RQ1: How is sustainability conceptualised and framed in the strategic and institutional documents governing tourism development in Mali Lošinj?
- RQ2: To what extent are sustainability objectives implemented in practice, particularly with regard to managing seasonality, infrastructure capacity, and environmental pressures in a mature island destination?
- RQ3: How do local residents perceive key tourism-related pressures and the effectiveness of sustainability-oriented measures?

This study contributes to the literature on sustainable regional development and island tourism governance in several important ways. First, it provides an in-depth empirical examination of how sustainability discourse is translated into practice in a mature island tourism destination, moving beyond purely conceptual discussions of island vulnerability. While previous studies frequently address structural challenges of island tourism, fewer analyses explore the implementation gap between sustainability-oriented strategies and operational realities at the

local governance level. Second, the paper advances the understanding of sustainability challenges in mature destinations by conceptualising them as cumulative and path-dependent processes rather than isolated pressures. The case of Mali Lošinj illustrates how long-term tourism intensity creates structural constraints that limit adaptive capacity, thereby linking tourism governance to broader regional development asymmetries characteristic of small island economies. Third, by triangulating institutional narratives with residents' perceptions, the study integrates governance and social acceptance perspectives, highlighting the importance of community legitimacy in sustaining regional tourism development. This contributes to sustainable regional development research by emphasising that effective sustainability transitions in island regions depend not only on strategic planning, but on governance capacity, coordination mechanisms, and local trust. Finally, the paper offers a place-based analytical framework applicable to other mature island destinations facing similar seasonality-driven structural constraints, thus contributing to comparative regional development research in tourism-dependent island contexts.

2. Contemporary challenges of island tourism development

Island tourism development is shaped by structural characteristics that fundamentally differentiate islands from mainland destinations. Spatial isolation, limited land availability, dependence on external markets, and restricted infrastructure capacity create a development context in which tourism growth represents both an opportunity and a source of vulnerability (Ridderstaat and Nijkamp, 2016). These characteristics are not temporary constraints, but long-term conditions that shape development trajectories and influence sustainability outcomes. One of the most persistent structural challenges is the pronounced seasonality of tourism traffic (Tsiotas, Krabokoukis, Kantianis, 2025). Tourism demand on islands is usually concentrated within a limited period, resulting in sharp fluctuations in economic activity, employment, and infrastructure use. Many island economies are heavily dependent on international tourism revenues, which exposes them to external economic shocks and demand fluctuations (Sheller, 2021). Seasonality is not only a question of demand, but a structural development challenge that increases economic dependence on tourism, while creating intense pressure during peak periods and underutilisation during the off-season (Gkarane et al., 2025). Seasonality directs most income and activity to a limited period of the year, amplifying the instability of income and employment for local communities (Weis, Chambers, Holladay, 2021; Movono and Scheyvens, 2022). Likewise, dependence on one sector reduces the ability to recover quickly from crises such as pandemics or extreme weather events (Gi, Onggo, Kunc, Bayer, 2021). Diversification strategies include the development of the blue economy and related activities that can offer alternative sources of income and greater economic resilience. The growth of peer-to-peer accommodation can change the supply structure, deepen regional imbalances, and increase seasonal pressures in urban areas of the island (Crisman and Winters, 2023). Overtourism on islands manifests as service overload, loss of utility benefits, and environmental degradation, especially in destinations with institutional deficiencies (Wolf, 2021). The concept of excessive tourism provides an analytical framework for understanding situations in which tourism intensity exceeds ecological, social, or infrastructural capacity (Mihalic, 2020). In island contexts, overtourism is often not defined by the absolute number of visitors, but by the relationship between tourist flows and limited spatial capacity (School of Business, University of Strathclyde, Glasgow, G4 0LG, UK et al., 2022). Political and market mechanisms that favour unrestricted growth often lead to social inequality and the marginalisation of local interests in tourism development (Wolf, 2021). Carrying capacity assessment tools such as capacity indices can help define quantitative visitation limits to conserve resources (Leka, Lagaris, Panagiotopoulou, 2022). Climate change threatens beaches, infrastructure, and tourism resources through sea level rise and increased storm intensity, extreme weather events, loosing biodiversity, requiring spatial planning and adaptation. Climate change adaptation systems that link tourism management with risk management can reduce the exposure of island destinations to climate shocks (Menegaki, Tugcu, 2025). Climate disasters and repeated external shocks increase reconstruction costs, creating a vicious cycle of degradation and economic losses for island communities (Hafsi, Aguilar-Becerra, Frausto-Martinez, 2023).

Increased tourism pressure significantly raises water demand and strains treatment systems, threatening coastal water quality and local water resources (Connell, Taulealo, 2021). Solid waste generation and wastewater treatment often exceed the capacities of island systems, damaging ecosystems and the attractiveness of destinations (Burbano, Valdivieso, Izurieta, Meredith, Ferri, 2022). Overexploitation of coastal and marine habitats due to mass and unregulated tourism can reduce biodiversity and disrupt ecosystem services (Weis, Chambers, Holladay, 2021). The constraints of energy networks and reliable water supply systems require investments in renewable energy sources and water reuse for long-term sustainability. Technological and infrastructural innovations can reduce costs and increase island autonomy, but require strategic funding and training of local staff (Pathak, Beynen, Akiwumi, Lindeman, 2021). Investments in public infrastructure need to be aligned with visitor management to prevent service collapses during peak seasons (Burbano, Valdivieso, Izurieta, Meredith, Ferri, 2022; Leka, Lagaris, Panagiotopoulou, 2022). The impact of tourism on local communities includes changes in employment opportunities, values, and perceptions of the authenticity of cultural practices. Increasing tourism can erode a sense of authenticity and local tradition if development is not participatory and inclusive of local residents (Agius, Briguglio, 2021). Demographic changes, such as youth emigration and the reorientation of the market towards seasonal employment, further weaken the social structure of islands (Gu, Onggo, Kunc, Bayer, 2021). Socio-ecological resilience at the community level is linked to participatory tourism models that strengthen local capacities and control over resources. The COVID-19 pandemic has highlighted the vulnerability of island tourism and created an opportunity to reconsider development paradigms based on mass tourism. Many island communities have experienced significant declines in income during the pandemic and have been forced to seek alternative sources of livelihood (Hafsi, Aguilar-Becerra, Frausto-Martinez, 2023; Reksa, Lissandhi, Syahid, 2021). Responses include short-term support measures, as well as initiatives to boost domestic tourism and policies aimed at greater resilience to future health and climate risks (Agius, Briguglio, 2021). Management strategies that combine demand-side mitigation, promotion of high-quality tourism, and strengthened local participation have shown promise in the literature (Reksa, Lissandhi, Syahid, 2021). Examples include the development of adaptation plans, visitor management schemes, and the promotion of ecotourism to mitigate seasonality (Movono, Scheyvens, 2022). Regional cooperation and knowledge exchange among islands can accelerate the adoption of solutions to common challenges such as water and energy availability and waste management. Modelling techniques and resilience indices assist policymakers in assessing recovery scenarios and long-term risks (Ruggieri, Calo, 2022). Introducing standards for sustainable management and transparent participation mechanisms can reduce institutional weaknesses that favour excessive growth and marginalisation of communities (Wolf, 2021; Agius, Briguglio, 2021). A focus on the blue economy and diversification of the sector can create new revenue channels, but requires assessment of social and environmental consequences. The combination of political measures, technical solutions, and local engagement will be crucial for the sustainable transition of island destinations. In future planning, it is important to integrate climate change scenarios, pandemic risks, socio-economic vulnerabilities, and development strategies. The resilience of island tourism will depend on the ability to manage the environment, economy, and social interests synergistically through inclusive and flexible policies. The perceptions and attitudes of residents are therefore a key element of sustainable tourism management, especially in island destinations where tourism directly affects everyday life (Qin et al., 2025)

3. Methodological approach

This study adopts a qualitative case study approach to explore contemporary challenges of island tourism development in the specific context of Mali Lošinj. The case study design is particularly suitable for analysing complex, place-specific phenomena where the aim is in-depth understanding rather than statistical generalisation. The primary methodological focus is qualitative document and discourse analysis. The analysis draws on strategic and institutional documents related to tourism development in Mali Lošinj, including tourism development strategies, sustainability programmes, and official reports issued by local authorities. The documents were selected based on their formal relevance to tourism

governance between 2013 and 2025. A qualitative thematic analysis was conducted to identify recurring sustainability-related concepts, governance mechanisms, and implementation constraints. The analysis followed an interpretative coding approach, focusing on the alignment between policy discourse and implementation challenges. These sources provide insight into policy priorities, governance arrangements, and the institutional framing of sustainability challenges. In addition, selected findings from a survey conducted among the local population are incorporated as a supplementary data source. The survey was administered online via Google Forms in October 2025 and was open to registered residents as well as individuals residing on the island for more than nine months per year. Participation was voluntary and anonymous, and 163 valid responses were collected. Survey data are used exclusively for triangulation purposes and are not employed as a primary research method or for hypothesis testing (Nunkoo and Ramkissoon 2011). Instead, they provide insight into residents' perceptions and allow comparison between institutional narratives and community experiences, thereby enhancing the interpretative robustness of the analysis.
This study is limited by its qualitative design and reliance on document analysis and a supplementary survey sample (N=163). The findings cannot be statistically generalised but aim to provide contextual insight into governance challenges in a mature island destination.

4. Results: Sustainability challenges in Mali Lošinj

4.1. Sustainability discourse in strategic and institutional documents

Strategic documents, such as national strategies and recovery plans, help to integrate environmental and social goals into tourism policy. The integration of policies and plans allows for the harmonisation of measures and indicators that support the sustainable management of destinations. Strategic documents connect national policies with local plans and regulations, enabling a coordinated approach to destination development. Implementing sustainability through strategic documents requires concrete tools to assess acceptable changes and scenario planning to manage tourism pressures. However, implementation often faces challenges such as weak regulatory standards, insufficient public-private sector cooperation, and institutional constraints. This section addresses RQ1 by analysing how sustainability is conceptualised and framed in strategic and institutional documents guiding tourism development in Mali Lošinj. Mali Lošinj is one of the most developed island tourism destinations in Croatia, characterised by a long-standing tourism tradition and a strong integration of tourism into the local socio-economic structure. Tourism plays a central role in the local economy, shaping employment patterns, infrastructure development, and the overall development orientation of the destination. As an island destination with limited spatial and environmental resources, Mali Lošinj operates within a context in which tourism development has historically functioned both as a driver of economic growth and as a source of cumulative pressures on infrastructure systems, coastal space, and local environmental resources. The development trajectory of tourism in Mali Lošinj reflects a gradual transition from traditional seaside tourism towards more diversified forms, particularly health, wellness, and nature-based tourism. This strategic positioning is consistently emphasised in official planning documents, which highlight the destination's natural assets, favourable climatic conditions, and long-established reputation in health tourism. Diversification has contributed to strengthening the destination's identity and market position, while also reinforcing its status as a mature tourism destination characterised by relatively high levels of visitor intensity. Tourism development in Mali Lošinj is guided by a set of institutional and strategic frameworks that explicitly recognise sustainability as a key development principle (*Strategija razvoja turizma: Mali Lošinj i Cres* 2021). Local and regional strategies emphasise the need to balance tourism growth with environmental protection, quality of life for residents, and long-term economic resilience. Policy objectives typically include controlled tourism development, improvement of tourism quality, mitigation of environmental impacts, and alignment of tourism activities with the island's carrying capacity (*Program razvoja održivog turizma Grada Mali Lošinj* 2013). These documents also stress the importance of cooperation among local authorities, tourism stakeholders, and the local community. At the operational level, tourism development is supported by multiple institutional actors, including local government bodies, tourism organisations, and public service providers. Official reports

indicate continuous efforts in destination promotion, product development, and infrastructure improvement aimed at supporting tourism demand. At the same time, these documents acknowledge structural constraints related to seasonality, infrastructure capacity, and environmental sensitivity, which are inherent to the island context and become particularly pronounced during peak tourism periods (Turistička zajednica Grada Malog Lošinja 2025). Overall, the combination of a strong tourism orientation, long-term development intensity, and an explicit institutional commitment to sustainability places Mali Lošinj in a distinctive position within the Croatian island tourism system. While the destination benefits from accumulated experience, a strong tourism brand, and diversified products, its maturity also implies exposure to cumulative pressures that require ongoing adaptation of governance practices related to infrastructure management, environmental protection measures, and coordination among local tourism institutions. This context provides the foundation for analysing the key sustainability challenges faced by Mali Lošinj.

4.2. Implementation constraints in a mature island destination

This section addresses RQ2 by examining the main constraints affecting the practical implementation of sustainability objectives in a mature island tourism destination. Implementing a sustainable development strategy in mature tourism destinations presents several challenges that require careful consideration. Sustainable development today reflects a strong commitment to inclusion, emphasising principles such as “for all,” “leaving no one behind,” and prioritising those who are most disadvantaged (Sepetis, Krupavičius, Ladias, 2024). Inclusive and sustainable development needs to be clearly defined to ensure a clear and, ideally, empirically operational distinction at any level between genuinely inclusive social protection policies (Sepetis, 2024). A significant issue is the lack of understanding of both the potential and limitations of sustainability, which makes it difficult to measure progress towards sustainability goals. Additionally, ageing infrastructure and declining visitor numbers in mature destinations highlight the need for innovative responses to environmental and social challenges (Heald, 2023). Stakeholder engagement is essential, as effective measurement and implementation of sustainability strategies depend on the involvement of all relevant actors. Moreover, balancing economic growth with environmental protection remains a constant challenge, requiring strategic planning to optimise resource allocation and encourage community participation (Ou, 2025). Transforming mature tourist resorts into sustainable destinations also demands a shift from simple renovations to the establishment of collaborative networks among stakeholders. However, some authors note that the complexity of relationships among stakeholders can hinder the effective implementation of sustainable strategies, as conflicting interests may complicate consensus-building. The sustainability challenges encountered in Mali Lošinj reflect broader patterns characteristic of mature island tourism destinations, while also displaying place-specific features linked to the island’s development trajectory and governance arrangements. Although sustainability is strongly emphasised in strategic documents, practical implications of tourism intensity reveal the interaction between peak-season population surges, limited capacity of transport and communal infrastructure, increased pressure on coastal environments, and coordination demands across local institutions. A central challenge is the pronounced seasonality of tourism demand and the resulting pressure on local infrastructure and public services (Gkarane et al. 2025). Tourism activity remains highly concentrated during the summer months, leading to significant temporary increases in population that far exceed the island’s permanent population. This seasonal concentration places considerable strain on transport systems, water supply, wastewater treatment, waste management, and other communal services, which are primarily designed to serve resident needs. Despite ongoing infrastructure investments, peak-season demand continues to expose structural capacity limits, highlighting the persistent tension between tourism intensity and island infrastructure constraints. Although seasonality is consistently identified as a central sustainability challenge in strategic documents, responses remain largely reactive and focus on managing peak-period pressures through infrastructure and service provision rather than addressing the underlying tourism development model. As a result, sustainability objectives are primarily implemented through capacity adjustments during the summer season, while structural dependence on highly seasonal tourism demand remains largely unchanged. Unlike less developed Croatian islands,

Mali Lošinj demonstrates institutional awareness of sustainability challenges; however, the structural dependence on high-intensity seasonal tourism suggests path dependency typical of mature destinations. Environmental pressures represent another key dimension of sustainability challenges in Mali Lošinj. The natural environment, particularly coastal and marine ecosystems, constitutes a core component of the destination's tourism appeal. However, cumulative pressures resulting from high visitor density during summer months, increased traffic congestion, and intensified use of coastal and recreational areas intensify stress on fragile ecosystems, especially during peak periods. These pressures are often gradual rather than acute, manifesting through congestion, spatial overcrowding, and increased use of natural areas. In this sense, elements commonly associated with overtourism emerge implicitly, highlighting the relevance of carrying capacity considerations in managing tourism development (Mihalic 2020). Sustainability challenges in Mali Lošinj also manifest in seasonal employment patterns, limited economic diversification beyond tourism, and coordination challenges among local governance actors. While tourism generates significant economic benefits, including employment and income, these benefits are closely tied to seasonal cycles and are not evenly distributed across the local community. High dependence on tourism limits opportunities for economic diversification and increases vulnerability to external shocks, while seasonal employment patterns contribute to labour market instability (Nesticò and Maselli 2020). At the governance level, strategic objectives related to sustainability face implementation challenges arising from institutional fragmentation, coordination difficulties, and the complexity of managing tourism within an island setting. Taken together, these challenges highlight that sustainability issues in Mali Lošinj are not isolated problems but rather the outcome of cumulative and interconnected processes. The coexistence of a strong sustainability discourse and persistent development pressures points to the importance of adaptive, context-sensitive governance approaches capable of addressing the specific conditions of mature island destinations.

4.3. Residents' perceptions of tourism pressures and policy effectiveness (RQ3)

This section addresses RQ3 by examining residents' perceptions of key tourism-related pressures and the perceived effectiveness of sustainability-oriented measures, using survey findings for triangulation purposes.

Research on residents' perceptions of tourism pressures and the effectiveness of public policies has been conducted in various contexts. Abdullah et al. found that residents' attitudes mediate their resistance to tourism in Malaysia, with perceived overcrowding and pressure on public services significantly influencing resistance levels (Abdullah et al., 2025). While the above research provides valuable insights, differences in perceptions across regions and community types indicate that a one-size-fits-all approach to tourism policies is ineffective. Instead, policies should be tailored to the specific socio-demographic and cultural characteristics of communities to ensure sustainable tourism development and reduce tensions between residents and visitors. Within the wider context of Croatian island tourism, Mali Lošinj stands out due to its long-term tourism development, high tourism intensity, and explicit institutional commitment to sustainability. While many Croatian islands face similar challenges related to seasonality, infrastructure constraints, and environmental sensitivity, Mali Lošinj is distinguished by the cumulative effects of decades of tourism development and by the maturity of its tourism system. Tourism has functioned as a dominant economic activity for an extended period, resulting in a high level of institutional experience, destination branding, and product diversification. This long-standing orientation has enhanced economic resilience and market visibility, but it has also intensified exposure to cumulative environmental and infrastructural pressures that are less pronounced in less developed island destinations. Another defining feature of Mali Lošinj is the prominence of sustainability within official planning and policy discourse. Sustainability principles are explicitly integrated into strategic documents and development programmes, positioning Mali Lošinj among destinations where sustainable tourism is framed as a central development objective rather than an emerging concept. Nevertheless, the persistence of pressures related to seasonal overcrowding, strain on public services, and environmental stress during peak tourism periods suggest that the key challenge lies not in strategic articulation but in effective implementation within the constraints of island governance.

Mali Lošinj can therefore be characterised as a mature island destination in which sustainability challenges arise primarily from the need to reconcile long-established tourism structures with evolving sustainability demands. This distinctiveness reinforces the relevance of Mali Lošinj as a case study for examining contemporary challenges of island tourism development in destinations where future sustainability depends on adaptive governance and effective policy coordination.

5. Residents' and institutional perspectives

The analysis of sustainability challenges in Mali Lošinj is further enriched by considering both institutional perspectives and residents' perceptions of tourism development. The understanding of sustainable development by institutions and local communities in Croatia covers various aspects essential to its implementation. Institutions recognise the importance of education for sustainable development, including empowering local communities through educational programmes that promote critical thinking and natural resource management. In addition, it should be noted that both the performance and sustainability of the tourism industry depend on institutional factors (Beha, Polo, Bogdan, Palma, 2024). Local knowledge and cultural heritage play a crucial role in the sustainable development of rural areas, where the resources and experiences of local people are utilised to achieve sustainable goals. In urban areas, the successful implementation of sustainable tourism requires the active participation of local people and the development of strategies that involve all stakeholders. However, there is criticism that the concepts of sustainable development and sustainability are often vague, which can lead to misuse for specific interests and make their implementation in legislation difficult. This section addresses RQ3 by examining residents' perceptions of tourism-related pressures and the perceived effectiveness of sustainability measures, using survey findings for triangulation purposes. Examining these perspectives in parallel provides insight into how sustainability challenges are framed at the policy level and how they are experienced within the local community. Institutional documents consistently emphasise sustainability as a guiding principle of tourism development. Policy narratives focus on improving tourism quality, protecting environmental resources, mitigating seasonal pressures, and enhancing residents' quality of life. Sustainability is thus presented as an integral component of destination governance, addressed through strategic planning, coordination among stakeholders, and gradual infrastructure improvements. Residents' perceptions, captured through the survey conducted in September 2025, complement this institutional perspective. The survey included both registered residents and individuals residing on the island for more than nine months per year, reflecting a broad representation of the local community. The survey is used solely for triangulation purposes and does not aim to provide a quantitative evaluation of policy effectiveness, but rather to contextualise institutional findings through residents' perceptions. Overall, respondents acknowledged the economic importance of tourism but expressed concerns regarding its intensity and seasonal concentration. Perceived pressures were most frequently associated with infrastructure capacity, public services, and environmental stress during peak tourism periods. While institutional narratives and residents' perceptions largely align regarding key challenges, differences emerge in assessments of policy effectiveness (Nunkoo and Ramkissoon 2011). Although sustainability objectives are clearly articulated in official documents, residents' responses indicate uncertainty about the extent to which these objectives translate into tangible improvements such as reduced congestion, improved communal services, and more balanced tourism flows throughout the year. This divergence highlights the importance of governance capacity, communication, and community involvement in sustaining local support for tourism development. The combined consideration of institutional and residents' perspectives emphasizes the multifaceted nature of sustainability challenges in Mali Lošinj. Triangulating these perspectives provides a more comprehensive understanding of how tourism-related pressures are perceived and managed in a mature island destination.

6. Discussion

From a sustainable regional development perspective, island tourism destinations represent structurally constrained regional systems characterised by economic monoculture, limited diversification capacity, and infrastructural asymmetry. In such contexts, tourism governance

becomes a core regional development mechanism rather than merely a sectoral management issue. The findings of this study demonstrate that the contemporary challenges of island tourism development identified in the literature are clearly reflected in the case of Mali Lošinj, while also revealing destination-specific dynamics linked to the maturity of its tourism system. The analysis confirms that island destinations operate within structurally constrained environments where tourism intensity, environmental limits, and governance capacity interact in complex ways. Challenges such as pronounced seasonality, infrastructure pressure, and environmental sensitivity closely align with patterns discussed in the broader literature on island tourism. In Mali Lošinj, these challenges are amplified by the cumulative effects of long-term tourism development, illustrating how sustainability issues become more pronounced as repeated seasonal peaks place increasing pressure on infrastructure systems and natural resources as destinations reach advanced stages of development. The findings also highlight the central role of governance in shaping sustainability outcomes. Although sustainability is clearly reflected in institutional planning, ongoing development pressures reveal gaps between policy goals and their practical implementation. This supports arguments in the literature that sustainability challenges in tourism often stem from governance limitations rather than from a lack of policy awareness. Comparing institutional perspectives with residents' perceptions further emphasises the social dimension of sustainability. While there is general agreement on the nature of key challenges, differences in perceived policy effectiveness underline the importance of local engagement and trust in institutions. In island contexts, where tourism directly affects daily life, social acceptance emerges as a critical component of sustainable tourism governance. Overall, the discussion reinforces the value of place-based, qualitative approaches in understanding island tourism development. The case of Mali Lošinj illustrates that sustainable tourism in mature island destinations requires continuous adaptation, coordinated governance, and sensitivity to local conditions rather than reliance on generic sustainability solutions. From a regional development perspective, the case of Mali Lošinj illustrates how tourism-dependent island regions face structural development asymmetries, requiring integrated regional governance approaches rather than isolated local interventions.

7. Conclusion

This paper analysed the contemporary challenges of island tourism development through a qualitative case study of Mali Lošinj. By combining conceptual insights from the literature with an in-depth analysis of local institutional frameworks and supplementary survey data, the study provides a comprehensive understanding of sustainability challenges in a mature island tourism destination. The findings indicate that Mali Lošinj faces challenges arising from persistent seasonal tourism concentration, limited infrastructure capacity during peak periods, cumulative environmental pressure, and constraints in implementing sustainability objectives through existing governance arrangements. While sustainability is strongly embedded in strategic planning and policy discourse, persistent development pressures reveal difficulties in translating strategic objectives into effective operational outcomes within the constraints of an island context. Residents' perceptions largely align with institutional assessments of key challenges, particularly regarding seasonal and environmental pressures, but also reveal uncertainties about the effectiveness of sustainability measures. These insights highlight the importance of governance capacity, transparency, and community engagement in sustaining support for tourism development. The case of Mali Lošinj contributes to the literature by illustrating how general sustainability challenges materialise in a mature island context and by emphasising the importance of place-based and adaptive governance approaches. Future research could extend this analysis through comparative or longitudinal studies of island destinations at different stages of tourism development. This case also demonstrates that in mature island tourism destinations the primary sustainability challenge is not the absence of strategic planning, but the limited capacity to implement sustainability objectives within existing infrastructural and institutional constraints. This finding contributes to the literature on island tourism development by highlighting the gap between sustainability-oriented strategies and their practical realisation under conditions of high tourism intensity and seasonality. The case of Mali Lošinj demonstrates that in mature island tourism regions, sustainable development depends less on strategic articulation and more on institutional

capacity to restructure seasonality-driven economic dependence. This insight has broader implications for regional development policy in small island economies across the Mediterranean and beyond.

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CULTURAL AND SOCIO-CULTURAL DETERMINANTS OF ENTREPRENEURIAL MINDSET AND BEHAVIOR: A REVIEW AND ANALYSIS

Imelda SEJDINI
Associate Professor, Business Administration Department,
University of Elbasan"Aleksandër Xhuvani"
E-mail: imelda.sejdini@yahoo.com,
ORCID: 0000-0002-9067-1259

Ina SEJDINI
Dr. Lecturer, Economics Department,
University of Elbasan"Aleksandër Xhuvani",
E-mail: ina_sejdini@live.com,
ORCID: 0000-0002-5381-2112

Ardita TODRI
Associate Professor, Finance and Accounting Department,
University of Elbasan "Aleksandër Xhuvani",
E-mail: ardita.todri@gmail.com,
ORCID**:** 0000-0002-3825-0780

Abstract

This article analyses the influence of cultural and socio-cultural factors on the development of entrepreneurial mindset and behavior across different regions worldwide. Analyzing existing literature, international reports, and recent statistics, it highlights how cultural dimensions such as individualism, collectivism, uncertainty avoidance, and long-term orientation shape entrepreneurial attitudes and actions. The study underscores that countries with open, innovation-friendly cultures tend to exhibit higher rates of new venture creation, whereas more conservative societies display lower entrepreneurial activity. The role of education, social norms, and public policies in fostering entrepreneurial culture is emphasized as crucial for economic growth and social progress. Overall, the findings suggest that understanding and leveraging cultural values can significantly enhance entrepreneurial development, advocating for targeted strategies to cultivate an environment conducive to innovation, risk-taking, and social capital building across diverse cultural contexts.

Keywords: entrepreneurial culture, cultural dimensions, innovation, risk-taking

JEL Classification: L26, F22, F63, O31

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1. Introduction

In today's increasingly interconnected and globalized world, the development of an entrepreneurial mindset and entrepreneurial culture has gained particular importance in fostering innovation, economic growth, and social development across different countries. Each nation shaped by its historical heritage, cultural values, and social structure, influences how individuals perceive and undertake entrepreneurial actions. In Europe, where innovation culture and entrepreneurial education are fundamental to sustainable economic development, emphasis is placed on integrating values such as creativity, autonomy, and rapid adaptability to change (European Innovation Scoreboard, 2023; European Education Area, 2022). Meanwhile, Asia presents a rich cultural landscape where collective values and respect for hierarchy significantly influence entrepreneurial behavior, with a focus on future orientation and tradition preservation being key factors in decision-making (Kirkman et al., 2006). In Africa and the Middle East, communities often rely on family networks and social relationships, resulting in an entrepreneurial mindset that is closely aligned with collective values and a sense of responsibility toward the group. These regions face substantial social and economic challenges; however, their strong cultural foundations serve as a basis for the creation of new initiatives, albeit often with a more cautious approach to risk (Azouri & Daou, 2022). China, one of the world's largest economies, exemplifies a careful balancing act between tradition and innovation, where values such as discipline, commitment, and a forward-looking outlook are integral to its entrepreneurial culture (He et al., 2019). In Russia, despite a robust industrial legacy, the development of an entrepreneurial mindset is closely tied to the challenges of economic reforms and rapid social changes (Yukhanaev et al., 2015). In the United States and Canada, a culture of competition, individualism, and self-confidence significantly influences the surge of new ventures and innovation, creating an environment where risk-taking and creativity are core elements of entrepreneurs' identities. In Australia and other developed countries, the cultivation of an entrepreneurial mindset is often linked to a culture of open innovation and heightened sensitivity to global changes (Reynolds & Curtin, 2010). This international landscape demonstrates that, despite cultural and structural differences, the development of an entrepreneurial mindset and the promotion of a robust entrepreneurial culture are key factors for economic and social advancement. This article aims to analyze in detail the evolution of the entrepreneurial mindset, the role of entrepreneurial culture, the impact of cultural values, and socio-cultural factors influencing entrepreneurial behavior, supported by recent international statistics and studies, to provide a comprehensive and balanced overview of this topic.

2. Literature Review

Empirical studies on entrepreneurial mindset indicate that it is influenced by a multitude of factors, including education, culture, and socio-economic elements. Entrepreneurship is closely linked to skills such as risk-taking, creativity, innovation, and intrinsic motivation. According to Klofsten et al. (2019), entrepreneurial education at all levels plays a crucial role in fostering an entrepreneurial mindset among individuals, while Hidayati and Satmaka (2018) emphasize that integrated programs within higher education enhance managerial skills and self-confidence necessary for starting a business. Another vital component is entrepreneurial culture, which is defined as a set of values, behaviors, and skills that shape how communities and individuals engage in creativity and innovation (Danish et al., 2019). Hofstede's (1994) cultural dimensions further demonstrate how factors such as collectivism, power distance, uncertainty avoidance, masculinity, and long-term orientation influence perceptions and behaviors in entrepreneurial activities. Recent empirical research identifies key factors that facilitate the development of an active entrepreneurial culture, including opportunity recognition, creativity, enabling partners, and role models (Anwar et al., 2023). A comparative analysis of Hofstede's studies (1980; 2010) suggests that countries with individualistic cultures are more likely to develop new ventures, whereas collectivist societies tend to foster close social interactions and community support. Furthermore, the influence of cultural values on entrepreneurial behavior is well-documented. Scholars such as Arrak et al. (2020) and Çelikkol et al. (2019) highlight that dimensions like individualism, satisfaction, and long-term orientation are common factors impacting opportunity perception and

entrepreneurial decision-making. Global statistics also corroborate the significant role of culture in entrepreneurial development. The Global Entrepreneurship Monitor (2023) reports that countries with cultures open to risk-taking and innovation, such as the United States and Singapore, exhibit higher levels of nascent entrepreneurship, with over 15% of the population aged 18–64 engaged in entrepreneurial activities. Conversely, nations with more reserved cultures toward change, such as Japan and Germany, display lower levels, approximately 8–10%. Additionally, literature indicates that the cultivation of an entrepreneurial culture is closely linked to public policies and investments in entrepreneurial education, which create environments conducive to creativity and the growth of new initiatives.

3. Methodology

This study is based on an analysis of available literature, international reports, and recent statistical data from reputable institutions such as the European Commission, the World Bank, OECD, and the GEM Consortium. The aim is to assess the impact of culture and cultural values on entrepreneurial mindset and entrepreneurial behavior by combining comparative methods and statistical data analysis. To achieve this objective, the latest reports from GEM (2023), the World Bank Database (2025), the European Innovation Scoreboard (2023), the European Education Area (2022), and OECD data on Entrepreneurial Ecosystem Diagnostics (2025), related to culture and entrepreneurship, were analyzed. Additionally, empirical studies published in international journals specializing in entrepreneurship were reviewed. Hofstede's cultural dimension models (1980, 1994, 2010) were also employed to interpret the cultural influence at the national and regional levels.

In this context, a comparative evaluative analysis was conducted between countries with different levels of open and reserved cultures, including the USA, Singapore, Japan, and Germany, as well as collectivist cultures such as China and South Korea. The analysis is focused on four elements: the development of entrepreneurial mindset, the role of entrepreneurial culture, the influence of cultural values, and socio-cultural factors.

4. Results

The analysis of entrepreneurship (in Table 1) is presented based on four elements: the development of an entrepreneurial mindset, the role of entrepreneurial culture, the influence of cultural values, and socio-cultural factors on entrepreneurial behavior. This analysis aims to illustrate how these factors interact and influence the development of entrepreneurship in accordance with the selected literature.

Table 1. Analysis of Entrepreneurial Mindset Development and the Impact of Entrepreneurial Culture

Concept	Description	Reference	Description of the Impact on Entrepreneurial Behavior	Main Cultural Values / Dimensions	Statistics
Development of the Entrepreneurial Mindset	Formation of a positive, creative mindset, calculated risk-taking, intrinsic motivation, and perseverance	Klofsten et al. (2019); Gruber & MacMillan (2017); Reynolds & Curtin (2010); Kirzner (2015); Yukhanaev et al. (2015); Fukuyama (2001)	Fosters awareness, creativity, and bold decision-making skills	Key dimensions: individualism, risk orientation, creativity, satisfaction	15-20% of the workforce in innovative countries are involved in new ventures (GEM, 2023)
The Role of Entrepreneurial Culture	Set of values, behaviors, and practices that promote creativity, innovation, and entrepreneurship	Danish et al. (2019); Donaldson (2021); Vías & Rivera-Cruz (2020); Alsaad	Creates favorable environments for innovation, collaboration, and advancement of new initiatives	Key dimensions: collectivism vs individualism, power distance, uncertainty avoidance,	Countries with innovative cultures like the USA and Singapore have high levels of new

		(2019); Arrak et al. (2020); Göçmen et al. (2025); Walker (2018)		long-term orientation	entrepreneurship (GEM, 2023)
Impact of Cultural Values on Entrepreneurial Behavior	Values such as individualism, collectivism, uncertainty avoidance, masculinity, and femininity influence entrepreneurs' activities and perceptions	Çelikkol et al. (2019); Alsaad (2019); Azouri & Daou (2022); Hofstede (1980, 1994, 2010); Hopp & Stephan (2012); Gartner et al. (1992); Kirkman et al. (2006); Yukhanaev et al. (2015).	Affect risk-taking tendencies, innovation, networking, and decision-making	Main dimensions: individualism, collectivism, uncertainty avoidance, future orientation	Individualist countries have more new ventures (GEM, 2023); collectivist cultures often support closer social interactions
Socio-cultural Factors in Entrepreneurial Behavior	Social environment, education, family, social norms, political stability, gender roles	Fukuyama (2001); Hidayati & Satmaka (2018); Gomes et al. (2025); Zaharova (2025); Etzioni (1988); Göçmen et al. (2025).	Influence the tendency to start a business, risk perception, and success	Main dimensions: social trust, social capital, social norms, political stability	Growth of entrepreneurship is higher in countries with high social capital and political stability (Fukuyama, 2001; GEM, 2023)

Source: Authors elaboration

Meanwhile, reports such as the European Innovation Scoreboard (2023), European Education Area (2022), GEM (2023), OECD (2025) and World Bank (2025) also address the development of entrepreneurship by linking it to four main elements: the development of the entrepreneurial mindset, the role of entrepreneurial culture, the impact of cultural values on entrepreneurial behavior, and socio-cultural factors influencing entrepreneurial behavior. Regarding the development of the entrepreneurial mindset, these reports emphasize the importance of education, innovation, and supportive policies that foster awareness and creativity among individuals. They note that creating a mindset oriented towards risk-taking, innovation, and entrepreneurship is essential for economic and social development, highlighting the significant role of educational institutions and public policies. In relation to the role of entrepreneurial culture, the reports discuss the influence of a sustainable, innovative, and collaborative culture that promotes entrepreneurship. They underscore that an entrepreneurial culture is cultivated through models of cooperation, innovation, and community trust, which are vital for encouraging new economic activities. Concerning the impact of cultural values on entrepreneurial behavior, the reports analyze how values such as trust, cooperation, creativity, and risk acceptance influence entrepreneurs' actions. They report that cultural values help shape perceptions of risk and opportunities, directly affecting entrepreneurial decisions and behavior. As for socio-cultural factors in entrepreneurial behavior, the reports discuss the influence of social norms, social networks, and community support. They point out that socio-cultural factors are essential in creating a favorable environment for entrepreneurship, including elements of culture and social traditions that either encourage or hinder entrepreneurial initiatives. In general, these reports emphasize that the development of entrepreneurship is a complex process deeply influenced by cultural, educational, social, and psychological factors. They acknowledge that promoting sustainable

entrepreneurial growth requires the formulation of policies and strategies that address all these aspects in an integrated manner.

5. Discussion

Data analysis and the reviewed studies indicate that culture is a key factor that determines entrepreneurial mindset and behavior. Cultural values and dimensions such as individualism, collectivism, uncertainty avoidance, and long-term orientation directly influence perceptions of risk, networking styles, and strategic decision-making (Hofstede, 1980; 2010; Alsaad, 2019; Klofsten et al., 2019). In countries with an open culture towards innovation, entrepreneurs are more willing to undertake bold actions, seek innovation, and accept the risk of failure (Danish et al., 2019; Gruber & MacMillan, 2017). Conversely, in conservative or collectivist cultures, entrepreneurs often operate based on family and community networks, avoiding risk and focusing on long-term stability (Arrak et al., 2020; Yukhanaev et al., 2015). An important aspect is also the influence of culture on the internationalization of business. Companies that understand and respect cultural diversity and adopt appropriate strategies for local markets are more likely to succeed (Donaldson, 2021; Çelikkol et al., 2019). The example of Airbnb, which has succeeded in building global trust by adapting its services to local norms, demonstrates the importance of cultural sensitivity in international business (Gomes et al., 2025). Finally, studies confirm that developing a strong entrepreneurial culture and raising awareness of cultural values are crucial factors for economic growth and innovation (Fukuyama, 2001; Hopp & Stephan, 2012). Thus, to build a favorable environment for entrepreneurship, governments, educational institutions, and companies should invest in education, training, and cultural awareness initiatives (Hidayati & Satmaka, 2018; European Education Area, 2022; OECD, 2025).

6. Conclusions

This study confirms that the development of an entrepreneurial mindset and individual behavior in this domain are mainly influenced by cultural and socio-cultural factors. Countries with open cultures towards innovation, risk-taking, and new ideas, such as Switzerland, Montecarlo, USA, Singapore, and Australia, exhibit high levels of new venture creation. In contrast, nations that uphold conservative values, such as the Balkans, Japan and Germany, tend to show lower levels of entrepreneurship, primarily due to a strong respect for tradition and hierarchy. At the international level, key dimensions of entrepreneurial culture that influence behavior include individualism, power distance, uncertainty avoidance, and long-term orientation. These dimensions shape how individuals perceive risk, innovation, and collaboration. Moreover, cultural values like individualism and future orientation serve as fundamental pillars for networking, creativity, and success in entrepreneurship. Therefore, it is recommended that public policies and entrepreneurs focus on creating environments that promote entrepreneurial education, the development of innovative values, and the strengthening of social capital, especially in countries where these elements are lacking. Additionally, raising awareness about the importance of risk-taking and creativity as vital factors for economic and social development is crucial. The main limitations of this study include the lack of precise individual-level data on entrepreneurs and the impact of internal psychological factors, as well as the considerable variability of international data concerning culture and economic development. Furthermore, the analysis was based on literature and international statistics without in-depth empirical studies at the individual or regional level.

Future research should explore more comprehensive studies on the influence of psychological factors and collective consciousness on entrepreneurial behavior. It is also important to analyze the impact of technology and innovation on changing entrepreneurial cultures. Additionally, comparative international studies are necessary to identify best practices and successful strategies for promoting an entrepreneurial mindset across diverse cultural and socio-economic contexts.

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RETHINKING OLIVE OIL PRODUCTION: PATHS TO SUSTAINABILITY

Isabel JOAQUINA RAMOS
Assistant Professor, Department of Landscape, Environment and Planning.
CICS.NOVA-UÉvora-Interdisciplinary Centre of Social Sciences.
University of Évora. Portugal.
E-mail: iar@uevora.pt

Conceição REGO
Assistant Professor, Department of Economics.
CEFAGE-U.É.-Center for Advanced Studies in Management and Economics.
University of Évora. Portugal.
E-mail: mcpr@uevora.pt

Maria da Conceição FREIRE
Assistant Professor, Department of Landscape, Environment and Planning.
Researcher at CHAIA-Centre for Art History and Artistic Research.
University of Évora. Portugal.
E-mail: mcmf@uevora.pt

Lília FIDALGO
Head of the Territorial Planning and Strategy Division,
Alentejo Regional Coordination and Development Commission.
Évora. Portugal
E-mail: lilia.fidalgo@ccdr-a.gov.pt

Abstract

Olive groves and olive oil production have been part of rural landscapes in Portugal since ancient times. While their social and cultural relevance are rooted in the past, their economic role stands out today. However, the intensification of production has been putting at risk the balance between territory, landscape and production. The challenge is to revitalise rural areas without pressure on natural resources, ecosystems and their inevitable relation to local communities, meaning to improve agricultural practices and quality of life. Sustainability programs have emerged to address these concerns. This article reflects on some impacts of the intensification of olive groves and shares insights from the Olive Oil of Alentejo Sustainability Program (OASP), focusing on Human Communities, Landscape Management, and Biodiversity. It presents suggestions for improvements in these areas and concludes that initiatives like OASP are important complements to public policy instruments. Also highlights the importance of involving public and private actors, researchers, and communities to develop innovative and responsible solutions that values and respects landscapes, ecosystems, and communities.

Keywords: Landscape, Biodiversity, Communities, Sustainable Management, Olive Oil Production

JEL Classification: Q01, Q15, R11, R52

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1. Introduction

The development of activities linked to olive growing is, among agricultural and agro-industrial production, one that requires the greatest analysis associated with environmental preservation and sustainability. In the Portuguese case, the emergence of large-scale intensive olive grove production, especially in the area benefiting from the Alqueva Dam's perimeter, requires a debate about the need to reconcile agricultural production with the preservation of ecosystems. Both the restriction of environmental preservation and the demand for sustainability imply that the activities carried out today do not contribute to the further destruction of the ecological balance necessary for the continuation of quality life, but also that they allow future generations to benefit from a set of resources that will enable them to have at least the same level of quality of life and availability of resources as today. In this case, the productive activities under analysis have in their favour, from this perspective, the fact that they have historically been in communion with the environment, making landscapes evolve in a dynamic, interactive, balanced way, rebuilding the natural habitats where they are installed. However, the changes resulting from the installation of intensive olive groves, the consequences for the ecological balance of the regions where these crops are located, and the change in the form of production (for example, family farms have given way to financial companies that exploit this crop in the same way as any other economic and financial asset) mean that the effects of this form of production on territorial sustainability and the balance of the landscape need to be studied in depth.

As stated before, this is currently gaining a more significant dimension in the southern part of the country, specifically in the Alentejo region, where the Alqueva dam is located. Alentejo region is, until our days, a territory and landscape with strong rural identity. The rural world, could be defined as "a complex and multi-dimensional phenomenon, referring to a set of distinct communities and territories - albeit overlapping, articulated and interconnected - characterised by diverse activities such as agriculture, handicrafts, small and medium-sized manufacturing companies, commerce, personal and collective services (public and private), non-profit organisations, based not only in small villages, towns and county seats, but also in natural spaces and cultivated areas" (Diniz & Gerry, 2009: 526-527).

Alentejo, Portugal's largest region, represents 1/3 of the country's territory, around 50% of the Utilised Agricultural Area (UAA) in mainland Portugal (Eurostat, 2022) and is the main producing region at national level. The region excels particularly in the production of cereals, olive groves, vineyards, cork and extensive livestock farming (INE, 2021). In Alentejo, 13% of employment is concentrated in the primary sector (agriculture, forestry and fishing) and this sector accounts for around 8.8% of the region's Gross Domestic Product (GDP) (INE, 2021).

In recent years, there has been sustained growth in vegetable and fruit production, particularly in areas covered by modern irrigation systems such as the Alqueva dam project (EDIA, 2022). The olive-growing sector is of strategic importance to the Alentejo economy. Olive oil production reached, in 2024, 180,000 tonnes, representing an increase of 12% over the previous year. The Alentejo region accounts for more than 80% of Portuguese olive oil production, mainly due to its 66,000 hectares of intensive hedge olive groves (with more than 1,500 olive trees per hectare), of which more than 50,000 have been planted in the last 10 years (INE, 2025).

The growing appreciation of the Mediterranean diet, recognised as Intangible Cultural Heritage of Humanity by UNESCO, has contributed to increasing exports and strengthening the competitiveness of olive oil produced in the region (UNESCO, 2013; DGAV, 2023). Alentejo's agri-food exports have shown sustained growth, with the main products exported being wine, olive oil, cork and nuts (INE, 2023). Agricultural producers have endeavoured to make farming practices more sustainable, which has contributed to access to more demanding and environmentally conscious markets, promoting the external competitiveness of the Alentejo agri-food sector.

Intensive agriculture has arisen due to the need to increase food production to answer to the growing world population, using technologies and a set of resources to maximize income per cultivated area. This approach aims to meet the demand for food, particularly in regions with high population density and limited resources. However, it is very clear today that

agricultural production must endeavour to be compatible with the promotion of sustainability, due to the need to respect the planet's limits and preserve resources. It is well known that the intensification of agricultural production leads to soil degradation, water contamination, loss of biodiversity and an increase in greenhouse gas emissions, among others (e.g. Gómez-Limón & Riesgo. 2012). The definition of sustainability is commonly accepted as the ability of current communities to carry out their activities using resources in a way that does not compromise the availability of resources or the quality of life of future generations (WCED, 1987). Furthermore, given that the use of resources is not uniform across all regions/continents, with major asymmetries between developed and developing countries and regions, it is also important to bear in mind that the use of resources must take care not only of future generations, but also of current generations who still need to increase their quality of life and their levels of development (Simões Lopes, 1984).

Considering the urgency of reconciling the efficiency of agricultural production, especially olive growing, with environmental preservation and the quality of life, and noting also that legislation in the field of land use planning is insufficient to promote the desired balance, this research intends to reflect on some of the effects of the intensification of agricultural practices, particularly in the case of olive groves, and share the knowledge acquired through the development of various sustainability criteria developed under the Olive Oil of Alentejo Sustainability Programme (OASP), related to Human Communities, Landscape Management, and Biodiversity, in the context of contemporary challenges. Under this Programme, criteria were developed both for the planning and implementation of new olive groves as for the management of existing olive groves. The aim was to increase biodiversity, achieve more appropriate management of landscapes and ecosystems, promote greater local and regional retention of the economic value created, and foster a fruitful relationship with the surrounding communities. It is a tool that identifies a set of mechanisms to mitigate the negative territorial effects of intensive agriculture and promotes sustainability, in a holistic manner, in the areas of production, society and the environment. For this, after this introduction the paper continues with a reflection about instruments for land use planning and management and territorial governance for sustainable development. The third section discusses the contribution of sustainability plans and programs as instruments for promoting territorial development. In the fourth section an overview about the Olive oil of Alentejo Sustainability Program is presented, as a more detailed description about the criteria related to the issues of regional development and landscape, namely, ecological infrastructure, biodiversity and identity. The paper concludes with a brief section of final remarks.

2. Instruments for Land Use Planning and Management and Territorial Governance for Sustainable Development

Territory is now a critical dimension of economic, social, and environmental development. The life and quality of life of local communities depend on a balanced territorial organization. The approval of the Law on Spatial Planning and Urbanism (in 1998; modified in 2014 by the Law 31/2014, 30th May) granted this area of public policy – spatial planning – the appropriate normative status, resulting from its definition as a Fundamental National Task.

Furthermore, Spatial Planning, as a public policy, is no longer limited to the physical organization of the territory (the organization of infrastructure networks and the delimitation of urban and rural areas) and now integrates a dimension of development and territorial economic and social cohesion, thus merging Spatial Planning with Territorial Development.

This planning policy is implemented through the territorial management planning system, organized within a framework of coherent and coordinated interaction, that includes four class of territorial management instruments: territorial development instruments, territorial planning instruments, sectoral policy instruments, and, finally, special instruments. These are also organized at four levels: national, regional, intermunicipal and municipal (DL 80/2015, 14th May).

The National spatial planning policy program establishes strategic options relevant to the organization of the national territory, constitutes the reference framework to be considered in the preparation of other territorial programs and plans, and it is an instrument for cooperation with other Member States in view of the organization of the European Union's territory.

Regional programs define the regional strategy for territorial development, integrating the options established at the national level and considering sub-regional and municipal local development strategies, constituting the reference framework for the development of inter-municipal programs and plans and municipal plans.

In Alentejo, this regional spatial planning program – PROTA (CCDRA, 2010) establishes a link with the national and regional planning dynamics carried out under QREN 2007-2013 – National Strategic Reference Framework (RCM 86/2007, 3rd July) and PRODER 2007-2013 – Rural Development Program (MAMAOT, 2011). The latter specifically for the agricultural and forestry sectors and rural development.

This link seeks to integrate and coordinate territorial policies with the programming policies for interventions co-financed by the European Union's Structural and Cohesion Funds, with a view to ensuring greater sustainability of the desired development trajectory and greater efficiency and effectiveness of action measures. Strengthening social, territorial, and environmental cohesion as factors of competitiveness and sustainable development.

Among other strategic territorial directives, PROTA (CCDRA, 2010) points out:

- the strategic role of agriculture and rural development and the qualification of the transformation processes associated with them, particularly those driven by the Alqueva multi-purpose project and other hydro-agricultural developments;
- that agriculture plays an important role in soil and biodiversity conservation. Many of the most characteristic natural values of Mediterranean ecosystems have remained in a favourable state of conservation, benefiting from cultural practices associated with traditional agro-forestry-pastoral use;
- however, certain more intensive forms of agriculture have had a negative impact on the conservation of soil, water, and wild flora and fauna.

Recent developments in both infrastructure supporting agricultural activity, with a considerable increase in irrigated land in Alentejo, and the global situation, with a significant increase in raw material prices and the resulting global food crisis, as said before having significantly altered the regional production framework and created conditions for the evolution of Alentejo agriculture as a leading economic activity.

From this perspective, the regional program establishes guidelines for municipal plans to accommodate the new reality of the agricultural sector, without forgetting the responsibility to guarantee the protection of resources and natural heritage, associated with the importance of ecosystem services, in their multiple dimensions:

a) Promote regional coordination to improve conditions for strengthening strategic value chains associated with the exploration and transformation of various natural and endogenous resources and the positive dynamics of the emergence of new activities.

b) Promote increased competitiveness in agricultural and forestry production through the creation and development of business practices, aiming to orient production towards the market, through innovation and the establishment of strategies from a sectoral perspective aiming at territorial, social, and economic dynamization and sustainability.

c) Promote the sustained valorisation of natural, landscape, and heritage resources in rural areas, valuing the positive externalities created by agroforestry systems and the maintenance of natural and landscape values associated with rural areas, as well as optimising the use of natural resources to ensure the systems' durability.

d) Contribute to the economic and social revitalisation of rural areas and to strengthening their attractiveness, through economic development and the creation of employment opportunities, in an integrated strategy of diversification of activities, accompanied by the acquisition of skills of the local populations.

e) Promote greater levels of integration and cooperation among entities and institutions in the field of scientific research and technological development, establishing a regional network of infrastructures and institutions with the aim of promoting regional scientific development capabilities, increasing the transfer of knowledge and technology to companies, and diversifying and modernising the productive fabric towards areas of greater innovation and technological intensity.

f) Promote regional coordination to improve conditions for strengthening strategic value chains associated with the exploration and transformation of various natural and

endogenous resources and the positive dynamics of the emergence of new activities.
Strong cooperation will be needed to ensure the sustainable management of rural areas and natural resources, conceived as an objective to be achieved, whether directly involved in the area and the use of resources, or indirectly, by companies, as actors in the implementation of environmentally sustainable management. The focus must be on the conservation of the natural and landscape values associated with rural areas and the valorisation of the positive externalities created by agroforestry systems, as well as on optimizing the use of natural resources.

3. Sustainability plans and programs as instruments for promoting territorial development

In recent decades – particularly the last three – the concept of sustainability has gained increasing prominence in the formulation of public policies and instruments for territorial development and planning. As highlighted in the previous section, the various legally mandatory plans and programs incorporate sustainability principles through comprehensive territorial strategies addressing environmental, social, and economic dimensions at the national, regional, subregional and local levels.

However, the specific characteristics of each territory often requires the development of complementary structural strategies that focus on concrete issues. These strategies aim to promote integrated and balanced growth, following the principles of place-based approaches (Barca, 2009, Barca et al., 2012) and are aligned with national, European, and international policy frameworks, including the United Nations Sustainable Development Goals (UN, 2015) that call for a commitment to sustainability through the promotion of innovation, the pursuit of sustainable economic growth, and the diversification of economic activities (Parrilla-González & Ortega-Alonso, 2022). Their objectives include the definition of concrete actions to address complex challenges such as climate change, social inequalities, and economic disparities, with the active involvement of diverse stakeholders (UN, 2015; Biermann et al., 2017). A defining feature of these strategies is their cross-disciplinary nature, particularly the promotion of collaborative networks among universities, research centres, and local communities. This dynamic facilitates the translation of scientific research into practical responses to territorial challenges. However, as stated by Marsden (2012:213), this comprehensive approach involves the incorporation of “a multitude of theoretical perspectives, cross-scale dynamics and approaches”, meaning “one of the largest scientific challenges of the day”.

In Portugal, beyond the legally mandated frameworks, various sustainability-related plans and programs have been implemented at different governance levels. These include local and regional climate action plans, Local Agenda 21 initiatives, municipal environmental plans, or strategic regional plans for tourism, among others such as the Action National Program Against Desertification. While their scope and content may vary, these initiatives share a common orientation toward long-term outcomes, seeking to provide strategic guidance for short and medium-term action. Participation from stakeholders, decision-makers, and civil society is actively encouraged to ensure legitimacy and effectiveness.

Sustainability plans or programs, though generally non-mandatory, establish sets of goals, indicators, and actions aimed at fostering continuous improvement in the performance of specific sectors or territories. They follow the core principles of sustainable development and frequently act as catalysts for structural change by creating synergies among local actors and promoting inclusive, participatory, and forward-looking territorial development (Ningrum et al. 2024). Their successful integration into broader development strategies is critical to promote sustainability.

By accounting for the identity and specificity of each territory, these plans or programs aim to generate economic value based on endogenous resources and to reinforce territorial cohesion. In doing so, they also contribute to improved quality of life through focused attention on environmental integrity and social equity. The overarching goal is to reduce regional disparities and ensure equitable access to opportunities and services (Coronato, 2020).

The assumptions of theory of endogenous development (Melo, 2009: 501) points out “the

importance of factors such as the involvement of local players in the analysis and decision-making processes, the local mobilisation of the territory's productive resources, the valorisation of factors and locally produced goods and services, the processes of creating or spreading innovations, the emerging gains from better local coordination of initiatives, the increase in locally retained added value and the territorial "internalisation" of the positive spill-over effects of public and private initiatives". These conditions emphasise the importance of local decision-makers, public, private and associative, as well as factors endogenous to the territory.

In the Alentejo region of Portugal, the growing pressure on natural resources and the intensification of agricultural systems have underscored the need to apply sustainability principles across different territorial contexts and sectors (Silveira et al., 2018).

One such example is the **OASP - Olive oil of Alentejo Sustainability Program**, a sustainability plan dedicated to the olive oil agricultural sector. Structured around the three pillars of sustainability - environmental, economic, and social - OASP brings together farmers, technicians, and public authorities in a joint effort to foster a culture of continuous improvement and shared responsibility (Lucas, 2023).

4. Olive oil of Alentejo Sustainability Program

4.1 An overview of the Program

Olive oil of Alentejo Sustainability Program (Lucas, 2023) is an innovative program aiming to promote and integrate sustainable agricultural practices into all phases of olive oil production, from the cultivation of olive trees to the extraction and marketing process. The aim is to increase and ensure quality and environmental responsibility in olive oil production in the Alentejo region, providing solutions to improve sustainability and competitiveness through more adequate practices. The focus is to reduce the environmental impacts of olive oil production and promote the responsible use of natural resources, while improving the profitability and competitiveness of production.

OASP was developed by a consortium between academia and the private sector - an added value for the program - in a continuous and mutual process of learning, bringing findings of recent research and technological subjects from academia to the business sector. The program follows the methodology adopted in a similar program for wine sustainability in Alentejo - Wine Alentejo Sustainability Program (https://sustentabilidade.vinhosdoalentejo.pt/en/wines-of-alentejo-sustainability-programme), both pioneer programs in Portugal.

The program establishes a certified system based on sustainability criteria, a holistic and comprehensive sustainable evaluation framework that encompasses the different and complementary aspects of environmental, social and economic dimensions. A total of 20 Chapters (141 criteria), including thematics such as olive production, landscape, biodiversity and ecosystem management, soil management, pests and diseases, irrigation, human resources, waste and surplus, quality of oil, water and air, packaging and components, cultural heritage, socioeconomic and regional development issues and connection with local communities, among others. This sustainability evaluation framework is based on four incremental levels of sustainability – pre-initial, initial, middle and developed – following a model of continuous improvement (Lucas, 2023).

Producers' participation in the program is voluntary. The evaluation is carried out by the producers themselves and validated by an external certified entity. The first step is to evaluate the current practices of olive grove and olive oil production, to answer the question "At which level am I for each criterion?"; next question is "What should I do to reach the next level of sustainability". Each level of each criterion provides guidance on more appropriate practices that producers can adopt to improve their performance, contributing in each criterion to an overall global level of performance required for certification.

In the next section, as an example, criteria related to **Socioeconomic, Regional Development and Connection with Surrounding Communities** and **Landscape, Biodiversity and Ecosystem Management** are highlighted.

4.2 About the contributions for regional development

The activity of agricultural companies has a wide variety of effects on the territory where

they are located. Identifying these effects and defining criteria to measure them, aiming at promoting the sustainability of olive-growing companies, is one of the components of the sustainability program presented in the previous section. The history of places shows that the installation of a company (or an activity) in a territory means that both are subject to mutual effects, both positive and negative. It is therefore a two-way relationship that creates mutual 'dependencies': the company influences the characteristics, rhythms and experiences of the local community and the latter, in turn, also conditions the company to an equal extent. Today's agricultural companies, in order to improve their patterns of sustainability, intends to adopt higher levels of awareness of the characteristics of the surrounding areas, seeking to make better use of the region's resources and fostering strong relations with communities, for example by creating jobs that are taken up by local residents, caring for the environment or establishing links with other companies and institutions. Thus, the framework for analysing the effects of these companies on the surrounding territory involves theoretical consideration based on the theory of endogenous development and considering the fundamental characteristics of the rural world.

Among the effects that are considered most relevant to promote higher levels of regional development are economic effects. These economic effects, where the impacts on production, income and employment stand out, the local contribution of companies can be very relevant. First and foremost because the realisation of production processes (mainly olive harvesting and oil production) leads to the use of local resources: for example, the land used to plant the olive groves, mills installations, among others. These are local resources that already exist or have been realised for this purpose, which increase the creation of economic value. The production of value takes the form of the result of sales of the products produced by the companies. These results are higher the greater the quantity produced and/or the greater the notoriety of the products. The income obtained in this way is distributed among the various participants in the production process (owners of land or other rented facilities, workers, suppliers, investors and/or company owners). From this distribution of income, the local community will receive more or less depending on the 'functional' links that exist with the company: for example, if the suppliers, workers, or entrepreneurs, landowners, inhabit in the local community, the distributed income will be (at least partially) retained and redistributed to the other activities, through the well-known Keynesian multiplier mechanism, that make up the life of the community.

Another very important local effect is job creation and labour qualification. In this case, the effect is greater the more workers live in the community surrounding the company. Job creation is the key to retaining (and/or attracting) the population in the territories. In the specific case of olive oil production, which takes place predominantly in the interior south of the country, where depopulation and ageing are strong characteristics, the possibility of settling and attracting an active population that helps to rejuvenate the population is a very important effect to consider in all the local impacts. Because of these characteristics, which means that the availability of labour is small, places with the greatest demand for agricultural workers have seen very significant migratory flows, especially of workers from the Indian sub-continent, which has posed very significant challenges in terms of the inclusion of these workers in local communities.

The effects of the presence of companies in these places are not limited to strictly economic issues. The way in which companies and other economic agents and communities relate and get to know each other is also very important. The nature and intensity of existing relationships depend on the way in which companies and other community institutions communicate with each other and are aware of their respective realities. Communication can be stimulated by companies or other institutions in the surrounding community and can take place, among other initiatives, through various actions such as open days, company outings/visits, informal talks or other participation in local organisations. The existence of efficient forms of communication leads to greater awareness of the characteristics and needs of companies and local communities. Some of the relevant issues in this area are related to the effect on the surrounding environment of the activities carried out by companies, such as the changes caused to local traffic (dust, speed, infrastructure, equipment, noise, etc.), the application of chemicals in production, soil erosion control and air quality, among others. The existence of (some) of these effects means that, either on their own initiative, by legal

imposition or by suggestion/negotiation with other local institutions, companies take some action to mitigate the local effects, specifically in terms of the effects of light (with measures to protect against the effects of lighting by reducing their incidence to the minimum necessary), noise (sound insulation, specific hours for certain activities, including 'idling') and traffic (limited speed, parking attendants at events, directional signs towards the company car park).

Another fundamental relation that can be established between olive-growing companies and other community institutions is through the joint development of socio-cultural activities. In this case, interactions between companies and other institutions in the local community can take different forms. For example, through school field trips to olive groves and mills, social work carried out by company employees in other institutions, support for activities in the areas of arts, culture and sport, promoted by Non-Governmental Organisations (NGO), Private Social Solidarity Institutions (IPSS) or local authorities, through financial or other support, which make possible to enrich the daily lives of the communities in the areas surrounding the companies.

Within this set of effects, it is also to highlight those that are felt in the field of environmental protection and enhancement, namely through the development of activities, collaboration with environmental organisations, habitat recovery, cleaning up forests, reservoirs and beaches, planting native trees, among others. This support can be financial or in terms of working time.

In the case of the Alentejo olive oil sustainability program (Lucas, 2023), the following factors were identified as relevant in the chapter on *Socio-economy, Development and Surrounding Communities*:

- Effect on direct job creation (skilled and unskilled): these criteria evolves from the situation in which the company does not directly hire human resources, to the situation in which the company does not consider the workers' place of origin, to the situation in which the company mostly hires workers from the region and grants benefits that promote their settlement in the region;
- Effects on Related Local Sectors: this is a criterion aimed at measuring links with local companies, which evolves from the absence of commercial relations with other companies in the region to the situation in which local companies are favoured by buying at least 50% of the current goods and services they need from them.
- Proportion of Production Exported: in this case, the company must evolve from the case in which the proportion of exports is low (less than 10 %) to the case in which the proportion of production exported is predominant (more than 50 %).
- Innovation and/or Knowledge Transfer: in this case the company is assessed from the situation in which the company does not carry out R&D activities or has relations with the scientific and technological system to the case in which the company uses specialised consultancy services, has relations with entities in the scientific and technological system and carries out R&D activities.
- Productive Efficiency: in this case the company is assessed to see if it fulfils all its financial and tax obligations, grows above the interest rate on passive operations, grows above the annual inflation rate and has the capacity to reinvest and distribute dividends.
- Communication and relations with communities and stakeholders: this criterion aims to identify the existence and operating conditions of existing communication channels between the company and members of the surrounding community, be the other companies, institutions or resident families.
- Awareness of the potential effects of 'neighbourhood' and community issues: this criterion assesses the consciousness of the attitudes and perceptions of 'neighbours' about the main issues that concern the company, the activities that can affect "neighbours" and community stakeholders and the need to communicate with 'neighbours' and community stakeholders and discuss relevant issues.
- Mitigation of the impacts of the activity on the lives of local populations: this criterion is fundamental in the relationship with the community as it assesses the company's knowledge of the effects it has on the community (light, noise, traffic,

odours,..), the actions it takes to mitigate them and the way it interacts with the community in this regard.

- Knowledge of local characteristics that may affect the company's activity: this assesses the company's comprehension of the characteristics of the local community that influence its activity, as well as the actions it takes to enhance (or mitigate) them, depending on their nature.
- The company's contribution to, and relationship with, the community: this criterion assesses the company's collaboration (or lack thereof) (proactive or reactive) with other organisations in the surrounding community and participation in community events.

The eleven criteria that comprise the chapter on socio-economy, regional development and the surrounding community emphasise aspects related to employment, productive efficiency, the characteristics of the company's interaction with the surrounding community and its contribution to promote development and quality of life.

4.3. About the landscape: ecological infrastructure, biodiversity and identity

Intensive agricultural systems must balance agricultural productivity with biodiversity, protection, conservation or improvement of ecological infrastructure, and maintenance of ecosystem services (MEA, 2005; Bommarco et al., 2013; Muñoz-Rojas and García-Ruiz, 2024) (Figures 1 and 2). Agricultural landscapes are characterized by dynamic land-use patterns, in which natural factors such as topography, water, soil, climate, vegetation and fauna interact each other and continuously with cultural elements such as architectural heritage, memory and land-use practices (Cancela, d'Abreu et al., 2004; Antrop, 2005).

Figure 1: Intensive and monocultural olive grove productions, Alentejo region, Portugal

© ANDRÉ PAXIUTA Source: Jornal "Público" (2021)

Figure 2: Diversified land-use (olive grove, vineyards, woodlands, crops, pastures, ponds, riparian areas) including intensive and traditional production systems, Alentejo region Portugal.

© MARIA FREIRE Source: own source

To ensure the appropriate installation and sustainable management of olive groves, an integrated landscape approach is essential to identify such links, to minimize landscape degradation, but also to increase its ecological and cultural value.

In the case of the Alentejo olive oil sustainability program (Lucas, 2023), the following eleven factors were identified as relevant in the chapter *Landscape, Biodiversity and Ecosystem Management*. These domains reflect natural and socio-cultural components (CE, 2000), in line with international agricultural practices (FAO, 2014) and Mediterranean agriculture and ecological knowledge (Freire, 2014; DGADR, 2022; Castiço & Cardoso, 2023; Muñoz-Rojas & García-Ruiz, 2024):

- Topography and water systems: this assessment identifies critical slopes, groundwater infiltration and recharge areas, natural drainage patterns, and watersheds. Management plans should maintain and/or introduce river corridors, respect and/or create buffer zones along watercourses (minimum 10 meters), and avoid altering basic terrain contours, such as ridges and drainage lines.
- Soils: this assessment identifies areas of high fertility, degraded soils, and land covered by reserve areas (National Agricultural Reserve - RAN and National Ecological Reserve - REN). Sustainable planting prioritizes soils with pedological characteristics suitable for olive groves, minimizing the risk of erosion, compaction, and contamination.
- Vegetation: this assessment identifies native, exotic, and invasive plant species and the ecological context in which they are found. The management plan should protect natural habitats and control invasive species, aiming to increase biodiversity and ecological connectivity. It should also include measures to offset/mitigate negative impacts resulting from potential vegetation destruction during olive grove establishment.
- Topoclimate: this assessment identifies the influence of topography on microclimates (e.g., low-lying, humid areas, north-facing slopes, and wind-

exposed areas). Management strategies adapted to these climatic conditions are encouraged, including avoiding olive groves in unfavourable areas, planting native species in wetter conditions, or installing hedges to reduce wind impacts.

- Protected natural and semi-natural habitats: this assessment identifies, and maps, protected habitats with protected status (e.g., Natura 2000 areas) to be preserved. Ecological compensation is a prerequisite for any intervention, through measures to create similar habitats and/or restore habitats to mitigate biodiversity loss (EEA, 2020).
- Wildlife habitats: this assessment identifies habitats to be preserved (e.g., rocky outcrops, riparian and lagoonal areas, nesting areas), but also those that should be improved through the creation of new habitats and ecological connectivity.
- Increasing biodiversity in olive groves: the strategy includes agricultural practices (e.g., maintaining existing and/or well-adapted native vegetation, establishing cover crops, pastures, and diversified hedgerows, mulching with shredded pruning material, and using animals such as sheep, chickens, or geese to control weeds or manage cover crops) that provide habitats for beneficial insects and reduce chemical treatment practices.
- Diversified landscape matrix: the strategy is based on the diversity of land use, the existence of ecological corridors, and the spatial configuration of olive groves, including natural habitat areas. The objective is to ensure that the landscape is resilient to heterogeneity and biodiversity (EC, 2020).
- Increasing areas of ecological interest: this assessment includes the conservation and improvement of soil, water and air, and the promotion of biodiversity (e.g., by protecting watercourses and surrounding protected areas, wetlands, ponds and agricultural ponds, woodlands, native oaks, monumental trees, hedgerows, stone walls, fallow land, areas with honey plants, and unproductive trees). These are essential for ensuring ecosystem services such as pollination, water regulation, and soil protection, but also for contributing to improved nature protection and restoration (EC, 2020).
- Potential for recreational tourism in rural areas: the strategy is based on the cultural, symbolic, and aesthetic value of olive grove landscapes as an important resource for nature tourism and environmental education. Activities such as observing/participating in parts of the olive cultivation process, trail networks, and visits to heritage areas and/or features diversify agricultural production.
- Landscape identity and character: the strategy consists of preserving the values resulting from the unique combination of natural and cultural characteristics associated with each specific place. Preserving these characteristics promotes local development and encourages local pride.

The adoption of these integrated management criteria promotes the multifunctionality of agricultural landscapes, combining production, conservation, and recreation (Freire et.al, 2021). This approach aligns with agriculture and ecological principles and the broader framework of sustainable agriculture (Altieri, 1999; Boller et al., 2004; Muñoz-Rojas & García-Ruiz, 2024).

The proposed measures go beyond mitigation. They value and promote ecological restoration, appropriate land use and resilience to climate change and socio-economic pressures. Progressive monitoring and management ensure the continuous improvement of productive, environmental and landscape results.

In conclusion, integrated landscape management, with emphasis on increasing the protection of resources and biodiversity, adequate diversity of agricultural uses associated with production and the valorisation of recreation, is seen as a promising strategy for reconciling agricultural productivity with environmental sustainability and rural development.

The scientific construction of this practical tool (for farmers, land managers and policy makers) is based on the objective of creating resilient and multifunctional Mediterranean landscapes, in addition to being considered a pedagogical tool, fundamental in this period of rapid transformation of this agricultural sector in Portugal.

5. Final Remarks

The intensification of olive groves and olive oil production is a reality that cannot be dismissed or ignored. The reasons outlined throughout this article for this fact are well-known and valid, especially considering territories like the Alentejo, which has a rural identity, a very low population density, and a very aging population. Valuing these territories from an economic perspective is a huge asset. However, it also means a huge pressure on natural resources and has had a negative impact on ecosystem preservation and territorial identity. Strategies aiming to promote sustainable production models must therefore be strengthened, where the economic component cannot override the environmental and social components - fundamental not only for environmental preservation, but also for the long-term economic viability of producers.

Despite the multiple international, European and national declarations, directives, regulations and laws (to name a few) related to sustainability and sustainable agriculture practices and the obligation to accomplish their requirements, most of them are developed in a sectoral way and place-neutral approaches. Its effectiveness depends on coordination between levels of governance, civil society involvement, and the ability to transform strategic objectives into concrete, monitorable actions.

In Alentejo, some producers are very aware of the issues posed by the intensification of the agriculture olive oil sector and have already put some efforts to minimise some of the negative impacts. However, isolated initiatives are not enough. It is necessary to engage all the producers, the communities, public and private institutions and organizations, academia and research centres, to create a well-grounded framework where everyone can contribute to a positive global outcome.

The Olive Oil of Alentejo Sustainability Program, based on a holistic and integrated approach, exemplifies and give insights, in a pedagogical way, on how the agricultural sector can move towards greater environmental, social, and economic responsibility, creating economic dynamism based on local resources and strengthening territorial identity and cohesion with respect for cultural and environmental concerns. Despite the initial costs that might occur at the beginning, for the producers, the growing demand for sustainable and certified products will pay off the initial investment. It offers benefits to producers, consumers, and the region, creating a more sustainable management for the sector. The program can be replicated in other olive oil-producing regions (inland or out) and the agricultural industry in general, as sustainability becomes one of the key criteria for long-term success. At last, lessons learned should be considered in the definition and implementation of public policies and informed decision-making.

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THE IMPACT OF INFORMATION TECHNOLOGIES ON SOCIAL COMMUNICATION AS A CATALYST FOR BUSINESS MANAGEMENT EFFICIENCY

Kushtrim UKA
PhD Candidate, University of Library Studies
and Information Technologies (ULSIT)
Sofia, Bulgaria
ukaa.kushtrim@gmail.com

Abstract

The rapid development of information technologies has significantly transformed the way social communication is conducted within business organizations, directly influencing managerial processes and organizational efficiency. In the context of the digital economy, technology-mediated social communication has become a key factor in coordinating activities, supporting decision-making, and achieving strategic objectives. The main purpose of this article is to analyze the role of information technologies in social communication and their impact on enhancing the efficiency of business management. The study is based on a combined methodological approach, integrating a theoretical analysis of relevant literature with empirical data collected through appropriate research instruments. The findings indicate that the integration of information technologies improves the quality of organizational communication, increases transparency, facilitates decision-making processes, and contributes to the optimization of managerial performance. The contribution of this study lies in expanding the theoretical framework on the relationship between social communication and business management, as well as in providing practical implications for managers seeking to enhance organizational efficiency through digital transformation.

Keywords: Information technologies; Social communication; Business management; Digital transformation; Organizational efficiency

JEL Classification: M15, O32, D83, J24

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1. Introduction

Digital transformation has brought profound changes to the way business organizations operate, communicate, and manage their resources. Information technologies have become strategic factors that directly influence organizational structures, institutional culture, and managerial processes (Laudon & Laudon, 2020). In this context, social communication within organizations has undergone a significant transformation, shifting from traditional forms to digital platforms that enable rapid, interactive, and continuous information exchange. Technology-mediated communication has become a fundamental component for coordinating activities, building professional relationships, and supporting managerial decision-making in increasingly dynamic business environments (Castells, 2010).

Although the scientific literature provides a considerable number of studies on information technologies and business management, many of these focus primarily on the technical aspects of technology or on its direct impact on financial performance. Relatively limited attention has been given to the role of social communication as a mediating mechanism between information technologies and managerial efficiency (Turban et al., 2015). This theoretical and empirical gap constrains a comprehensive understanding of how technology influences decision-making processes, organizational coordination, and managerial performance in business organizations. Within this context, the main objective of this study is to analyze the role of information technologies in social communication and their impact on enhancing the efficiency of business management. The study seeks to identify the ways in which information technologies improve the quality of organizational communication and to assess the effects of this improvement on managerial and decision-making processes, drawing on established theoretical and empirical approaches in the literature (Westermann et al., 2014). The scientific significance of this article lies in its contribution to expanding the interdisciplinary literature that connects social communication, information technologies, and business management, with particular emphasis on the mediating role of social communication in managerial processes. From a practical perspective, the study provides important implications for managers and business decision-makers who face the challenges of digital transformation and the need to enhance organizational efficiency (Brynjolfsson & McAfee, 2014).

2. Literature Review and Theoretical Framework

Contemporary literature on information technologies demonstrates that their impact on business organizations extends beyond process automation and improvements in technical infrastructure. Information technologies have evolved into central elements of social communication within organizations, directly influencing the ways in which individuals interact, exchange information, and make decisions (Castells, 2010). Numerous scholars emphasize that technology-mediated organizational communication constitutes a key component of modern management, as it affects knowledge sharing, activity coordination, and the development of professional relationships (Turban et al., 2015). In the context of social communication, information technologies have transformed traditional forms of interaction by creating digital platforms that enable continuous, rapid, and interactive communication. These developments have contributed to changes in traditional hierarchical structures, fostering more horizontal communication models and increasing employees' access to organizational information (Boyd & Ellison, 2007). From a business management perspective, organizational efficiency is closely linked to the quality of both internal and external communication. The integration of information technologies into social communication reduces informational uncertainty, enhances coordination among organizational units, and supports data-driven managerial decision-making (Laudon & Laudon, 2020). However, the literature also highlights that the benefits of technology are not automatic and depend on how it is accepted and utilized by individuals within organizations. Within this framework, the Technology Acceptance Model argues that the effective use of information technologies depends on perceived usefulness and perceived ease of use, which directly influence individuals' communicative behavior (Davis, 1989). Complementarily, the Diffusion of Innovations Theory explains that the adoption of new technologies within organizations is influenced by social, cultural, and communicative factors, emphasizing the role of communication in the spread of innovation (Rogers, 2003). An additional perspective

is provided by the socio-technical approach, which argues that technology and the organization's social system are interdependent and should be analyzed in an integrated manner. According to this approach, the effectiveness of information technologies in business management depends on their alignment with organizational structures, institutional culture, and social communication practices (Bostrom & Heinen, 1977). This perspective emphasizes that technology does not generate efficiency independently, but rather through its interaction with human and organizational factors.

3. Conceptual Framework and Research Hypotheses

The conceptual framework of this study is built on the premise that information technologies influence the efficiency of business management not only directly, but primarily through their role in improving social communication within organizations. In this sense, social communication serves as a mediating mechanism between the use of information technologies and managerial outcomes. This approach is supported by the literature, which emphasizes that technology creates organizational value only when it is effectively integrated into the communicative and social processes of the organization (Bostrom & Heinen, 1977; Westermann et al., 2014). Based on the Technology Acceptance Model, perceived usefulness and perceived ease of use of information technologies directly influence their acceptance and utilization by individuals, thereby shaping communication and collaboration practices within organizations (Davis, 1989). The successful use of information technologies enhances transparency, accelerates information exchange, and improves the quality of organizational communication—elements that are considered essential for effective decision-making and managerial coordination (Laudon & Laudon, 2020). Complementarily, the Diffusion of Innovations Theory suggests that the adoption of new technologies within organizations is a social and communicative process influenced by organizational structure, institutional culture, and communication networks (Rogers, 2003). This theory highlights the importance of social communication in the diffusion and institutionalization of information technologies, shaping the ways in which they are transformed into effective managerial tools. Drawing on these theoretical perspectives, the study conceptualizes business management efficiency as the result of the interaction between the use of information technologies and the quality of social communication within the organization. Managerial efficiency is manifested through improved decision-making, enhanced coordination of activities, process optimization, and increased organizational performance (Brynjolfsson & McAfee, 2014). Within this framework, information technologies are not treated merely as technical infrastructure, but as social and organizational factors that shape managerial practices. Based on the proposed conceptual framework and the existing literature, the following research hypotheses are formulated:

Hypothesis 1: The integration of information technologies has a positive impact on the quality of social communication within business organizations.

Hypothesis 2: The quality of social communication positively influences the efficiency of business management.

Hypothesis 3: Information technologies have a positive impact on the efficiency of business management.

Hypothesis 4: The impact of information technologies on business management efficiency is mediated by the quality of social communication.

These hypotheses aim to empirically test the relationships among information technologies, social communication, and managerial efficiency, thereby providing a deeper understanding of the mechanisms through which digital transformation influences business management. The proposed conceptual framework serves as an analytical basis for structuring the research methodology and for analyzing the empirical results.

4. Research Methodology

This study is based on a mixed methodological approach, integrating qualitative and quantitative elements in order to ensure a comprehensive and balanced understanding of the role of information technologies in social communication and their impact on business management efficiency. The use of this approach is appropriate for studies that aim to analyze complex relationships among technological, social, and organizational factors (Creswell &

Plano Clark, 2018). From a conceptual perspective, the study adopts an explanatory research design, as it seeks to test the relationships among the variables identified in the conceptual framework, namely the use of information technologies, the quality of social communication, and business management efficiency. The research design is aligned with the study's hypotheses, enabling the empirical examination of both direct and mediating effects (Hair et al., 2019).

Data collection was conducted through structured research instruments, primarily questionnaires designed to measure managers' and employees' perceptions regarding the use of information technologies in social communication and their effects on managerial processes. The study sample includes business organizations operating in various sectors, ensuring diversity in organizational size and fields of activity. The sampling strategy was purposive, focusing on organizations that have integrated information technologies into their communication and management processes. This approach allows for the analysis of the actual impact of technology in concrete organizational settings and enhances the practical validity of the findings (Saunders et al., 2019). Data analysis was performed using appropriate statistical techniques, including descriptive and inferential analyses, with the aim of testing the study's hypotheses. To assess the relationships among variables and the mediating effect of social communication, analytical models suitable for organizational and managerial research were applied (Baron & Kenny, 1986). Qualitative data were analyzed through thematic analysis, identifying patterns and themes that support the interpretation of quantitative results.

To ensure the reliability and validity of the study, established methodological standards of scientific research were followed. Measurement instruments were tested for internal consistency and conceptual clarity, while the data collection process adhered to ethical research principles, guaranteeing anonymity and informed consent of participants (Bryman, 2016). This methodological approach provides a solid empirical foundation for analyzing the role of information technologies in social communication and their impact on business management efficiency.

5. Analysis of Empirical Research Results

This chapter presents the analysis of the results of the empirical research conducted through a structured questionnaire, developed with the participation of 88 respondents from various organizational sectors, including the private sector, the public sector, non-profit organizations, as well as education and research institutions. The primary objective of this research was to assess the role of information technologies and knowledge management in organizational communication and overall organizational performance, with particular emphasis on human resource management and operational efficiency. The data analysis focused on interpreting the distribution of responses across the thematic categories of the questionnaire, including respondents' demographic characteristics, knowledge management practices, the use of digital technologies, their impact on organizational performance, as well as the challenges and improvement needs identified by the participants themselves. For this purpose, descriptive analysis methods were employed, enabling a clear presentation of dominant trends and key patterns emerging from the empirical data.

The results presented in this chapter provide a realistic overview of the current state of knowledge management and the use of information technologies in the organizations included in the study, reflecting the perceptions and practical experiences of organizational actors. In this context, the analysis serves as an empirical foundation for further theoretical discussion and for drawing relevant conclusions that are directly linked to the study's objectives and the hypotheses formulated in the preceding sections of the paper.

6. Data Analysis

6.1 Position in the Organization

The majority of respondents were regular employees (79%), followed by personnel in logistical support roles (10%). Administrative staff accounted for 7% of the sample, while managers represented 4%. No respondents identified as Information Technology (IT) specialists

Table 1. Respondents' Current Position in the Organization

Position	Frequency (%)
Manager	4
Administrative staff	7
Information Technology (IT) specialist	0
Regular employee	79
Other (Logistical support)	10
Total	**100**

The data collected regarding respondents' current positions within their organizations indicate a distribution that primarily reflects the perspectives of operational and administrative employees, thereby providing a realistic picture of everyday organizational practices. As shown by the results, 79% of respondents are regular employees, indicating that the majority of participants are directly involved in the operational and functional processes of their organizations. This group is particularly important for the study, as their perceptions reflect how information technologies and knowledge management function in practice and how they influence day-to-day organizational performance. A smaller proportion of respondents, 7%, represent administrative staff, who typically play a key role in information circulation, documentation, and organizational coordination. Meanwhile, 4% of respondents hold managerial positions, indicating a relatively limited representation of senior management levels within the sample. Although this percentage is small, their contribution remains important for interpreting strategic attitudes toward knowledge management and the use of technology. Additionally, 10% of respondents are engaged in logistical support functions, representing roles that, although often not directly involved in decision-making, are significantly affected by information systems and knowledge management practices. The presence of these categories enriches the sample and contributes to a more comprehensive understanding of organizational dynamics.

Overall, the structure of the sample indicates that the research is primarily grounded in the experiences of operational and administrative staff, providing valuable empirical data for analyzing the impact of information technologies and knowledge management at the practical level of organizational functioning.

6.2 Sector of the Organization

Most respondents were employed in the private sector (77.0%). Non-profit organizations accounted for 8.0% of respondents, while 7.5% worked in public–private organizations. The public sector represented 6.0% of the sample, and only 1.5% of respondents were affiliated with education and scientific research institutions.

Table 2. Sector of the Organization

Sector	Frequency (%)
Public sector	6.0
Private sector	77.0
Education and scientific research	1.5
Non-profit organizations	8.0
Other (Public–Private)	7.5
Total	**100.0**

The analysis of data related to the sector of the organizations in which respondents operate indicates a clear dominance of the private sector, which is represented by 77% of the participants in the study. This result suggests that the findings primarily reflect the experiences and practices of private organizations, which are typically characterized by a

stronger orientation toward operational efficiency, organizational flexibility, and the pragmatic adoption of information technologies for knowledge management. The public sector is represented by 6% of respondents, indicating a more limited participation of public institutions in the sample. Nevertheless, the presence of this sector remains important for capturing structural and institutional differences in the use of technologies and knowledge management practices, particularly in the context of administrative procedures and organizational governance. A more modest representation is also observed in the education and scientific research sector, with 1.5%, as well as in the non-profit sector, with 8%. Although these categories are represented by lower percentages, they contribute to the diversity of the sample and provide valuable perspectives on knowledge management practices in contexts where the creation, preservation, and dissemination of knowledge constitute an integral part of the organizational mission.
Furthermore, 7.5% of respondents are part of public–private organizations, reflecting hybrid forms of organization that combine elements of both the public and private sectors. This category is particularly relevant for the study, as such organizations often face dual challenges in knowledge management and in the integration of information technologies, due to the interplay between administrative and market-oriented logics.

6.3 Professional Experience

The majority of respondents (59%) had between 6 and 10 years of professional experience. A further 28% reported having 3–5 years of experience, while 9% had less than 3 years of experience. Only 4% of respondents had more than 10 years of professional experience. These findings indicate that the sample was predominantly composed of individuals with moderate to substantial professional experience.

Table 3. Respondents' Professional Experience

Professional Experience	Frequency (%)
Less than 3 years	9
3–5 years	28
6–10 years	59
More than 10 years	4
Total	**100**

The analysis of data related to respondents' professional experience indicates that the sample included in the study is characterized by a relatively high level of work experience, which enhances the credibility of the perceptions and assessments provided regarding knowledge management and the use of information technologies within organizations. The results show that 59% of respondents have 6 to 10 years of professional experience, representing the largest group in the sample. This segment includes employees who have moved beyond the initial stages of their careers and have acquired stable knowledge of organizational processes, managerial structures, and workplace practices. A substantial proportion of respondents, 28%, report 3 to 5 years of professional experience, indicating the presence of a group of relatively young but already professionally consolidated employees. This group offers valuable perspectives on adaptation to new technologies and on how knowledge management is integrated into contemporary work practices.
On the other hand, 9% of respondents have less than 3 years of professional experience, representing employees in the early stages of their careers. Although this category constitutes the smallest proportion of the sample, its contribution is important in reflecting the perceptions of the younger workforce, which is typically more exposed to digital technologies and modern communication tools. In contrast, only 4% of respondents report more than 10 years of professional experience, indicating a more limited representation of highly experienced staff. Nevertheless, this group remains significant for the analysis, as it includes individuals with deep institutional knowledge and long-term experience in managing organizational processes.

6.4 Knowledge Management Practices

Information collection and storage was the most commonly implemented information and knowledge management practice, reported by 42% of respondents. Information sharing within teams was identified by 33% of participants, while 19% indicated the use of technologies for information management, such as digital platforms. Archiving or disposing of outdated information was reported by 6% of respondents. No respondents selected "None of the above," suggesting that all organizations in the sample had adopted at least one information and knowledge management practice.

Table 4. Information and Knowledge Management Practices Implemented in the Organization

Practice	Frequency (%)
Information collection and storage	42
Information sharing within teams	33
Use of technologies for information management (e.g., digital platforms)	19
Archiving or disposal of outdated information	6
None of the above	0
Total	**100**

The analysis of results related to information and knowledge management practices indicates that the organizations included in the study are primarily oriented toward basic and traditional knowledge management practices, while the adoption of more advanced digital approaches remains relatively limited. As evidenced by the data, 42% of respondents report that information collection and storage are practiced in their organizations, representing the most widespread practice. This finding suggests that the primary focus of knowledge management remains on documentation and information preservation rather than on its active utilization for strategic purposes. A considerable proportion of respondents, 33%, indicate that information sharing within teams is practiced in their organizations, suggesting that horizontal communication and knowledge sharing at the operational level are present, but not dominant. This implies that, although a certain level of collaboration among employees exists, these practices are not yet fully institutionalized as part of a structured knowledge management system. By contrast, only 19% of respondents report the use of technologies for information management, such as digital platforms, indicating a relatively low level of technological integration in knowledge management practices. This result suggests that, although information technologies are present in many organizations, they are not yet systematically leveraged to support knowledge management processes. A very small proportion of respondents**, 6%,** emphasize the practice of archiving or disposing of outdated information, implying that information lifecycle management is not a high priority for most organizations. This may lead to the accumulation of unnecessary information and difficulties in accessing relevant knowledge. It is noteworthy that none of the respondents (0%) reported a complete absence of information and knowledge management practices, indicating that all organizations included in the study have at least a minimal form of such practices in place. However, the overall results suggest that knowledge management in the analyzed organizations is still at an early or transitional stage, with a strong need for further development—particularly in terms of digitalization and the institutionalization of knowledge management processes.

6.5 Information and Knowledge Management for Organizational Success

A substantial majority of respondents perceived information and knowledge management as essential for organizational success. Specifically, 62% rated it as very important, while an additional 25% considered it important. Only 12% viewed it as moderately important, and 1% regarded it as slightly important. No respondents indicated that information and knowledge management was not important at all. These findings demonstrate a strong consensus regarding the strategic value of effective information and knowledge management in achieving organizational success.

Table 5. Importance of Information and Knowledge Management for Organizational Success

Importance Level	Frequency (%)
Very important	62
Important	25
Moderately important	12
Slightly important	1
Not important at all	0
Total	**100**

The results of the question addressing the importance of information and knowledge management for organizational success indicate a very high level of awareness among respondents regarding the strategic role of this process in organizational functioning and performance. As reflected in the data, 62% of respondents evaluate information and knowledge management as very important, identifying it as a key factor for achieving organizational objectives and ensuring long-term sustainability. An additional 25% of respondents consider information and knowledge management to be important, meaning that, in total, 87% of participants demonstrate a strong and positive perception of the importance of this dimension for organizational success. By contrast, 12% of respondent's rate information and knowledge management as moderately important, while only 1% consider it slightly important. It is noteworthy that none of the respondents (0%) evaluated information and knowledge management as not important at all, indicating that this concept is widely accepted as an integral component of the modern functioning of organizations. Overall, these results reveal a clear discrepancy between the high level of awareness regarding the importance of knowledge management and the relatively limited level of its practical implementation, as evidenced in the analysis of the preceding question. This discrepancy underscores the need to move from a declarative understanding of the importance of knowledge management toward the development of concrete mechanisms, organizational structures, and technological solutions that translate this perceived importance into measurable organizational outcomes.

6.6 Technologies Used

Collaboration and communication tools were the most widely used technologies for knowledge management and knowledge sharing, reported by 56% of respondents. Cloud platforms, such as Microsoft 365 and Google Workspace, were used by 38% of participants. ERP systems, including SAP, Microsoft Dynamics, and Odoo, accounted for 4% of responses, while AI-based solutions were reported by only 2% of respondents. No participants indicated that their organizations lacked specific technologies for knowledge management, suggesting that all surveyed organizations employed at least one technological solution to support knowledge-related activities.

Table 6. Technologies Used for Knowledge Management and Knowledge Sharing

Technology Used	Frequency (%)
Cloud platforms (e.g., Microsoft 365, Google Workspace)	38
Collaboration and communication tools (e.g., Microsoft Teams, Zoom, Slack, WhatsApp)	56
ERP systems (e.g., SAP, Microsoft Dynamics, Odoo)	4
Artificial intelligence (AI)-based solutions	2
No specific technologies are used for knowledge management	0
Total	**100**

The results of the question addressing the use of technologies for knowledge management and

knowledge sharing indicate a clear organizational orientation toward practical and easily accessible tools, while the adoption of more advanced systems remains relatively limited. As evidenced by the data, 56% of respondent's report using collaboration and communication tools such as Microsoft Teams, Zoom, Slack, and WhatsApp, making this category the most dominant. This finding suggests that knowledge management in most organizations is primarily supported through everyday communication and informal or semi-formal information exchange, rather than through structured systems specifically designed for knowledge management. A substantial proportion of respondents, 38%, report using cloud platforms such as Microsoft 365 and Google Workspace. These platforms provide more structured opportunities for document storage, sharing, and collaborative work, indicating a moderate level of digitalization in knowledge management processes. However, the fact that this category ranks below communication tools suggests that the advanced functionalities of these platforms are not always systematically leveraged for strategic knowledge management purposes. By contrast, the use of ERP systems is reported by only 4% of respondents, while AI-based solutions are mentioned by just 2%. These results indicate that more sophisticated technologies—which could potentially support advanced knowledge analytics, process automation, and strategic decision-making—are still at very early stages of adoption among the organizations included in the study. It is particularly noteworthy that none of the respondents (**0%**) reported a complete absence of technologies for knowledge management. This indicates that all participating organizations have at least a basic level of technological support for information exchange, although the degree of sophistication and institutionalization of these technologies varies considerably.

6.7 Perceived Effectiveness of Technologies Used for Knowledge Management

The findings indicate a generally positive perception of the effectiveness of technologies used for knowledge management. More than half of the respondents (55%) rated these technologies as effective, while 32% considered them very effective. A smaller proportion of participants (11%) viewed them as moderately effective, and only 2% perceived them as slightly effective. No respondents reported that the technologies were not effective at all. Overall, 87% of respondents assessed knowledge management technologies as either effective or very effective, highlighting their significant contribution to supporting knowledge-related processes within organizations.

Table 7. Perceived Effectiveness of Technologies Used for Knowledge Management

Effectiveness Level	Frequency (%)
Very effective	32
Effective	55
Moderately effective	11
Slightly effective	2
Not effective at all	0
Total	**100**

The results of the question related to the evaluation of the effectiveness of technologies used for knowledge management indicate an overall positive perception among respondents regarding the role these technologies play in supporting organizational processes. As reflected in the data, 32% of respondents assess the technologies in use as very effective, while 55% consider them effective. Accordingly, a total of 87% of participants express a clearly positive assessment of the effectiveness of technologies in knowledge management. A smaller proportion of respondents, 11%, evaluate the technologies as moderately effective, suggesting that for some participants the full potential of these technologies has not yet been fully exploited. This may be associated with factors such as insufficient staff training, the complexity of existing platforms, or the lack of effective integration between technology and organizational processes. Only 2% of respondents assess the technologies as slightly effective, and it is noteworthy that none of the respondents (0%) consider them not effective at all. This finding underscores the fact that information technologies, regardless of their

varying levels of sophistication, are widely perceived as functional and useful tools for managing and sharing knowledge within organizations. Overall, these results indicate a strong alignment between the use of technologies for knowledge management and the perceived effectiveness of these technologies, suggesting that current investments in technological solutions have yielded positive outcomes in practice.

6.8 Organizational Performance and Knowledge Management

Respondents identified several ways in which knowledge management contributes to organizational performance. The most frequently reported contributions were increased operational efficiency (33%) and improved human resource management (33%). Additionally, 13% of respondents indicated that knowledge management enhances organizational communication, while 12% stated that it fosters innovation. Facilitating strategic decision-making was reported by 9% of participants. These findings suggest that knowledge management is primarily valued for its role in improving organizational efficiency and supporting effective human resource practices, while also contributing to communication, innovation, and decision-making processes.

Table 8. Contributions of Knowledge Management to Organizational Performance

Contribution	Frequency (%)
Fosters innovation	12
Increases operational efficiency	33
Facilitates strategic decision-making	9
Improves human resource management	33
Enhances organizational communication	13
Total	**100**

The results of the question examining the ways in which knowledge management contributes to organizational performance indicate that its impact is perceived primarily in the functional and human dimensions of organizations. As reflected in the data, 33% of respondents assess that knowledge management increases operational efficiency, while an equally high proportion (33%) emphasize its role in improving human resource management. These findings suggest that knowledge management is predominantly viewed as a practical instrument that supports the optimization of work processes and the development of human capacities within organizations. A smaller proportion of respondents, 13%, highlight that knowledge management enhances organizational communication, indicating that improved information sharing and circulation contribute to increased coordination and collaboration among individuals and organizational units. Similarly, 12% of respondents perceive knowledge management as a driver of innovation, suggesting that this dimension is seen less as a direct source of innovation and more as an indirect support for innovative processes. Meanwhile, only 9% of respondents emphasize that knowledge management facilitates strategic decision-making, indicating that the link between knowledge management and decision-making at the strategic level has not yet been fully consolidated in the perceptions of organizational actors. This result may be interpreted as an indication that knowledge management is more frequently applied at operational and administrative levels rather than being utilized as a strategic instrument for the long-term direction of the organization.

6.9 Integration of the technology in your organization

The results indicate that the integration of technology with knowledge management has a substantial impact on organizational performance and operations. A total of 39% of respondents reported that this integration affects their organization to a very great extent, while 37% indicated to a considerable extent. Additionally, 21% perceived the impact as moderate, and only 3% considered it to be small. No respondents stated that the integration of technology and knowledge management had no impact at all. Overall, 76% of participants reported a considerable or very great impact, underscoring the critical role of technological tools in enhancing knowledge management processes and organizational effectiveness.

Table 9. Extent to Which the Integration of Technology with Knowledge Management Affects the Organization

Extent of Impact	Frequency (%)
To a very great extent	39
To a considerable extent	37
To a moderate extent	21
To a small extent	3
Not at all	0
Total	**100**

The results of the question assessing the extent to which the integration of technology with knowledge management affects organizational functioning indicate a highly positive and consistent perception among respondents regarding the transformative role of this integration. As reflected in the data, 39% of respondents assess that the integration of technology with knowledge management has an impact to a very great extent, while 37% consider its impact to a considerable extent. Accordingly, a total of 76% of participants report a high level of impact of technological integration within their organizations. A proportion of 21% of respondents evaluate this integration as having a moderate impact, suggesting that although technology is present, its full potential has not yet been fully realized across all organizations. This may be related to factors such as the lack of clear knowledge management strategies, limitations in human resource capacities, or the partial integration of technologies into key organizational processes.

Only 3% of respondent's report that the integration of technology with knowledge management has an impact to a small extent, and it is noteworthy that none of the respondents (0%) indicate a complete lack of impact. This finding demonstrates that the integration of technology with knowledge management is widely perceived as an essential component of the modern functioning of organizations.

6.10 Challenges and Recommendations

The most frequently reported challenge in knowledge management was the complexity of existing technologies, cited by 38% of respondents. This was followed by resistance to knowledge sharing (29%) and lack of appropriate technologies (21%). Fewer respondents identified lack of staff skills in knowledge management (10%), while only 2% reported lack of support from top management as a challenge. Overall, the findings suggest that technical and organizational barriers—particularly system complexity and knowledge-sharing resistance—are the primary obstacles to effective knowledge management implementation.

Table 10. Main Challenges Faced by Organizations in Knowledge Management

Challenge	Frequency (%)
Lack of appropriate technologies	21
Resistance to knowledge sharing	29
Complexity of existing technologies	38
Lack of staff skills in knowledge management	10
Lack of support from top management	2
Total	**100**

The results of the question addressing the main challenges organizations face in knowledge management indicate that the most significant barriers are primarily related to technological and organizational aspects, while strategic and managerial factors are perceived as less problematic. As evidenced by the data, 38% of respondents identify the complexity of existing technologies as the main challenge in knowledge management. This finding suggests that, although technologies are present within organizations, their effective use is often hindered by non-user-friendly interfaces, insufficient system integration, or inadequate staff

training. A substantial proportion of respondents, 29%, emphasize resistance to knowledge sharing as a major obstacle. This challenge is directly related to the cultural dimension of organizations, where factors such as lack of trust, fear of losing professional status, or the absence of motivational mechanisms may hinder the sharing of knowledge among employees and organizational units. Meanwhile, 21% of respondents report the lack of appropriate technologies as a significant challenge, indicating that some organizations have not yet invested sufficiently in technological solutions that effectively support knowledge management. This finding is particularly relevant in the context of small and medium-sized organizations, where financial and technological resources are often limited. By contrast, only 10% of respondents identify the lack of staff skills in knowledge management as a major challenge, while 2% highlight the lack of support from top management. These relatively low percentages suggest that respondents perceive technological and cultural issues as more prominent than the absence of strategic commitment from senior leadership, although in practice these factors may be closely interconnected.

6.11 Knowledge management in your organization

Respondents identified staff training in knowledge management as the most necessary improvement (36%). This was followed by the development of more user-friendly platforms (26%). Additionally, 14% of respondents emphasized the need for clearer knowledge management policies, while both investment in new technologies and stronger support from top management were each selected by 12% of participants. These results suggest that human capacity development and system usability are perceived as the most critical areas for improving knowledge management effectiveness within organizations.

Table 11. Necessary Improvements for Knowledge Management in the Organization

Required Improvement	Frequency (%)
Development of more user-friendly platforms	26
Staff training in knowledge management	36
Investment in new technologies	12
Stronger support from top management	12
Development of clearer knowledge management policies	14
Total	**100**

The results of the question addressing the most necessary improvements for knowledge management in organizations clearly indicate that respondents' priorities are primarily oriented toward human capacity development and enhancing the usability of existing technologies. As reflected in the data, 36% of respondents identify staff training in knowledge management as the most essential improvement. This finding underscores the fact that, despite the presence of certain technologies and practices, insufficient staff skills and competencies remain a major barrier to the effective utilization of organizational knowledge. A substantial proportion of respondents, 26%, emphasize the development of simpler and more user-friendly platforms as a priority need. This result is directly linked to the findings of the previous question, where the complexity of existing technologies was identified as one of the main challenges. It suggests that improving system interfaces and platform functionalities could significantly increase both the adoption and effectiveness of technological tools in knowledge management. Meanwhile, 14% of respondents consider the development of clearer knowledge management policies to be necessary, highlighting the importance of formal frameworks and organizational guidelines for the institutionalization of knowledge management practices. This finding suggests that, beyond technological solutions and training initiatives, there is a clear need for normative and procedural clarity in this domain. On the other hand, 12% of respondents stress the need for investment in new technologies, while an equal percentage (12%) call for stronger support from top management. These proportions indicate that, although technology and leadership are recognized as important factors, respondents perceive them as less immediate priorities compared to human capacity development and improvements in the usability of existing systems.

7. Discussion of Results

The empirical findings of this study largely confirm the conclusions of contemporary literature regarding the role of information technologies and knowledge management in improving organizational performance. The results indicate that, although organizations demonstrate a high level of awareness of the strategic importance of knowledge management, its practical implementation remains primarily focused on basic forms of information collection, storage, and sharing, while the use of advanced technological systems remains relatively limited. This finding is consistent with the observations of Castells (2010), who emphasizes that the network society is not defined merely by the presence of technology, but by the way it is integrated into organizational structures and decision-making processes.
The dominance of communication and collaboration tools, such as Microsoft Teams and similar platforms, over structured knowledge management systems reinforces the argument of Laudon and Laudon (2020), according to whom organizations often use information technologies primarily for operational rather than strategic purposes. Moreover, the high level of perceived effectiveness of technologies reported by most respondents aligns with Davis's (1989) Technology Acceptance Model, which posits that perceived usefulness and ease of use directly influence users' adoption of technology. However, the results also reveal a mismatch between the theoretical potential of knowledge management and its actual impact on strategic decision-making and innovation. This finding supports the socio-technical perspective of Bostrom and Heinen (1977), which argues that technology does not generate sustainable value without appropriate organizational and cultural adaptation.

7.2 Theoretical Implications

From a theoretical perspective, this study contributes to deepening the debate on the interaction between technology, knowledge management, and organizational performance by providing empirical evidence from an organizational context that remains underexplored in the international literature. The findings support the view that knowledge management should not be conceptualized solely as a technological function, but rather as a complex process encompassing human, organizational, and cultural dimensions. The study suggests that the integration of technology with knowledge management acts as a mediating factor between digital infrastructure and organizational performance, thereby confirming theoretical approaches that emphasize the importance of organizational capabilities rather than technological resources alone. In this regard, the findings contribute to the literature on digital transformation by arguing that its success depends on organizations' ability to transform technology into usable and institutionalized knowledge.

7.3 Practical Implications for Business Management

From a practical standpoint, the results of the study offer several important implications for business management and organizational leadership. First, organizations should shift their focus from isolated investments in technology toward the development of human capacities, particularly through staff training in knowledge management and knowledge-sharing practices. The findings clearly indicate that training and the simplification of digital platforms are perceived as top priorities for improvement, suggesting that usability and human competencies are critical factors for the success of digital initiatives. Second, top management should play a more active role in institutionalizing knowledge management by integrating it into human resource policies, performance evaluation systems, and strategic decision-making processes. Without such support, knowledge management risks remaining a fragmented and predominantly operational practice. Third, organizations should pursue an integrated approach in which information technologies, organizational culture, and managerial structures function in a coordinated and harmonized manner. Only under such conditions can knowledge management evolve from a formal process into a genuine source of competitive advantage and long-term business sustainability.

8. Conclusions and Recommendations

8.1 Summary of Key Findings

This study examined the role of information technologies and knowledge management in organizational performance, with particular emphasis on organizational communication, human resource management, and operational efficiency. The empirical findings reveal a high level of awareness among organizational actors regarding the strategic importance of knowledge management, as the vast majority of respondents consider it to be very important or important for organizational success. However, this awareness is not always accompanied by an advanced level of practical implementation.

The results indicate that dominant knowledge management practices remain focused on information collection and storage, as well as team-level information sharing, while the use of dedicated knowledge management technologies is more limited. From a technological perspective, organizations rely primarily on collaboration tools and cloud platforms, which are widely perceived as effective but are used mainly for operational rather than strategic purposes. Furthermore, the findings show that knowledge management contributes primarily to increased operational efficiency and improved human resource management, while its impact on innovation and strategic decision-making remains relatively limited.

8.2 Contribution of the Study

The main contribution of this study lies in providing empirical evidence on the interaction between information technologies, knowledge management, and organizational performance within an organizational context that has received limited attention in international research. The study enriches the theoretical debate by confirming that technology alone does not guarantee performance improvement, but must be integrated with human capacities, organizational culture, and managerial structures.

From a methodological perspective, the study offers a practical model of empirical research that combines descriptive analysis with theoretical interpretation, thereby bridging the gap between theory and organizational practice. Moreover, the findings contribute to the digital transformation literature by highlighting the importance of knowledge management as a mediating mechanism between technology and organizational performance.

8.3 Limitations of the Study

Despite its scientific value, this study has several limitations that should be considered when interpreting the results. First, the sample size of 88 respondents, although sufficient for descriptive and interpretive analysis, limits the generalizability of the findings across all organizations. Second, the sectoral distribution of respondents, with a dominance of the private sector, may have influenced perceptions regarding the use and effectiveness of technologies and knowledge management practices.

Another limitation relates to the subjective nature of the data, which are based on respondents' self-assessments rather than objective indicators of organizational performance. In addition, the cross-sectional design of the study does not allow for the examination of long-term changes over time or the full identification of causal relationships.

8.4 Directions for Future Research

Based on the findings and limitations of this study, future research could focus on expanding the sample size and ensuring a more balanced inclusion of different sectors, particularly the public sector and the education and research sector. Additionally, future studies may apply more advanced methodological approaches, such as inferential analysis, structural equation modeling, or longitudinal designs, to explore more deeply the relationships between technology, knowledge management, and organizational performance.

Another important direction for future research involves analyzing the role of leadership and organizational culture in the success of knowledge management initiatives, as well as assessing the impact of emerging technologies, including artificial intelligence, on the strategic management of knowledge. These approaches would contribute to building a more comprehensive and dynamic understanding of the role of technology and knowledge in contemporary organizations.

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TURNING KNOWLEDGE INTO CAPITAL: HOW ADULT EDUCATION AND RVCC UNLOCK COMMUNITY ENTREPRENEURSHIP IN RURAL TERRITORIES

Susana Soares Pinheiro Vieira PESCADA
Assistant Professor, Universidade do Algarve, Portugal
spescada@ualg.pt

Fernando José Calado e Silva Nunes TEIXEIRA
Associate Professor, Instituto Politécnico de Beja, Beja, Portugal
fernando.teixeira@ipbeja.pt

António Manuel Felício Espírito SANTO
Instituto Politécnico de Beja, Beja, Portugal
antonio.espiritosanto@ipbeja.pt

Abstract

This study examines how Adult Education and the Recognition, Validation and Certification of Competencies processes (RVCC) can be strategically mobilized to activate human capital, foster local entrepreneurship and promote sustainable development in Almodôvar, a low-density rural municipality in the Alentejo region. Based on a qualitative and exploratory approach, supported by semi-structured interviews with 15 participants, including learners and programme promoters, and analysed through thematic analysis, the research repositions competency recognition as a strategic resource rather than merely an educational outcome.The findings show that structured learning pathways and the recognition of experiential knowledge function as catalysts for individual empowerment, increased employability and strengthened entrepreneurial confidence, generating human capital with relevance for local economic dynamics. At the community level, these initiatives reinforce trust-based cooperation networks and stimulate civic engagement, both essential for territorially rooted entrepreneurial ecosystems. However, structural barriers persist, including mobility constraints, scheduling rigidity and resource scarcity, which limit expansion, sustainability and overall impact.

Keywords: Adult Education; RVCC; Strategic Empowerment; Community Entrepreneurship; Human Capital; Territorial Resilience; Lifelong Learning; Rural Development.

JEL Classification: R11, R12, L26, J24, Q18

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1. Introduction

Low-density rural territories across southern Europe face persistent structural challenges, including depopulation, demographic ageing, economic fragility, and limited institutional density, which together constrain their development trajectories; in regions such as Alentejo in southern Portugal, these dynamics have eroded local labour markets and weakened the conditions for entrepreneurship and innovation, yet a growing body of research on endogenous rural development argues that the future of these territories depends less on attracting external resources than on activating and mobilising locally available assets, particularly human capital (Almeida and Daniel, 2023). Within this perspective, adult education and lifelong learning emerge as strategic levers for territorial resilience, and in Portugal, the RVCC process, delivered through the national network of Qualifica Centres, allows adults to formally validate knowledge and skills acquired through professional, civic, and everyday experience; by converting tacit and often invisible knowledge into recognised qualifications, RVCC has the potential to improve employability, strengthen self-confidence, and expand individuals' capacity to engage in economic and entrepreneurial activity (Biney, 2023), although the principal challenge facing many low-density territories is not the absence of capabilities but the limited recognition and mobilisation of competencies that already exist within their communities. Despite the policy relevance of these processes, their role as instruments of human capital activation and community entrepreneurship in rural contexts remains insufficiently understood, particularly from the perspective of those who experience them directly, as existing research has tended to treat competency recognition as an educational outcome rather than as a strategic resource for local development. This study addresses this gap by examining how Adult Education and the RVCC process can be strategically mobilised to activate human capital, foster local entrepreneurship, and promote sustainable development in Almodôvar, a low-density rural municipality in Alentejo, adopting a qualitative and exploratory approach based on semi-structured interviews with fifteen participants, including adult learners and programme promoters, which were analysed through thematic analysis to reposition competency recognition as a strategic resource rather than a mere educational result.

2. Theoretical Framework

The theoretical architecture of this study integrates three interconnected domains: human capital theory applied to territorial development, lifelong learning and competency recognition as instruments of empowerment, and community entrepreneurship as a dimension of endogenous rural development.

Human capital theory conceptualises investment in education, skills and experiential knowledge as a driver of productive capacity and territorial resilience, and in low density rural regions the recognition and formalisation of competencies acquired through life and work experience, such as those validated through RVCC processes, can be understood as a mechanism of human capital activation whereby the conversion of tacit knowledge into recognised qualifications improves individuals' labour market positioning and expands their potential contribution to local economic development and entrepreneurial activity (Bin & Qiong, 2024).

This process is reinforced by transformative and experiential learning perspectives, which emphasise that adult learning grounded in lived experience promotes identity reconstruction, agency and enhanced self-efficacy, particularly among adults with interrupted educational trajectories, where reflective and autobiographical methodologies enable participants to reinterpret professional, family and community experiences as valuable learning assets and recognised competencies (Wang et al., 2021).

At the community level, social capital and communities of practice provide a useful lens for understanding how learning environments generate trust based networks with entrepreneurial relevance, as shared learning experiences and mutual recognition foster collaborative norms, peer support and knowledge exchange, thereby strengthening entrepreneurial ecosystems embedded in local territories while, in rural contexts, these relational resources often compensate for institutional fragility and limited market opportunities (O'Connor & Audretsch, 2023). Within this framework, community entrepreneurship is understood not

merely as business creation but as the collective mobilisation of local actors around shared development objectives, with adult education initiatives that strengthen local capabilities, social cohesion and collaborative action contributing to the emergence of community based entrepreneurial processes and sustainable rural development (Hertel et al., 2019). Despite this conceptual richness, the three domains have largely developed in parallel, leaving important gaps. Although human capital theory and lifelong learning explain individual qualification and social capital explains collective cooperation, the literature rarely explains how the formal recognition of experiential competencies serves as a bridging mechanism that converts activated individual human capital into collective, territorially embedded entrepreneurship, particularly in low-density rural settings where institutional support is scarce, and entrepreneurial ecosystem research remains predominantly urban-centric and provides limited conceptual tools for these rural territories, where the configuration of actors, resources, and institutions differs markedly from metropolitan contexts (Aguilar, 2021). In parallel, recognition of prior learning in Portugal has been examined chiefly through a utilitarian, employability-oriented lens, with little attention to its potential as a catalyst of community entrepreneurship and endogenous development (Guimarães & Mikulec, 2021). Finally, the gendered and contextual barriers that determine who can effectively mobilise recognised competencies remain under-theorised, even though they decisively shape participation and outcomes in rural areas (Semkunde et al., 2022). Addressing these interrelated gaps, the present study positions RVCC as a strategic resource for human capital activation and community entrepreneurship in a low-density rural territory.

3. Methodology

The study adopts a qualitative descriptive-exploratory design, an approach that is particularly suitable for examining social phenomena through the meanings and interpretations attributed by participants to their own experiences (Colorafi & Evans, 2016). This methodological orientation is consistent with the objective of understanding how educational processes are experienced and perceived in specific contexts rather than evaluating them through standardised quantitative indicators (Doyle et al., 2020). Data were collected through semi-structured interviews, a widely used technique in qualitative research because it allows participants to describe their experiences while providing sufficient flexibility to explore emerging themes (Kallio et al., 2016). The sample comprised 15 participants divided into two groups: ten adult learners enrolled in or recently completing RVCC processes at the Qualifica Centre of Almodôvar and five programme promoters and technical staff involved in the planning and implementation of adult education initiatives. Participants were selected through purposive sampling to ensure diversity in educational background, occupational status, and level of engagement with the programmes, thereby maximising the richness and variation of perspectives collected (Campbell et al., 2020). Two interview protocols were developed, one for each participant group, following recommendations that interview guides should be adapted to the characteristics and roles of respondents to enhance the relevance and depth of the data obtained (Kallio et al., 2016). The interviews were structured around five thematic dimensions: educational trajectories and participation experiences; expectations and perceived outcomes; individual and community impacts; barriers and facilitating factors; and recommendations for programme improvement. Interviews lasted approximately 90 minutes, were conducted face-to-face, audio-recorded with participants' consent, and subsequently transcribed verbatim to ensure the accuracy and completeness of the data (Doyle et al., 2020). Data analysis followed the thematic analysis framework proposed by Braun and Clarke (2006), a flexible and rigorous method for identifying, analysing, and interpreting patterns within qualitative data. The analytical process involved familiarisation with the data, systematic coding supported by MAXQDA software, the development and refinement of thematic categories, and independent validation by two researchers to enhance analytical consistency and credibility (Braun & Clarke, 2006). To further strengthen the trustworthiness of the findings, methodological triangulation was employed through the comparison of interview data with programme documentation and institutional reports, a strategy widely recognised for improving the credibility and robustness of qualitative research (Carter et al., 2014).

4. Results and Discussion

The findings demonstrate that the RVCC process extends well beyond its formal educational function, acting as a mechanism for human capital activation and local development. Both adult learners and programme promoters highlighted that the recognition of competencies acquired through professional and life experiences contributed to significant changes in self-perception, confidence, and social positioning. Participants reported a stronger awareness of their capabilities and greater legitimacy regarding their knowledge and skills, while formal certification was associated with improved employability, enhanced professional credibility, and, in some cases, opportunities for self-employment or the expansion of existing economic activities. These findings support the argument that the recognition of prior learning transforms experiential knowledge into formally recognised competencies with economic and social value (Baumeler et al., 2023). By making previously informal and often invisible knowledge visible and transferable, RVCC contributes not only to educational attainment but also to employability, self-efficacy, and entrepreneurial readiness, a result that is consistent with recent evidence from Portuguese Qualifica Centres (Cardim et al., 2026; Biney, 2023). The reflective portfolio methodology emerged as a particularly important tool in this process, enabling participants to identify, organise, and communicate competencies developed throughout their life trajectories (Calha, 2017). The results further indicate that RVCC contributes to the activation of entrepreneurial attitudes and lifelong learning dispositions. Fourteen participants reported improvements in professional competencies, twelve highlighted increased self-confidence, and ten indicated greater participation in community activities. Several learners described a greater willingness to take initiative, manage professional risks, and formalise previously informal practices. Although business creation was not directly assessed, these outcomes reflect key antecedents of entrepreneurial behaviour, including confidence, self-awareness, and perceived legitimacy. This evidence reinforces previous research highlighting the role of human capital development and lifelong learning in fostering entrepreneurship and regional resilience (Biney, 2023). At the collective level, the programmes generated important relational benefits. Most participants referred to the creation or strengthening of cooperation networks, mutual support relationships, and local social ties that frequently persisted beyond the duration of the educational activities. Promoters emphasised that the programmes created valuable opportunities for interaction in a geographically dispersed rural territory, contributing to trust-building, collective identity, and collaborative capacity. These findings are particularly relevant from a territorial development perspective, as informal social networks often function as entrepreneurial support structures in contexts characterised by low institutional density (Hammer & Frimanslund, 2022). Previous studies similarly emphasise the importance of social capital and cooperative networks in supporting entrepreneurship and local economic development (Zhao & Li, 2021). The results also suggest that the principal challenge facing low-density rural territories is not a lack of capabilities but rather the limited recognition and mobilisation of existing competencies (Almeida & Daniel, 2024). By validating knowledge acquired through work, civic participation, and everyday experience, RVCC transforms latent resources into active development assets that strengthen both individual agency and community participation (Baumeler et al., 2023). Despite these positive outcomes, participants identified several barriers that restrict programme accessibility and long-term impact, including transportation difficulties, scheduling inflexibility, limited resources, and insufficient outreach. These constraints were particularly significant for women with caregiving responsibilities. Such barriers reflect broader spatial inequalities that characterise many rural territories and continue to limit the scalability of adult education initiatives. Consistent with previous research on rural entrepreneurship and territorial development, overcoming these challenges requires flexible, locally embedded, and partnership-based implementation models capable of responding to the specific realities of low-density regions (Pato et al., 2021; Candeias & Sarkar, 2022).

5. Conclusion

This study examined how RVCC process can be strategically mobilised to activate human capital, foster local entrepreneurship, and promote sustainable development in a low-density rural municipality in Alentejo. Drawing on a qualitative and exploratory approach, the

findings show that RVCC operates well beyond its formal educational function by acting as a mechanism for human capital activation and local development. At the individual level, the recognition of competencies acquired through life and work experience strengthens participants' self-perception, confidence, and social legitimacy, while formal certification is associated with improved employability, professional credibility, and, in some cases, opportunities for self-employment or the expansion of existing activities, outcomes that reflect key antecedents of entrepreneurial behaviour and suggest that competency recognition nurtures entrepreneurial readiness and lifelong learning dispositions. At the collective level, the programmes reinforce trust-based cooperation networks, mutual support, and civic engagement, which are relational resources of particular importance in geographically dispersed territories characterised by low institutional density. Taken together, the results support the central argument that the main challenge facing low-density rural territories is not a lack of capabilities but rather the limited recognition and mobilisation of existing competencies, since by making invisible knowledge visible and transferable, RVCC converts latent resources into active development assets that strengthen both individual agency and community participation. Nevertheless, structural barriers, including mobility constraints, scheduling rigidity, resource scarcity, and limited outreach, continue to restrict accessibility and long-term impact, with particularly significant effects for women with caregiving responsibilities, which indicates that overcoming these constraints requires flexible, locally embedded, and partnership-based implementation models attuned to the realities of low-density regions. This study is not without limitations, as its qualitative and exploratory design and its focus on a single municipality limit the generalisability of the findings, and entrepreneurial outcomes were assessed through perceptions and antecedents rather than measured business creation. Future research could adopt comparative or longitudinal designs across multiple territories, combine qualitative and quantitative evidence, and examine more directly the long-term links between competency recognition, entrepreneurship, and territorial resilience. Overall, the study reinforces the value of repositioning adult education and competency recognition as strategic instruments for unlocking community entrepreneurship and sustainable development in rural territories.

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Announcements, Conferences, News

65th ERSA Congress
Global Challenges and Regional Responses in a Transition Era 25 to 28 August 2026 | Sofia, Bulgaria

Event Overview[1]

The 65th ERSA Congress will take place from 25 to 28 August 2026 in Sofia, Bulgaria, under the theme “Global Challenges and Regional Responses in a Transition Era”. The congress is organised by the European Regional Science Association (ERSA) and represents one of the key annual international meetings in regional science, regional economics, and spatial analysis. It brings together researchers, policymakers, and practitioners working on regional development and territorial cohesion.

The congress focuses on how regions respond to major global transitions and structural challenges. While the official programme highlights a broad research agenda, it places strong emphasis on contemporary issues such as economic transformation, spatial inequalities, innovation dynamics, sustainability transitions, and policy responses to global shocks. The congress aims to provide a platform for advancing theoretical and empirical research on regional resilience and adaptation in a rapidly changing world.

The scientific programme covers a wide range of regional science topics, including regional economic development, spatial planning, innovation systems, urban and rural dynamics, regional labour markets, infrastructure and connectivity, environmental sustainability, and territorial governance. It also supports interdisciplinary contributions addressing global change and regional policy responses.

Key dates for the 65th ERSA Congress include the call for special session proposals starting on 10 October 2025, the deadline for special sessions on 7 January 2026, abstract and paper submission opening on 12 January 2026, the submission deadline on 28 February 2026, notification of acceptance and registration opening on 16 March 2026, early-bird registration deadline on 24 May 2026, and the final deadline for presenters on 15 June 2026.

The congress will take place from 25 to 28 August 2026 in Sofia, and follows the tradition of ERSA annual meetings, including the ceremonial handover of the ERSA flag, which took place on 29 August 2025 during the closing ceremony of the previous congress in Athens.

More information: https://ersa.org/events/65th-ersa-congress/

[1] ***Event overview edited by Kreshnik Bello, Professor, SRDS J.***

2026 RSA Annual Conference
Regions as Arenas in a Changing World
15 to 18 June 2026 | Gothenburg, Sweden

Event Overview[2]

The 2026 RSA Annual Conference will take place from 15 to 18 June 2026 in Gothenburg, Sweden, under the theme "Regions as Arenas in a Changing World". The conference is organized by the Regional Studies Association (RSA) in partnership with the School of Business, Economics and Law at the University of Gothenburg, Sweden. The conference is recognized as one of the leading international events in regional studies, economic geography, regional development, and spatial policy. According to the organizers, it is expected to bring together participants from around 55 countries and feature more than 700 presentations, alongside keynote lectures, workshops, networking opportunities, field trips, and professional development sessions.

The 2026 edition focuses on the evolving role of regions as key arenas shaped by major global transformations. The call for contributions highlights several pressing challenges, including the rapid development of artificial intelligence (AI), environmental and sustainability challenges, the slowdown of globalization, rising policy protectionism, and the increasing strategic importance of natural resources and infrastructure. It also draws attention to growing tensions in scientific discourse and public debate. In this context, the organizers emphasize the need for renewed theoretical approaches and stronger empirical research to better understand regional interdependencies and policy responses in an increasingly uncertain global environment.

The conference program covers a wide range of thematic areas, such as:

Agglomeration, Clusters, and Externalities	AI and Big Data in Regional Studies
Circular Economy, Green and Just Transitions	Demography, Labour Markets, and Migration
Entrepreneurship and Innovation Systems	Financing Regional Development and Change
Gender, Diversity, and Equity in Regional Development	Regional Governance, Policies, and Institutional Change
Global Value Chains and International Business	Peripheral and Cross-border Regions
Populism, Nationalism, and Social Change	Regional Development in the Global South
Regional Inequalities and EU Cohesion Policy	Regional Innovation and Technological Change
Spatial Economy, Infrastructure, and Housing	

The Academic Organizers of the conference are Martin Henning, Roman Martin, Hanna Martin, and Sarah Franz from the Centre for Regional Analysis (CRA), School of Business, Economics and Law, University of Gothenburg, Sweden. The plenary program includes four major sessions across 16-18 June 2026, addressing themes such as spatial theory, place-based policy approaches, historical path dependencies of regions, and future directions for regional studies under uncertainty.

Key administrative dates include the opening of registration on 1 April 2026 and the deadline for presenters and discussants on 19 May 2026.

More information: https://www.regionalstudies.org/events/rsa26/

[2] **Event overview edited by Kreshnik Bello, Professor, SRDS J.**

Academic Profiles

Academic Profile

Professor JANICE C. EBERLY
President-Elected 2026
The American Economic Association (AEA)

James R. and Helen D. Russell Distinguished Professor of Finance, Kellogg School of Management at Northwestern University.

Statement of Purpose: Economics brings powerful tools to understand and analyze issues in social science. To live up to that promise, we need to attract and retain talent, develop data and analytics, and engage students. The AEA mission to advance the field is dynamic and challenging. As economists, we rely on collaborators, students, researchers, and a host of academic, public and private resources. In a changing field, the AEA needs to be correspondingly resilient. We can apply our tools to evaluate our progress and experiment with new initiatives. As president-elect, I would focus particularly on data access and opportunities for young scholars, plus attention to emerging issues. Economics cannot thrive without growing young scholars — who are often the first to experience new challenges. The AEA consistently supports data innovation through its committees and journals and continues to advise public and private data resources.

Present and Previous Positions: James R. and Helen D. Russell Distinguished Professor of Finance, 2002–, Senior Associate Dean, Strategy and Academics, 2020–23, and John L. and Helen Kellogg Associate Professor of Finance, 1998–2002, Kellogg School of Management at Northwestern University; Distinguished Senior Fellow and Visiting Faculty, 2023–24, Golub Center for Finance and Policy, Sloan School of Management, Massachusetts Institute of Technology; Assistant Secretary for Economic Policy and Chief Economist, 2011–13; Counselor to the Secretary, 2011, US Treasury, Washington, D.C.; Assistant/Associate Professor of Finance, 1991–98, Wharton School of the University of Pennsylvania.

Degrees: Ph.D. Economics, Massachusetts Institute of Technology, 1986–91; (Valedictorian) B.S., University of California, Davis, 1983–86

Publications: "Rents and Intangible Capital: A Q+ Framework," (with Crouzet), *Journal of Finance*, 2023; "The Economics of Intangible Capital," (with Crouzet, Eisfeldt & Papanikolaou), *JEP*, 2022; "Intangibles, Markups, and the Measurement of Productivity Growth," (with Crouzet*), Journal of Monetary Economics*, 2021; "Risk, the College Premium, and Aggregate Human Capital Investment," (with Athreya), *AEJ: Macroeconomics*, 2021; "Optimal Inattention to the Stock Market with Information Costs and Transactions Costs," (with Abel and Panageas), *Econometrica*, 2013; "How Q and Cash Flow Affect Investment without Frictions: An Analytic Explanation," (with Abel), *Review of Economic Studies*, 2011, "Optimal Investment with Costly Reversibility," (with Abel), *Review of Economic Studies*, 1996; "Options, the Value of Capital, and Investment," (with Abel, Dixit, and Pindyck), *Quarterly Journal of Economics*, 1996; "A Unified Model of Investment Under Uncertainty," (with Abel), *AER*, 1994; "Adjustment of Consumers' Durables Stocks: Evidence from Automobile Purchases," *Journal of Political Economy*, 1994.

AEA Offices, Committee Memberships, and Honors: Vice President, 2019–20; Executive Committee Member, 2008–10; AEACGR, 2022–; Job Search Committee for Editor of *AER: Insights*, 2022–23; Nominating Committee, 2001–02, 2010–11, 2021–22; Chair, Job Search Committee for Editor of the *JEP*, 2020; Program Committee 2006–07, 2008–09, 2020–21; AEAStat Committee, 2016–21; Honors and Awards Committee, 2017–20; Job Search Committee for Editor of the *AEJ: Macroeconomics*, 2017; Board of Editors, *AER: Insights*, 2019–.

Other Affiliations and Honors: Fellow of the Econometric Society, 2024; Fellow of the American Academy of Arts and Sciences, 2013; Dimensional Fund Advisors Award 2024, 1st Prize, Best Capital Markets Paper in the *Journal of Finance*; Alfred P. Sloan Research Fellow, 1995–99; Sloan Foundation Graduate Fellowship, 1990–91; Executive Editor, *Journal of Finance: Insights and Perspectives*, 2025; Co-Editor, *Brookings Papers on Economic Activity*, 2015–; Panel of Economic Advisors, Congressional Budget Office, 2010–11; Advisory Board, Bureau of Economic Analysis, US Department of Commerce, 2009–11.

Academic Profile by:
Associate Professor Filipos RUXHO
Sustainable Regional Development Scientific Journal - SRDSJ

References:

https://www.aeaweb.org/about-aea/leadership/election-winners

Academic Profile

Associate Professor Gülşah ÇELIK GÜL | Department of Chemistry | Balıkesir University in Turkey.

Dr. Gülşah Çelik Gül is an Associate Professor in the Department of Chemistry at Balıkesir University in Turkey. In addition to her academic role, she is a co-founder of Novalabs Chemistry Incorporated Company, an academic spin-off company located in the Balıkesir Technopark.

Academic Profile & Research Focus

Dr. Çelik Gül specializes in boron chemistry, nanomaterials, and sustainable industrial applications.
Her primary research areas include:
Boron and Sodium Borate: Optimizing parameters for borate solutions using different surfactants.
Surface Chemistry & Surfactants: Investigating the thermodynamic and micellar properties of surfactant systems.
Academic Evaluation Models: Developing multi-criteria decision-making models to evaluate the research performance of university infrastructure.

Teaching & Awards

At Balıkesir University, she actively teaches and mentors students. Her recent academic achievements include receiving the 2025 Academic Publication Performance Award from Balıkesir University.

Entrepreneurship & Innovation

Bridging the gap between academia and industry, Dr. Çelik Gül co-founded *Novalabs Chem*, an R&D company operating in the Balıkesir Technopark (BAUNTEK). Through this platform, she works on practical, science-based solutions for the chemical industry and actively bridges the gap by guiding university students through the local Technopark ecosystem. She is also a recognized advocate for women in STEM, participating in various podcasts and panels as a female entrepreneur.

Key Publications & Citations

Dr. Çelik Gül has numerous published academic papers and has garnered over 230 academic citations. Some of her notable works include:

- *"The investigation of optimization parameters of sodium borate solution treated with different surfactants"*
- *"From resource to innovation: A decision framework for sustainable boron research infrastructure"*

Academic Profile by:
Associate Professor Filipos RUXHO
Sustainable Regional Development Scientific Journal - SRDSJ

References:

- Gülşah ÇELIK GÜL | ResearchGate
- Doç. Dr. GÜLŞAH ÇELİK GÜL - BAUN Avesis

Academic Profile

Prof. Ass. Dr. Bardh L. XËRXA

Assistant Professor of Environmental and Biological Sciences, Universum International College, Kosovo, powered by Arizona State University; Environmental Scientist, Climate Policy Expert, Biodiversity Conservation Specialist, and European Integration Practitioner for chapter 27.

Statement of Purpose

Environmental sustainability, biodiversity conservation, climate resilience, and the green transition represent some of the most significant challenges and opportunities facing societies today. Throughout my academic, scientific, and professional career, I have worked at the intersection of environmental science, public policy, climate governance, and European integration, promoting evidence-based solutions for sustainable development. My work focuses on strengthening biodiversity conservation, advancing climate action, supporting environmental compliance with European Union standards, and translating scientific knowledge into practical policy instruments. Through research, teaching, project management, and international cooperation, I seek to contribute to a greener, more resilient, and sustainable future for Kosovo, the Western Balkans, and beyond.

Present and Previous Positions

Assistant Professor of Environmental and Biological Sciences, Universum International College, Kosovo, 2024–present; Member, IUCN Thematic Group on Biodiversity Conservation (Eastern Europe and Central Asia), 2025–present; Environmental Specialist, World Bank Project SDGSDP (P178162), Digital Kosovo Project, 2025; External Environment and Climate Expert, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Kosovo, 2025–2026; Senior Project Manager, Youth Environmental Impact (YENI) Project, Caritas Switzerland in Kosovo, 2022–2025; External Expert Evaluator, European Cooperation in Science and Technology (COST); Senior Researcher and Environment/Energy Policy Expert, INDEP Institute, Kosovo, 2020–2021; Certified Reviewer, Elsevier and Science Publishing Group, 2020–present; Senior Officer for European Integration (Environment, Climate and Energy Chapters), Prime Minister's Office / Ministry of European Integration, Environmental Expert and Contributor, Kosovo Red Book of Fauna Project (SIDA), 2017–2018; Ecologist and National Consultant, United Nations Development Programme (UNDP), Kosovo, 2010–2012; Freelance Ecologist and Environmental Consultant, 2008–2011.

Degrees

Ph.D. in Ecology and Conservation Biology, University of Prishtina "Hasan Prishtina", Kosovo, 2020;; M.A. in European Public Affairs, Maastricht University, Netherlands, 2013; M.Sc. in Ecology and Environmental Protection, University of Prishtina "Hasan Prishtina", Kosovo, 2009; B.Sc. in Ecology and Environmental Protection, University of Prishtina "Hasan Prishtina", Kosovo, 2007.

Selected Publications

"Mayflies (Ephemeroptera) of Kosovo: Conservation Status, Key Threats, and Management Priorities," *Acta Biologica Slovenica*, 2026; "Seasonal Fish Diversity, Distribution and Their Relation to Physicochemical Parameters: A Case Study of the Lepenc River Basin, Kosovo," *Ecological Engineering & Environmental Technology*, 2025; "Evaluation of Prizren River (Kosovo) Water Quality Using Benthic Macroinvertebrates as Bioindicators," *Acta Zoologica Bulgarica*, 2025; "First Checklist of Mayflies (Insecta, Ephemeroptera) from Kosovo," *ZooKeys*, 2019; "The Impact of Inhabited Areas on Quality of Streams and Rivers of a High Alpine Municipality in Southern Kosovo," *Ecological Engineering & Environmental Technology*, 2021; *Species Composition, Ecology and Distribution of Mayflies in Kosovo*, Ph.D. Dissertation, University of Prishtina, 2020.

Other Affiliations and Honors

Member of the IUCN Working Group on Biodiversity Conservation; Member, Ecological Society of America (ESA); Member, British Ecological Society (BES); Member of the Royal Entomological Society (United Kingdom); Member, European Energy Centre (EEC), London; Member, Indiana Water Resources Association (USA); National Expert for the European Mayflies Checklists for Kosovo and Albania; Certified

Reviewer for Elsevier scientific journals; ORCID, Scopus and Web of Science Researcher. USAID Transformational Leadership Alumni EU Young Cell Scheme Alumni.

Academic Profile by:
Associate Professor Filipos RUXHO
Sustainable Regional Development Scientific Journal - SRDSJ

References:

https://www.linkedin.com/in/bardh-l-xerxa-phd-ecology-environmental-protection/
https://orcid.org/0000-0002-1088-3180

Book Reviews

Book Review

Financial Tax Law, by Armand KRASNIQI, 2026 | ISBN: 978-9951-989-48-0 | 478 pages | Publishing House "Libri im" [in Albanian].

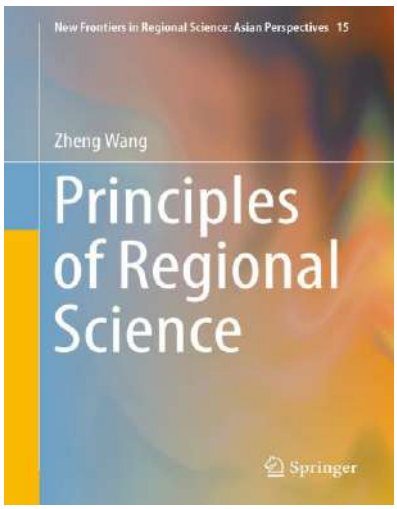
The book **Financial Tax Law**, written by **Professor Armand Krasniqi**, is a newly released work (Publication Year: 2026) available in the Albanian academic literature. The author is a professor of law and economics and currently serves as a Rector of University of Haxhi Zeka of Peja and as a Full Professor of law courses at the Faculty of Economics at the University of Prishtina, Kosovo. More than 100 articles by Prof. Armand Krasniqi have been published in scientific journals, book chapters, and conference proceedings, covering abroad topics, such as Law, Business, Regional Economics, International relations and other related. In the context of the interdisciplinary academic background of the author, this book covers a significant number of issues related to the multidisciplinary field of financial tax law. The book is divided into 15 chapters and contains a wealth of information and explanations about taxes. The book meets the necessary requirements to be an educational book and an important document that can be used for studies at the university level, and beyond.

- The first chapter, entitled "General issues and the object of the study: Public finance and financial law", introduces the basic concepts of finance and financial law.
- The second chapter, "Disintegration of financial law", analyzes the reasons for the separation of financial law and the separation of tax law, describing the complexity of the growth of tax law and the impact of public policies, globalization, and political and social dynamism.
- The third chapter, "The importance of tax principles (economic perspective)", focuses on the economic, socio-political and legal-administrative principles of taxation.
- The fourth chapter, "Public revenues and expenditures", deals with the historical development of public revenues and expenditures, including the main historical stages from the Magna Carta Libertatum to the contemporary system of expenditures and revenues.
- Chapter five, "Budget and Budgetary Law", deals with the state budget as an annual financial plan of public revenues and expenditures, as well as the budgetary law that regulates the legal norms for the compilation, approval, implementation and control of the budget.
- Chapter six, "The concept and structure of tax system regulation", explains fiscal terminology, types of tax systems and factors affecting their organization.
- Chapter seven, "The basis of tax system regulation", focuses on fiscal sovereignty, legal instruments for tax obligations and the principle of legality.
- Chapter eight, "The structure of the tax system", describes in detail all types of taxes, customs, fees, contributions, compensations, state loans and excise duties.
- Chapter nine, "The basic elements of tax (financial) liability", explains the subject, source, object, basis and level of tax liability, including tax exemptions and facilities. The author clarifies the way of creating
- Chapter ten, "The meaning and types of tax legal relations", analyzes property and administrative relations between taxpayers and tax authorities, including the creation, implementation and termination of tax obligations.
- Chapter eleven, "The control function of tax authorities", deals with tax audits, their forms and the procedural rights of taxpayers during the audit.
- Chapter twelve, "Taxpayer rights", analyses the basic rights of taxpayers and their components, providing a clear approach to the legal and administrative protection provided to individuals and legal entities.
- Chapter thirteen, "The tax system of the Republic of Kosovo", deals with the post-war history, the establishment and functioning of the Central Fiscal Authority and the Tax Administration of Kosovo, as well as the main tax laws in force.

In conclusion, this book presents a comprehensive, historical and practical study of the tax system and financial law. It combines theory, history, law and practice, making it an important academic and

professional reference. Although the book may seem a bit overloaded with multiple texts at first glance, in principle, the book provides a clear and detailed understanding of the tax system and its functioning in general, in Kosovo and in the international context. Although the writing is simple and in standard language, the addition of practical examples and chapter summaries increase clarity and ease of reading.

Book Review by
Associate Professor Filipos RUXHO
Sustainable Regional Development Scientific Journal - SRDSJ



Book Review

Principles of Regional Science | by Professor Zheng Wang | Springer |

This book summarizes the research findings in regarding a region as a rational and abstract concept and explores the principles of regional science. Focusing on location theory, spatial dynamics and regional evolution theory, it stresses that the region as a scientific concept is an essential abstract of an economic entity of a place. While it introduces a number of case studies, the content is general and universal rather than specific.

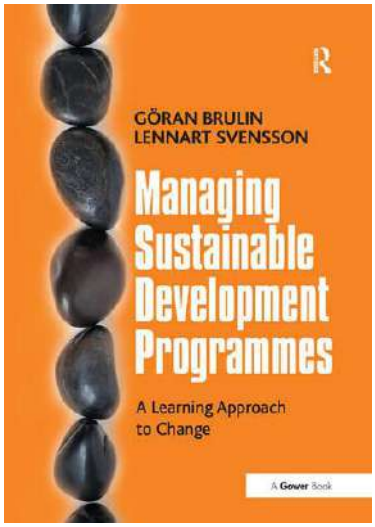
Beginning with location theory – the basis of regional science – it explains how regions breed their own characteristics as economic entities against a background of place. For example, it discusses the location theory of the tourism industry and analyzes issues of facility location and R&D-industry location theory.

The second part of the book addresses interactions with the spatial dynamics, including the dynamic mechanism of regions against a background of space. Spatial dynamics, which includes concepts from statistical physics, provides insights into the dynamic mechanism of aggregation, diffusion, and industrial clustering in regional science as well as in geography and economics.

The book then describes regional dynamics as a development of spatial dynamics: REGION is completely independent as a research object and is no longer part of spatial dynamics. This book also discusses in detail regions as the dynamic characteristics of the economy or the basic characteristics of a certain place and examines the theory of regional evolution. It argues that regions are evolution and irreversible features of development with path dependence, which are the characteristics of a region that differ from general economic phenomena.

This book by ***Professor Zheng Wang*** is outstanding. Its focus on Regional Science will open this area up to a wide variety of theoretical and applied researchers. I recommend the work without reservations. It covers critically important principles in the field and should be read and used by students, faculty and applied researchers doing policy analysis. I can see this as an important handbook and reference work as well as a textbook in the field.

Book Review by:
Associate Professor Filipos RUXHO
Sustainable Regional Development Scientific Journal - SRDSJ



Book Review

Managing Sustainable Development Programmes: A Learning Approach to Change. By Göran Brulin and Lennart Svensson | ISBN 9781032836928 | 2024 | Routledge

European structural funds were developed to assist EU member states to improve infrastructure, strengthen competitiveness and increase employment.

However, these projects have not always succeeded in achieving their intended aims or maintained their benefits after funding ended. It is important, therefore, to ask how such programmes can be designed to deliver more effectively, achieve long-lasting results and incorporate continuous improvement into their methodology.

In this book, Brulin and Svensson have developed a strong critique of traditional programme implementation, reviewing the role of the project manager and the suitability of linear programme logic.
Instead, they advocate active-ownership management, with a focus on stakeholder collaboration and dynamic learning to provide a multiplier effect for projects. They also highlight aspects of programme design that will allow activities in projects to continue after funding ceases.

The book offers an alternative to traditional project management where the “planning- and method-steered project thinking is supplemented, and to some extent replaced, by an alternative view of knowledge formation where processes, learning, innovation and coordination are central elements”.
This book provides useful insights for all those involved in managing complex projects.

Book Review by:
Associate Professor Filipos RUXHO
Sustainable Regional Development Scientific Journal - SRDSJ

Guidelines

For the writers & a format model for the articles submitted
to be reviewed & published in the journal

Sustainable Regional Development Scientific Journal

(RePec, EconPapaers, RSAI, BnF) – www.srdsjournal.eu

Guidelines for the Writers & a format model for the Articles submitted to be reviewed & published in thejournal.

The Title of the paper must be centered, and the font must be Times New Roman, size 12, in Uppercase, in Bold

For the writers' personal information use the Times New Roman font, size 11, in bold, and centered. Use lowercase for the first name and uppercase for the last name. The line below the name includes the professional title and workplace; use the Times New Roman font, size 10, centered. In the third line write only the contact e-mail address in Times New Roman 10, centered.

Name LAST NAME
Professional Title, WorkplaceE-mail Address

Name LAST NAME
Professional Title, WorkplaceE-mail Address

Abstract

The abstract consists of a single paragraph, no longer than 250 words. The font must be Times New Roman, size 11. The text must be justified. The title "Abstract" must be aligned left, in Times New Roman, size 11, in bold. A space of one line must be left between the title and the text of the abstract. The abstract must contain sufficient information, be factual, and include the basic data of the paper.
Keywords: Use 3 to 5 keywords, separated by commas
JEL classification: We kindly request that you classify your paper according to the JEL system, which is used to classify articles, dissertations, books, book reviews, and a variety of other applications. The use of the JEL classification is necessary so that your paper be properly indexed in databases such as EconLit. Select the codes that represent your article and separate them by commas. You can find information on the JEL system here: https://www.aeaweb.org/jel/guide/jel.php

1. Introduction

All articles must begin with an introduction, a section which demarcates the theoretical background and the goals of the paper.
The present document provides the necessary information and formatting guidelines for you to write your article. We recommend that you copy this file to your computer and insert your own text in it, keeping the format that has already been set. All the different parts of the article (title, main text, headers, titles, etc.) have already been set, as in the present document- model. The main text must be written in regular Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph.
We recommend that you save this document to your computer as a Word document model. Therefore, it will be easy for you to have your article in the correct format and ready to be submitted. **The only form in which the file will be accepted is MS Word 2003**. If you have a later version of Microsoft Office / Word, you can edit it as follows:

- Once you have finished formatting your text, create a pdf file, and then save your file as a Word "97-2003" (.doc) file.
- Compare the two files – the pdf one and the Word "97-2003" (.doc) one.
- If you do not note any significant differences between the two, then – and only then – you can submit your article to us, **sending both the pdf and the Word "97-2003" (.doc) files** to our e- mail address. If you use a word processor other than Microsoft Word, we recommend that you follow

the same procedure as above, creating a pdf file and using the appropriate add-on in order to save your document in MS Word "97-2003" (.doc) form. Once you compare the two files (and find no significant differences), send us both.

1. General Guidelines on Paper Formatting

1.1. Body

The body of the text consists of different sections, which describe the content of the article (for example: Method, Findings, Analysis, Discussion, etc.). You can use up to three levels of sections – sub-sections. For the Body of the text, use the default format style in Word, selecting the Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph (this is further detailed in the section "Paragraphs").

1.2. References

The references included in the paper must be cited at the end of the text. All references used in the body of the paper must be listed alphabetically (this is further detailed in the section "References").

1.3. Appendices

The section "Appendices" follows the section "References".

2. Page formatting

2.1. Page size

The page size must be A4 (21 x 29,7 cm), and its orientation must be "portrait". This stands for all the pages of the paper. "Landscape" orientation is inadmissible.

2.2. Margins

Top margin: 2,54cm Bottom margin: 1,5cm
Left and right margins: 3,17cmGutter margin: 0cm

2.3. Headers and Footers

Go to "Format" → "Page", and select a 1,25cm margin for the header and a 1,25cm margin for the footer. Do not write inside the headers and footers, and do not insert page numbers.

2.4. Footnotes

The use of footnotes or endnotes is expressly prohibited. In case further explanation is deemed necessary, you must integrate it in the body of the paper.

2.5. Abbreviations and Acronyms

Abbreviations and acronyms must be defined in the abstract, as well as the first time each one is used in the body of the text.

2.6. Section headers

We recommend that you use up to three sections – sub-sections. Select a simple numbering for the sections – sub-sections according to the present model.

2.7. First level header format

For the headers of the main sections use the Times New Roman font, size 11, in bold and underlined, and leave a size 12 spacing before the paragraph and a size 6 spacing after the paragraph. The header must be aligned left. Use a capital letter only for the first letter of the header.

2.8. Second level header format

For second level headers, follow this model. Use the Times New Roman font, size 11, in bold, and leave a size 12 spacing before the paragraph and a size 3 spacing after the paragraph. Select a 0.5 cm indent. The header must be aligned left. Use a capital letter only for the first letter of the header.

2.8.1. Third level header

For third level headers, follow this model. Use the Times New Roman font, size 11, in bold and italics,

and leave a size 6 spacing before the paragraph and a size 0 spacing after the paragraph. The header must be aligned left, with a left indent of 1 cm. Use a capital letter only for the first letter of the header.

3. Paragraphs

In every paragraph, use the Times New Roman font, size 11, with single line spacing. We recommend you modify the default (normal) format style in Word and use that in your text. For all paragraphs, the spacings before and after the paragraph must be size 0, and the line spacing single. Use a 0,5cm indent only for the first line of each paragraph. Leave no spacings nor lines between paragraphs.

3.1. Lists

In case you need to present data in the form of a list, use the following format:

- Bullet indent: 1,14cm
- Text:
  - Following tab at: 1,5 cm
  - Indent at: 1,5cm

Use the same format (the above values) if you use numbering for your list.

1. Example of numbered list 1
2. Example of numbered list 1

4. Figures, images, and tables

4.1. Figures and images

Insert your figures and images directly after the part where they are mentioned in the body of text. They must be centered, numbered, and have a short descriptive title.

Figures put together "as they are", using Office tools, are absolutely inadmissible. The figures used must have been exclusively inserted as images in Word, in gif, jpg, or png form (with an analysis of at least 200dpi), and in line with the text. The width of an image must not exceed 14,5cm so that it does not exceed the margins set above.

The images, figures, and tables must be inserted "as they are" in the text, in line with it.

Figures and images which have been inserted in a text box are absolutely inadmissible.

4.1.1. Reference inside the text

Avoid phrases such as "the table above" or the "figure below" when citing figures and images. Use instead "in Table 1", "in Figure 2", etc.

4.1.2. Examples

A model of how to format figures/images follows. For the title, use the Times New Roman font, size 10, in bold. Write the title above the figure, and set a size 6 spacing before the title anda size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the image and its title must be centered.

Directly below the figure you must cite the source from which you took the image, or any note regarding the figure, written in Times New Roman, size 10. Write it below the figure, leaving a size 0 spacing before and after it, use a line spacing of 1.5 line, and make it centered.

Image 1: Title

Source: cite the source

4.2. Tables

For the title, use the Times New Roman font, size 10, in bold. Write the title above the table, and set a size 6 spacing before the title and a size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the table and its title must be centered. The width of the table must not exceed 14,5cm so that it does not exceed the page margins set.

Table 1. Example of how a table must be formatted

Age	Frequency	Percentage %
Under 40	44	32.1
40 - 49	68	49.6
Over 50	25	18.2
Total	**137**	**100.0**

Source: cite the source

If the table needs to continue on the next page, select in the "Table properties" that the first line be repeated as a header in every page, as in the above example of Table 1. **Tables (or figures or images) which are included in pages with a "Landscape" orientation are absolutely inadmissible.**
Every table must have horizontal lines 1 pt. wide at the top and bottom, as shown in the example. The use of vertical lines and color fill at the background of the cells is strictly prohibited.
Directly below the table you must cite the source or any note regarding the table, written in Times New Roman, size 10. Write it below the table, leaving a size 0 spacing before and a size 6spacing after it, and make it centered.

5. Mathematical formulas

There is a variety of tools in order to insert and process mathematical formulas, such as the "Mathematics", found in the most recent editions of Word, "Math Type", "Fast Math Formula Editor", "MathCast Equation Editor", "Math Editor". Since it is impossible for us to provide youwith compatibility with all these tools in all their editions, **we can only admit your paper if it contains mathematical formulas solely in the form of images.**
Keep a continuous numbering for the mathematical formulas and center them in the page, as shown in the following example:

(1) $$y = ax^2 + bx + c$$

The same stands for formulas or particular mathematical symbols you may have integrated in your text. For instance, if you want to use the term in your text, you must insert it as an imaged, in line with the text. ax^2 The images containing the mathematical formulas must be legible (at least 300dpi).

In the exceptional case of a text which may contain a great number of mathematical formulas, the writer may send it to us in TeX form if they so wish.

6. References

We recommend that you use the Chicago Manual of Style Author-Date system, as it is recommended by the AEA (American Economic Association) for the journals included in the EconLit database, and it is the dominant style of bibliography in the field of Economics. For more information, you can go to the following links:

- https://www.aeaweb.org/journals/policies/sample-references
- http://www.chicagomanualofstyle.org/tools_citationguide.html
- http://libguides.williams.edu/citing/chicago-author-date#s-lg-box-12037253

6.1. Online references (internet citations)

Check your links again before sending your file, to confirm that they are active.
Avoid long internet links. Where possible, also cite the title of the website operator-owner. Return the font color to black, and remove the hyperlink. Links such as the following are impractical and distasteful, therefore should be avoided.

Example of an inadmissible hyperlink
https://el.wikipedia.org/wiki/%CE%9F%CE%B9%CE%BA%CE%BF%CE%BD%CE%BF%CE%BC%CE%B9%CE%BA%CE%AC

6.2. References Formatting

For your list of references, use the Times New Roman font, size 10, with single line spacing. The paragraph format must include a size 0 spacing before the paragraph and a size 0 spacing after it,

aligned left. Use a 0,5 cm indent only for the first line of each paragraph. Leave no spacings or lines between paragraphs.

6.3. Example of how References must be formatted

Ruxho F., 2024. "Kosovo employee's perception of economic growth and decent work according to sustainability", Sustainable Regional Development Scientific Journal, Vol. I, (3), pp. 53-66

Ruxho F., Ladias C.A, 2022. "Increasing funding for the regional industry of Kosovo and impact on economic growth" Regional Science Inquiry Journal, Vol. XIV. (1), pp. 117-126

Ruxho F., Ladias C.A, Tafarshiku A., Abazi E., 2023. "Regional employee's perceptions on decent work and economic growth: labour market of Albania and Kosovo", Regional Science Inquiry, Vol. XV, (2), pp.13-23.

Ruxho F., Ladias C.A., 2022. "The logistic drivers as a powerful performance indicator in the development of regional companies of Kosovo" Regional Science Inquiry Journal, Vol. XIV. (2), pp. 95-106

Ruxho F., Petropoulos D., Negoro D.A. 2024. "Public debt as a determinant of the economic growth in Kosovo", Sustainable Regional Development Scientific Journal, Vol. I, (1), pp. 55-67

Sanchis, D. Z., Haddad, M. D. C. F. L., Girotto, E., & Silva, A. M. R. (2020). Patient safety culture: perception of nursing professionals in high complexity institutions. *Revista brasileira de enfermagem*, *73*, e20190174. https://doi.org/10.1590/0034-7167-2019-0174.

Romer, Christina D., and David H. Romer. 2010. "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks: Dataset." American Economic Review. http://www.aeaweb.org/articles.php?doi=10.1257/aer.100.3.763 (accessed August 22, 2012).