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Editorial Introduction

It is with great pleasure that we present the new issue of the *Journal of Regenerative Economics*, continuing the journal's mission to promote interdisciplinary research and dialogue on sustainable and regenerative economic development. With each new issue, the journal strengthens its role as an open-access, peer-reviewed platform dedicated to advancing knowledge and encouraging collaboration among scholars, researchers, and practitioners interested in regenerative economic systems and sustainability-oriented policies.

The articles included in this issue reflect the diversity of contemporary research topics that contribute to the broader understanding of regenerative economics. The contributions address a range of themes, including smart urban development, fiscal systems in the Western Balkans, higher education performance, regenerative agriculture, macroeconomic stability, career development in the context of circular economy, and sustainable urban mobility. Together, these studies highlight the growing importance of integrating sustainability principles into various economic sectors and policy frameworks.

The issue opens with the article "Smart Urban Development as a Framework for Regenerative Economy" by Jelena Veljković, Jelena J. Stanković, and Ivana Marjanović. The authors examine the role of smart urban development in supporting regenerative economic processes, emphasizing the importance of technological innovation, integrated planning, and digital governance mechanisms in creating more sustainable and resilient urban systems.

The second article, "The Role of Non-Tax Revenues in the Fiscal Systems of Western Balkan Countries," authored by Gordan Janković, explores the significance of non-tax revenues within the fiscal structures of Western Balkan economies. The paper provides an analytical overview of the composition and role of these revenues, highlighting their contribution to fiscal stability and the functioning of public finance systems in transitional economies.

In the third contribution, "Benchmarking as a Mechanism for Enhancing the Human Capital Performance of Higher Education Institutions," Milica Jovanović Vujatović, Bojan Krstić, Ljiljana Bonić, and Matijaž Hribar analyze the use of benchmarking as an instrument for improving the efficiency and competitiveness of higher education institutions. The

authors emphasize the importance of comparative evaluation and performance measurement in strengthening institutional capacities and advancing human capital development.

The fourth article, “Regenerative Agriculture as a Factor of Economic Sustainability: Perspectives and Challenges in European Context,” by Ivana Filipović, Sonja Jovanović, and Zorana Kostić, addresses the growing relevance of regenerative agricultural practices in achieving long-term environmental and economic sustainability. The paper discusses both the opportunities and the challenges associated with implementing regenerative agricultural models within the broader European policy framework.

In the fifth paper, “Interest Rate as a Determinant of Fiscal Sustainability in the Southeast European Region,” Miloš Golubović focuses on the relationship between interest rates and fiscal sustainability. The study examines how changes in interest rates influence public debt dynamics and fiscal policy outcomes in Southeast European economies.

The article “Building Sustainable Career in the Era of the Circular Economy,” authored by Sandra Milanović Zbiljić and Biljana Đorđević, explores the evolving nature of career development in the context of circular economic transformation. The authors discuss the skills, competencies, and professional pathways necessary for individuals to adapt to emerging sustainability-oriented economic models.

The issue concludes with the article “Sustainable Urban Mobility in Serbian Cities: Status, Challenges, and Policy Directions,” by Ivana Kostadinović, Marina Stanojević, and Dejan Đorđević. The authors provide an overview of the current state of urban mobility systems in Serbian cities, identifying key challenges and proposing policy directions aimed at improving sustainability and efficiency in urban transportation.

We extend our sincere gratitude to all authors and reviewers whose contributions have made this issue possible. Their dedication and scholarly engagement play a crucial role in strengthening the academic dialogue on regenerative economics and in advancing research that supports the transition toward more sustainable economic systems.

Editor-in-Chief
Jelena J. Stanković, PhD

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SMART URBAN DEVELOPMENT AS A FRAMEWORK FOR REGENERATIVE ECONOMY

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Abstract: *The destructive and reckless behavior of human beings, corporations, institutions, and governments, driven by an unwavering commitment to economic growth at any cost has severely undermined the planet's finely balanced life-support mechanisms, to the extent that the abundance of resources, opportunities, and choices can no longer be taken for granted. In the era of the hegemony of data, innovation, and science, the rhetoric of the smart city has emerged as a logical trajectory for the urban development of the future. The regenerative economy, by contrast, is recognized as an urgently needed model of economic development with significant potential to foster partnerships between natural and socio-ecological systems, thereby promoting universal well-being and embedding these relationships within established governance and institutional frameworks. Since transformative patterns should be multifaceted, complementary, and synergistic rather than rival or exclusionary, the objective of this paper is to establish a conceptual linkage between the regenerative economy and the smart city, and to identify the specificities and implications of their interrelationship.*

Keywords: *Sustainability, smart urban development, smart city, regenerative economy, smart regenerative development.*

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1. Introduction

Ecological signals of planetary decline have become visible throughout all domains. Over the past five decades, nature has diminished across all systems, terrestrial, freshwater, marine, as well as in wildlife populations and coral reefs, by 69%, 85%, 56%, 73%, 70-90%, respectively. The annual cost of environmental degradation amounts to USD 7 trillion. By the end of this century, global temperatures are expected to rise by 3^{o} C (WWF, 2024). Humanity has surpassed the threshold at which addressing the disintegration of the biogeocoenosis requires joint efforts to inflict less harm. An affirmative and regenerative shift is therefore imperative (Jain, 2021). This entails replacing individualistic and mechanistic perspectives with a systematic one, introducing a renewed scope of responsibility entrusted to the regenerative civilisation for the stewardship of life on the planet, under an operational framework that transcends the pursuit of purely technical solutions to crises based on tried-and-tested practices (Künkel & Ragnarsdottir, 2022). The ultimate outcome of these transformative endeavours lies in the transition towards a regenerative economy.

The steering of economic and urban development towards optimal outcomes is influenced by technological innovation, which finds its fullest expression in the smart city discourse. Over the past decade, the ICT sector has outpaced the growth of OECD economies threefold (OECD, 2024). By 2030, the EU data market is projected to reach €116 billion with an average annual growth rate of 3.4%, while the EU data economy is expected to attain €1 trillion growing at a compound annual rate of 5.5%, which would raise its share of European GDP from 4.8% in 2025 to 5.7% in 2030, and its induced effects from 33% to 36% over the same period (EC, 2023). The generative AI market is anticipated to reach $1.3 trillion by 2032, expanding at 42% annually, extending its influence from 1% to 10% of total expenditures across IT hardware, software services, advertising and gaming sectors, while generating $280 billion in new software revenues (BI, 2023).

A review of the literature suggests that regenerative economics and the smart cities embody concepts of exceptional significance, both inherently optimistic about humanity's capacity to evolve within the boundaries of inclusive, eco-benign, and progressive ways of conduct. They are dedicated to the continuous pursuit of enduring and sustainable solutions aimed at achieving superior levels of economic, social, and environmental well-being, while redefining and profoundly altering the very principles of sustainable excellence. Accordingly, the principal aim of this paper is to highlight the compatibility, reciprocity, and causality between these two concepts, suggesting that the smart city ecosystem represents the most fertile ground for the realisation of regenerative economic processes, practices, and models. In this regard, the first part of the paper examines the theoretical and applied foundations of the regenerative economy, the second part offers an overview of the research corpus on smart urban development, while the central section substantiates the argument that the smart city serves as a backbone of a regenerative economy.

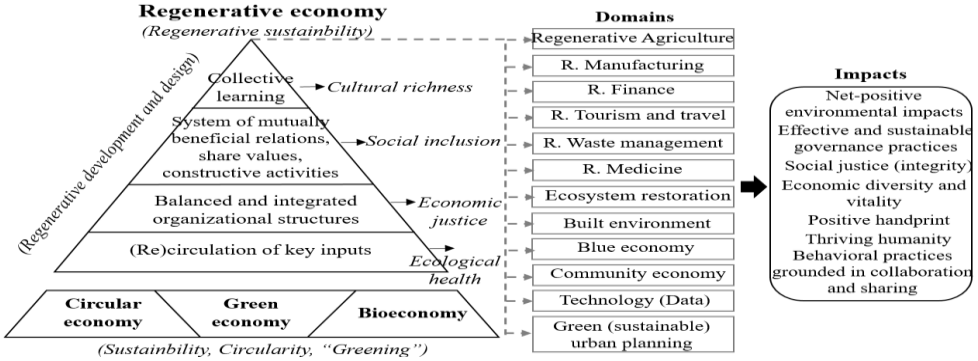
2. A Conceptual Framework and Practical Implications of the Regenerative Economy

As global ecological challenges intensify, placing unprecedented strain on the planet, humanity, and human communities and settlements, the regenerative economy emerges as a proactive, optimistic, profound, and strategic paradigm (Lalević Filipović et al., 2024). Through its comprehensive and integrated orientation, activating the inherent self-maintaining and developmental tendencies of natural and social systems, and integrating ecological revitalization, social justice, and economic prosperity, the regenerative economy promises systematic transformation, qualitatively superior sustainable development, and long-term resilience, while addressing inconsistencies, shortcomings, and partial approaches to complex sustainability challenges, as well as the modest outcomes of isolated and uncoordinated policies and interventions, that are common to numerous contemporary economic development paradigms such as the green, circular, and bio-economies. These concepts are reinterpreted and enriched with new perspectives, incorporating the ideas of ecosystem restoration, regenerative strategies, and processes grounded in the vitality of biological resources, respectively. The interdisciplinary nature of the regenerative economy is reflected in the extensive literature organized around themes such as sustainability and ecological impacts, climate change and energy, urban and built environments, economic-industrial systems, education and social impacts, technological innovations and systems, and policies, governance, and standards (Čegar et al., 2024, pp. 1-2). The regenerative economy operates through the symbiosis of circular, green, and sharing economy models (Avdokushin & Kuznetsova, 2023, p.11). It represents an advancement in the understanding of the sustainability paradigm by introducing the rhetoric of regenerative sustainability, fundamentally grounded in creating the necessary conditions for the momentum of critical social and ecological systems through the intrinsic coupling of ecological and social aspects (Brown, 2021). It is also linked to regenerative design (and development), which succeeds where sustainability approaches fall short, mediating planetary boundaries, social equity, and economic growth, while offering resilient and efficient governance strategies aligned with the reaches of natural ecosystems (East, 2020). Ultimately, the regenerative economy seeks to establish long-term flourishing economic systems, and as such, it is not in clash with the idea of shaping the further development of civilisation through the intensification of technological drive, yet without incurring self-destruction or disregarding nature (Perkins & Jessup, 2021).

The regenerative economy is grounded in the intertwined concepts of restoration and regeneration, with regeneration taking precedence by extending deeper and broader than mere restoration. Instead of restoring something to its original state, it aims to enhance it, recover it from disruptions, and enable the self-renewal of its functions (Morseletto, 2020). Based on the premise that the principles governing vital self-organising and self-sustaining organisms can be projected onto economic systems, the regenerative economy explicitly addresses key issues such as inequality, poverty, scarcity of natural inputs, contamination, deficits, health, education, and regulation; establishes limits on consumption that exceed production, pollution beyond assimilative capacity, and the depletion of essential building blocks that

sustain social and ecological structures; sets up systems in which energy and resources circulate continuously to enable functional self-replacement of damaged components; advocates for societal well-being at the intersection of economic, financial, individual, social, and ecological prosperity; and encourages integrity, diversity, fair competition, and progressive and adaptive development (Jain, 2021). The regenerative economy encompasses principles such as the (re)circulation of key flows; balanced and integrated organisational structures, systems of mutually beneficial relationships, shared values, constructive actions; and collective learning (Fath et al., 2019). An alternative systematisation of its principles includes place, planet, position, people, peace, diversity, and progress (Shannon et al., 2022).

Figure 1. The Regenerative Economy Ecosystem



Source: Authors

Transformative practices of the regenerative economy are applicable across a variety of sectors including agriculture, healthcare, finance, energy, manufacturing and supply chains, waste management, tourism and travel (Jovanović Vujatović et al., 2024, p. 171). Particularly promising applications lie in ecosystem restoration (wetlands, green infrastructure, degraded land, biodiversity, habitats), green and sustainable urban planning, the blue economy, social innovation, technology and data, the built environment (van der Laag & Östh, 2025). The practical ramifications of regenerative economics are reflected in the promotion of local agricultural economies, investment in natural capital, the development of open-source technologies for the public good in support of sustainability, systemic adaptation of institutions to a regenerative lens (Perkins & Jessup, 2021). Despite the absence of consensus surrounding its terminological and conceptual contours (Järvenpää et al., 2023), the regenerative economy ecosystem can be illustrated as depicted in Figure 1 above.

3. The Paradigm of Smart Urban Development and the Smart City Concept

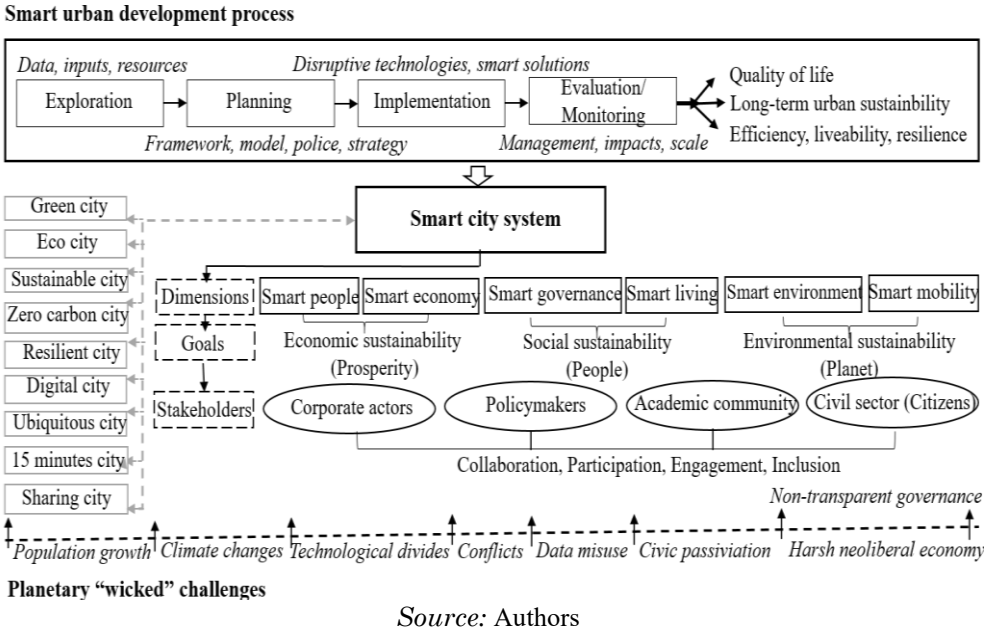
The 21st century belongs to cities. Urban areas are at the forefront of both natural population growth and mass migrations, with projections indicating that by 2050 there will be 12 metacities, 43 megacities, 66 large cities, 597 medium-sized cities, 710 cities with populations under one million, and numerous urban settlements with fewer than 500,000 inhabitants, collectively housing 68% of the global population

(6.7 billion people). of this total, 88%, 83%, 59%, and 50% of the population of high income, upper-middle-income, lower-middle-income, and low-income countries, respectively. Cities are responsible for 71-76% of harmful emissions and 67-76% of energy consumption (UN-DESA, 2019). Planetary sustainability challenges such as rapid population growth, natural resource stocks depletion, climate change, technological disparities and digital divides, data misuse, exploitative corporate practices inherent in mainstream economic models (neoliberal economics, conflicts, and opaque governance, resonate most strongly within urban settings, assigning cities a pivotal role in shaping and managing policies capable of securing promising development pathways for humanity (Yigitcanlar & Cugurullo, 2020, pp. 2-4). The efficiency of urban economies, driven by economic and strategic variables, primarily the growth of urban cultural amenities and location (Kresl & Singh, 1999), the presence of tertiary economic functions and network integration within the urban structure (Capello & Camagni, 2000), territorial capital (Camagni, 2008), spatial, interactive, and cultural proximity (Martin & Simmie, 2008), as well as regional absorption capacity and cognitive capital (Caragliu & Nijkamp, 2012), influences national and global economic outcomes, with cities emerging as focal points of the full spectrum of high-level socio-economic activities.

Addressing urban issues is recognised as a priority task, pursued through a range of contemporary urban development paradigms. The literature on urban growth and development identifies three main research directions. The first focuses on translating insights from urban process analysis into sustainable development and regeneration strategies and policies based on collective action. The second examines urban systems through the lens of urban metabolism, aiming to reduce their adverse environmental impacts and to optimise the flows of resources, energy, and materials within the system, as well as pollution, waste, and exportable outputs generated through interactions with other urban systems. The third emphasises smart urban development, understood as a process of investing in human, social, and ecological capital by leveraging the opportunities created by modern technological infrastructure to access services and information, ultimately pursuing urban sustainability in its broadest sense (Peponi & Morgado, 2020). The outcome of smart urban development is the smart city itself (Huston, 2017), positioned at the intersection of social and technological dimensions and new models of public governance, where urban challenges are transformed into investment opportunities, with corporate actors, alongside local government authorities, playing a central role in this process (Anand & Navio-Marco, 2018, p. 796). Owing to its all-encompassing perspective, rooted in the notion that being smart entails a commitment to enhancing the city's economic, environmental, and social indicators, as well as those of its residents (Silva et al., 2018), the concept of the smart city reigns supreme among contemporary urban paradigms (green, sustainable, eco, low-carbon, resilient, digital, intelligent, ubiquitous, 15-minute, creative, liveable, and sharing cities). It partially overlaps, correlates, or establishes symbiotic relationships with these concepts, and in some instances, subsumes them. A smart city represents a locus where a critical role in development, decision-making, and the implementation of both political agendas and efficient, secure, and seamless public services are delegated to modern disruptive ICT (Ullah et al., 2020). Smart city initiatives have emerged as a global and omnipresent undertaking (Joss et al., 2019), enabled by the

high mobility and replicative power of smart urban policy ideas, mechanisms, and practices (Crivello, 2015). Although the exact number of smart cities worldwide remains indeterminate, their proliferation is evident, with leading examples rapidly materialising across Europe, China, the Indian subcontinent, Sub-Saharan Africa, and North and Latin America. Currently, 462 smart urban projects implemented across 65 countries (Smart City Expo World Congress, 2025) form part of a much broader and continuously expanding smart city ecosystem. The popularisation of smart cities as a corporate branding strategy has further accelerated the sector's growth. With an anticipated compound annual growth rate of 19.11%, the global smart city market is projected to reach $4.04 trillion by 2030. Europe is expected to remain the largest market, while the Asia-Pacific region, together with smart services and smart objects, is forecast to represent the fastest-growing region, segment, and solution, with growth rates of 20.3%, 19.7%, and 19.2%, respectively (Mordor Intelligence, 2025). Yet, the deep entanglement of smart cities with local specificities renders them a glocal urban strategy (Dameri et al., 2019), a phenomenon that exists in a liminal space between worlding and provincialising (Burns et al., 2021).

Figure 2. A Conceptual Framework for the Narrative of Smart Urban Development and the Smart City System



Source: Authors

Engaging a specific city in the process of becoming smart requires sustained effort, guided by the collaborative involvement of a wide range of urban stakeholders, across multiple urban features and domains (Clement et al., 2022). Consequently, numerous dimensions of a smart city can be identified, with varying emphasis by different authors. Among the most prominent classifications is the one that focuses on smart people, smart governance, smart living, smart environment, smart mobility, and smart economy (Giffinger et al., 2007). The dimension of "smart people" is essentially a modernised and refined term denoting members of the creative class

(Florida, 2002), segments of the urban population recognised as leaders, champions, and entrepreneurs (Harrington, 2017), skilled knowledge workers (Glaeser & Berry, 2006), and active citizens acting as urban sensors (Vanolo, 2016). The "smart governance" dimension incorporates digital platforms and innovations, business intelligence, and data-driven management, fundamentally aimed at enhancing public administration standards and the quality of public services (Kaiser, 2024). The "smart living" dimension refers to the use of ICT, IoT, e-governance, and e-democracy within specific domains of urban life, aimed at enriching ecological, social, economic, bio-physical, and psychological well-being in a non-discriminatory and sustainable manner (Vinod Kumar, 2020, p. 65). The "smart environment" dimension involves automated resource control systems, greenhouse gas monitoring, and environmental hazard mitigation, all aimed at preserving biodiversity, safeguarding ecological quality, and ensuring a sustainable living environment for future generations (Salleh et al., 2022). The "smart mobility" dimension refers to a flexible, accessible, eco-friendly, socially responsible, and ICT-driven system for real-time data collection and processing, aimed at fine-tuning the use of the urban transport system and simplifying the management of traffic demand outputs in the city (Mirović et al., 2024). The "smart economy" refers to an urban economic system that is digitally supported, innovative in turning constraints into opportunities, resilient to changes in wider economic systems, resistant to internal and external shocks, and transformative in fostering positive outcomes and equal prosperity opportunities for all urban actors (Mwaniki et al., 2017, p. 761). In addition to these dimensions, a smart city encompasses smart buildings (Radziejowska & Sobotka, 2021), smart grids (Silva et al., 2025), smart healthcare (Gagliardi & Albergo, 2023), smart education (Molnar, 2021), and smart security (Ismagilova et al., 2022). The conceptual framework of the process-oriented narrative of smart urban development, with the smart city as its outcome, is illustrated in Figure 2 above.

4. The Smart City as a Testbed for the Regenerative Economy

Despite substantial areas of convergence between smart cities and regenerative economies, there remains a conspicuous lack of systematic inquiry into the phenomena, interrelationships, and dynamics at their nexus, as well as insufficient articulation and integration aimed at generating a new knowledge base to underpin the creation of enduring value. Smart and regenerative urban development is frequently examined without conceptual continuity, even though adopting a holistic and interdisciplinary approach to urban development is critical. Such an approach emerges at the intersection of socio-ecological systemic economies, driven by technological innovation, and the ecological principles of urban design, operationalised through an urban regenerative metabolism encompassing both the built environment and its intangible counterpart (Peponi & Morgado, 2020). This gap may be attributed to the relative novelty and ambivalence of both concepts, their status as paradigms radically distinct from mainstream economic and urban theory, and the ongoing institutionalisation process, which requires the support of the professional community, international organisations, and governmental bodies.

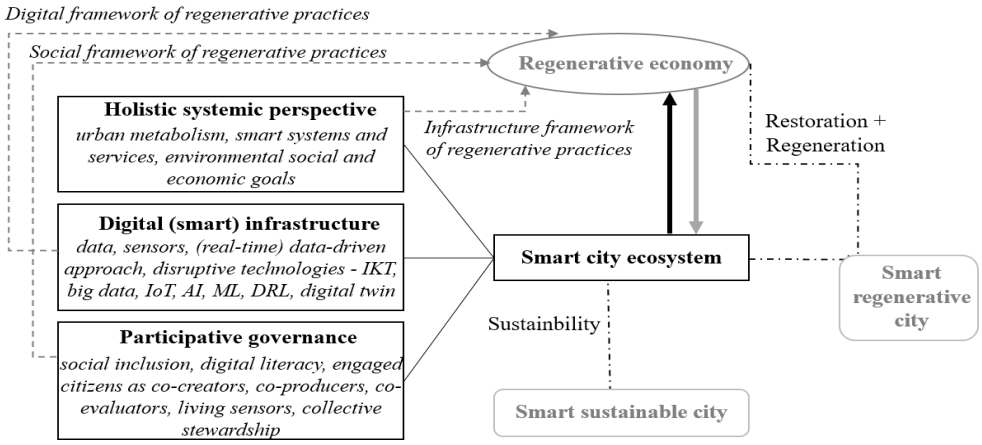
The regenerative economy and the smart city converge around a holistic vision of sustainability, a conviction in people and communities as agents of change, reflecting a bottom-up governance approach, and a proclivity for harnessing innovative technological solutions to optimise and restore ecological functions, thereby fostering urban transformation and operationalising regenerative principles (the precise monitoring and feedback of ecological and social impacts, the management of regenerative processes, the activation of intelligent regenerative energy networks, bioregional planning, and the application of collective intelligence to spatial regeneration). Moreover, smart city systems are increasingly recognised as essential infrastructural, digital, and social frameworks for embedding the principles of regenerative design (and the regenerative economy) within transforming urban spaces (Allam & Newman, 2023). In this regard, the smart city serves as a techno-systemic substratum, whereas the regenerative economy delineates the ethical and economic context.

Truly regenerative economies cannot emerge within purely profit-driven contexts; they require decentralisation, eco-friendly legislation, investments in ecosystem restoration, educational reforms fostering empathy and environmental stewardship, and socially beneficial objectives (Hinton, 2022). Their models address not only the regeneration of resources but also that of human communities and local economies (Drupsteen & Wakkee, 2024). Regenerative practices demand localisation and collaboration across communities, academia, and the business sector (Das & Bocken, 2024). The flourishing of such economies depends on an equally holistic environment, exemplified by smart cities conceived as living systems attuned to cultural and historical urban dynamics, where technological infrastructures intersect with cultural dimensions (urban heritage and creative industries as elements of smart city branding), metabolism (intelligent systems curbing overconsumption and waste), and governance (urban solutions derived from data, protocols, and partnerships linking local and regional authorities, businesses, and civil society) (Allam & Newman, 2018).

Digital infrastructure in smart cities facilitates metabolic synergies across urban subsystems by interconnecting them, while ICT and IoT orchestrate the operation of urban infrastructures, systems and services, thereby promoting economic, ecological, social, and cultural excellence and resilience. In contexts where a profligate mindset drives the transition from linear to circular urban metabolisms, holistic regenerative design is applied to urban metabolic flows and human–natural capital relationships. Systems thinking, real-time data-driven approaches, and open urban data**,** combined with principles of urban ecology and the regenerative economy, embed biomimetic principles into urban systems design, enabling cities to self-renew and recover to a state superior to their pre-risk conditions. Such a city functions as a temple of regenerative principles and practices: it purifies air, water, and soil; provides habitats for species; limits harmful emissions; generates renewable energy; encourages recycling, wastewater reuse, and rainwater harvesting; supports the circulation of biodegradable materials, the recycling of non-biodegradable waste, and the efficient management of e-waste; promotes green spaces, environmentally friendly mobility, and intelligent green and blue infrastructure; fosters healthier lifestyles; enhances resilience to hazards via intelligent risk modelling; and

underpins cultural and artistic production as well as technological and scientific research (Peponi & Morgado, 2021). Overall, digital infrastructure, woven from data streams, sensors, automated systems, knowledge engineering, and inter-domain knowledge-sharing processes within the urban fabric (Balakrishna, 2012), and supported by the enabling capacities of IoT, AI, ML, and DRL technologies (Ullah et al., 2020), reconfigures the smart city into a digital-ecological organism. Such an organism, endowed with embedded digital intelligence, learns from its own metabolic processes, adapts dynamically, regenerates resources and itself. Simultaneously, it advances the urban transition towards closed-loop systems in which energy, water, and materials are continuously recycled and repurposed through digitally integrated networks that interlink citizens and industrial systems. The regenerative potential of smart city technologies extends far beyond sustainable resource governance; it represents a paradigmatic shift in intelligent urban waste management, where digital intelligence transforms the challenge of disposal into an opportunity for renewal. AI-driven waste classification, together with IoT-enabled and blockchain-supported real-time tracking systems, has been shown to reduce collection costs by up to 30%, increase material recovery rates to 95%, and convert traditionally linear distributive structures into smart circular innovation networks (Čišić et al., 2025). Unquestionably, the smart city stands as both the infrastructural and digital frontier of the regenerative economy.

Figure 3. A Conceptual Model of the Smart City as an Experimental Ground for the Regenerative Economy



Source: Authors

Citizen participation forms a cornerstone of data-driven urban transformations, wherein feedback generated through inclusive engagement by a digitally literate public complements centralized policies that frequently exhibit limited sensitivity to local realities and potential urban crises (Bvuma, 2024). Within smart cities, residents occupy multiple roles - as ICT users, democratic participants in urban decision-making, co-creators of urban processes (Simonofski et al., 2017, p. 229), and co-authors of evaluative criteria as well as co-assessors of the urban project intelligence, sustainability, and impact (Paskaleva et al., 2021). The smart city thus functions as a social infrastructure supporting a regenerative economy. Empowered

smart city citizenship, facilitated by digital platforms, open data protocols, and e-participation mechanisms, operationalizes regenerative economy principles through collective action across key domains - regeneration and circularity, localization and contextualization, adaptability and innovation, transparency and accountability, participation and distribution, and regulation and contribution (Künkel, 2022, pp. 315-316). While inclusive, open governance in smart cities mitigates the challenges inherent in implementing a regenerative economy, the smart city market simultaneously incentivizes business actors to adopt regenerative business models, in which circularity, reflecting the cyclical nature of data, technologies, knowledge, policies, and smart city solutions, constitutes a core component (Mylonas et al., 2024). Multimodal and hybrid governance mechanisms, progressing from structural to procedural hybridity, integrate models of public hierarchy, market-based governance, partnerships (networks), and community-based governance, while accentuating the catalytic and orchestrating role of local government, thereby supporting the regenerative transition (Anttiroiko, 2023). Finally, smart city metrics, comprising diverse approaches, analytical tools, and indicators (Hajek et al., 2022), offer an invaluable instrument for evaluating the realisation of regenerative economy processes. Accordingly, the smart city emerges as a highly conducive environment for translating theoretical models of the regenerative economy into tangible, measurable, and self-sustaining practices, as illustrated in Figure 3.

Ultimately, the future developmental trajectory of smart cities, which until recently was largely aligned with the discourse of smart sustainable cities, whose focus is shifting from a technocratic vision of urban development towards a more nuanced examination of the impacts of smart technologies on sustainability, resilience, climate change, UN SDGs, and the growing integration of environmental and ecological indicators within smart city assessment frameworks (Blasi et al., 2022; Janik et al., 2020; Yigitcanlar et al., 2019; Bibri, 2018), should be reoriented towards the vision of the smart regenerative city. Smart cities, widely recognised as experimental testbeds for the implementation of regenerative economy principles in real urban contexts, are emerging as exemplars of regenerative socio-ecological systems that preserve integrity over time, promote both ecological and human regeneration, and foster mutually reinforcing dynamics between the two (Buckton et al., 2023).They entail a more refined application of advanced technologies, embedded directly within the urban fabric, than has hitherto been the case, not merely to harmonise overall urban implications, both positive and negative, towards producing neutral effects on planetary health, but to support the positive forces driving the active regeneration of ecological and social systems, and the evolution of cities that give back (Nauwelaers et al., 2024).

5. Concluding Remarks

Regenerative economics constitutes a transformative framework designed to support economies burdened by social and environmental challenges (Shannon et al., 2022), being equally responsive to economic, ecological, and social dimensions. The ultimate objective of transformative efforts to mitigate the consequences of linear and degenerative economic models which compromise the Planet's inherent

regenerative capacity (Das & Bocken, 2024), is manifested in the transition towards a regenerative economy that transcends green and circular economies (broader context), and integrates the philosophy of regeneration into the continuum of modern social relations at both regional and global scales (narrower context) (Avdokushin & Kuznetsova, 2023, p. 9). Simultaneously, the phenomena that predominantly shape contemporary global society, namely urbanisation and technologisation, are reconciled within the concept of the smart city. The ongoing co-evolution of socio-cultural, technological and ecological processes converges in user-centric smart cities that are adaptable to climatic and natural hazards, proficient in encouraging community cohesion and activating the green economy, progressive in terms of urban ecological quality and overall quality of life, and oriented towards the intelligent optimisation of urban metabolic processes (Peponi & Morgado, 2021).

The main contribution of this study lies in its strategic approach and systematic articulation of the interactions, implications, and specificities of the relationship between smart cities and regenerative economics, highlighting potential areas, dimensions, and aspects of smart cities that facilitate the transition to regenerative economy within the urban milieu. This topic has been insufficiently explored in the literature, particularly in domestic context, and a comprehensive review that reaches further and deeper beyond the fragmented research on smart urban development and regenerative principles has been notably absent. The findings demonstrate that the technocratic foundation of smart cities, when complemented by human-centric perspective, contributes to the effective implementation of regenerative initiatives, and that a city can attain its full regenerative functionality only when smart solutions and data-driven strategies synergistically support ecological, social, and economic functions, i.e., within the smart cities ecosystem. The smart city thus emerges as an infrastructural, digital, social, and regulatory mechanism for the operationalisation of regenerative economics. Inclusive governance structure and digitally enhanced intelligence of the smart city act as activators of regenerative adaptations and catalysts for realising the full potential of regenerative economics, making it the cradle of regenerative development.

Future research is expected to evolve along several lines: first, in quantifying the efficiency of regenerative economics within specific smart urban contexts, using indicators from relevant smart city evaluation frameworks adapted to reflect regenerative processes, and subsequently enabling cross-comparison. A second line of inquiry concerns a systematic review of the scientific corpus on smart regenerative cities (identifying research gaps, emerging topics, conceptual-theoretical models) or original quantitative studies addressing their scope (development and validation of assessment frameworks and indicators, case studies, comparative analyses, simulation models). This is particularly relevant given that the smart regenerative city represents the outcome of the ongoing synthesis of technological inventiveness and regenerative reflection within urban studies, aimed at realising the vision of a durable and replicable model of urban development for the future. Furthermore, forthcoming investigations may focus on the technologies underpinning smart regenerative cities, particularly in the context of digital systems and governance, biophilic design, and neighbourhood-scale urban planning.

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PAMETAN URBANI RAZVOJ KAO OKVIR REGENERATIVNE EKONOMIJE

Apstrakt: *Destruktivno i nesavesno ponašanje ljudskih bića, korporacija, institucija, vlada, vođeno logikom ekonomskog rasta po svaku cenu, bez obzira na posledice, ozbiljno ugrožava balansirajuće mehanizme sistema očuvanja života na planeti, čineći da se obilje resursa, šansi, izbora više ne može uzeti zdravo za gotovo. U eri hegemonije podataka, inovacija, nauke, retorika pametnog grada izdvaja se kao logičan iskorak ka urbanom razvoju budućnosti. Regenerativna ekonomija, s druge strane, prepoznaje se kao prekopotreban model ekonomskog razvoja sa ogromnim potencijalom uspostavljanja partnerskih odnosa između prirodnih i socio-ekoloških sistema, s ciljem sveopšteg blagostanja, te njihovom formalizacijom, putem legitimnih upravljačkih i institucionalnih struktura. Kako bi transformativni obrasci trebalo da budu višeznačni, komlpementarni i sinergijski, pre nego rivalski i isključivi, to se kao cilj rada nameće povezivanje koncepata regenerativne ekonomije i pametnog grada i determinisanje specifičnosti i implikacija ove veze.*

Ključne reči: *održivost, pametan urbani razvoj, pametan grad, regenerativna ekonomija, pametan regenerativan razvoj*

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THE ROLE OF NON-TAX REVENUES IN THE FISCAL SYSTEMS OF WESTERN BALKAN COUNTRIES

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Abstract: *This study examines the impact of non-tax revenue on the budget balance in the Western Balkan countries, aiming to determine whether this segment of public revenues can represent a sustainable mechanism for fiscal consolidation. The analysis covers five countries (Serbia, North Macedonia, Montenegro, Albania, and Bosnia and Herzegovina) over the period 2008–2024, using annual panel data expressed as a percentage of GDP. The research procedure was conducted using Pooled OLS, Random Effects, and Fixed Effects models, which allow for a comparison of the impact of non-tax revenues under different assumptions about country heterogeneity. Additionally, the F-test, Breusch-Pagan LM test, Hausman test, as well as checks for autocorrelation and heteroskedasticity were conducted, enabling the selection of the optimal model specification. The panel test results indicate that there are no statistical reasons to apply REM or FEM approaches, and Pooled OLS is identified as the most appropriate model. The coefficient for non-tax revenues remains stable and significant across all models (β≈1.3), confirming the robustness of the findings and suggesting that an increase in non-tax revenues contributes to a reduction in the budget deficit. The Granger causality test shows a one-way relationship—non-tax revenues Granger-cause changes in the budget balance, while the reverse direction is not statistically confirmed. Thus, the study empirically confirms that diversification of the revenue side of the budget can serve as an effective channel for fiscal consolidation in a region predominantly reliant on tax revenues. The results indicate that the potential for strengthening non-tax revenues deserves greater attention in the formulation of fiscal strategies in the Western Balkans, as it can contribute to the creation of a more resilient, sustainable, and fiscally balanced budget system.*

Keywords: *Non-tax revenues, budget deficit, panel analysis, fiscal systems, Western Balkans.*

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1. Introduction

Contemporary fiscal systems face challenges in maintaining public finance stability amid limited tax capacities, rising public expenditures, and macroeconomic shocks. In this context, non-tax revenues are becoming an increasingly important component of fiscal systems, as they allow for the diversification of budgetary resources and the strengthening of fiscal resilience. Non-tax revenues encompass a wide range of sources, including revenues from public assets, dividends from state-owned enterprises, administrative fees, concession payments, and fines. Although their share in total budget revenues is not always dominant, the literature highlights their key role in complementing tax revenues and stabilizing fiscal system, particularly in economies with pronounced fiscal constraints (Boadway & Keen, 2023; OECD, 2024).

The Western Balkan region, with its specific structural characteristics of fiscal systems and historically low tax capacities, represents a particularly suitable area for studying the role of non-tax revenues. Countries in the region have traditionally relied on revenues from fees, parafiscal charges, and state-owned enterprises. However, low predictability and weak institutional oversight often limit their fiscal potential (Bartlett & Prica, 2021). Contemporary empirical literature suggests that effective management of public assets, clear regulation of fees and charges, and the restructuring of state-owned enterprises can significantly increase the stability and predictability of non-tax revenues, making them a sustainable instrument for fiscal consolidation (Allen & Krause, 2021).

The aim of this paper is to analyze the role of non-tax revenues in the fiscal systems of Western Balkan countries through an empirical assessment of their impact on the budget balance over the period 2008–2024. Investigating this issue has both practical and theoretical value, as it can provide insights into the potential of non-tax revenues to contribute to deficit reduction and the enhancement of fiscal sustainability in a region with limited tax capacities.

2. Theoretical framework of the role of non-tax revenues in the fiscal systems of Western Balkan countries

Non-tax revenues represent a heterogeneous category of public revenues, encompassing income from fees and charges, revenues from public assets, dividends from state-owned enterprises, administrative fees, concession payments, fines and penalties, as well as other non-normative sources of state revenue. Although they do not always occupy a dominant position in the overall budget structure, contemporary literature suggests that their fiscal role goes beyond merely supplementing tax revenues, particularly in economies with pronounced fiscal constraints and high public expenditure demands (Boadway & Keen, 2023). According to OECD analyses, the growth of non-tax revenues results from institutional improvements, the modernization of public asset management, and increased transparency in public service financing, making them an increasingly important instrument of fiscal policy in countries with limited tax capacity (OECD, 2024). In developing countries, these

revenues often play a stabilizing role during periods when the tax base weakens due to structural shocks, thus becoming one of the main supplementary supports for fiscal sustainability (Gupta et al., 2022).

Empirical literature highlights that the fiscal contribution of non-tax revenues is strongly dependent on the institutional architecture of the public sector. In economies where public assets are efficiently managed, where clear regulations exist for fees and charges, and where state-owned enterprises are restructured according to the principles of commercial sustainability, non-tax revenues can represent a predictable and stable source of funding (Allen & Krause, 2021). Conversely, the lack of transparency, politicization of state-owned enterprises, and weak control over concessions and natural resources often lead to volatility in these revenues and reduce their fiscal significance (IMF, 2023). Studies from Central and Eastern European countries show that reforms of fee and charge systems directly influence their contribution to the budget, with the rationalization of parafiscal charges, the digitalization of public services, and clear regulatory frameworks being key factors in enhancing fiscal efficiency (European Commission, 2022).

A particular focus in recent literature is the role of non-tax revenues in fiscal stabilization during crises. Analyses conducted following the COVID-19 pandemic indicate that revenues from dividends, concessions, and public assets became an additional source of flexibility in many European economies, particularly in countries with limited fiscal space and slow recovery of the tax base (World Bank, 2023). However, risks were also identified, including the procyclical nature of state-owned enterprise revenues, declines in fee income due to reduced economic activity, and lower investment in areas where concessions serve as a budgetary revenue source. These findings suggest that non-tax revenues cannot serve as automatic stabilizers but can significantly strengthen fiscal resilience if they are based on sustainable and well-regulated sources (IMF Fiscal Monitor, 2024).

In the Western Balkan region, the literature indicates that the importance of non-tax revenues primarily stems from structural characteristics of fiscal systems and long-standing institutional constraints (Bartlett & Prica, 2021). The countries of the region have traditionally relied on revenues from fees, parafiscal charges, concession payments, as well as income from state-owned enterprises and public assets, with their share in total revenues being significantly higher than in most EU member states (World Bank, 2024). At the same time, numerous studies emphasize that insufficient transparency, weak governance structures in state-owned enterprises, and unregulated parafiscal charges lead to low predictability and stability of these revenues, complicating long-term fiscal planning (Marović et al., 2022). In practice, non-tax revenues often have a political dimension, being used to fill short-term fiscal gaps rather than as part of a strategic public finance management approach.

Recent studies analyzing the fiscal perspectives of the Western Balkans note that the role of non-tax revenues is expected to grow in the coming years due to increasing budgetary obligations in infrastructure, energy, the green transition, and demographic policies. Revenues from energy sector concessions, the management of mineral resources, and the modernization of state-owned enterprises represent key potential sources of budget stabilization, but only if reforms in public asset

management are implemented and unregulated parafiscal charges are reduced (EBRD, 2024). In a region where tax capacities are limited and public spending is structurally rigid, non-tax revenues are becoming an increasingly important component of fiscal sustainability, particularly in the context of slow nominal growth and rising debt service costs.

Broadly speaking, the literature indicates that Western Balkan countries face a dual challenge: the need to diversify budget revenues amid limited tax capacities and the simultaneous necessity of institutional strengthening in the management of non-tax revenues as a precondition for their stability. According to analyses by the European Commission and international financial institutions, the countries of the region must modernize their fee systems, improve public asset management, enhance the efficiency of state-owned enterprises, and introduce strict regulation of parafiscal charges for non-tax revenues to become a predictable fiscal instrument rather than an ad hoc source of budget consolidation (European Commission, 2025; IMF, 2024). These conclusions confirm that the role of non-tax revenues in the fiscal systems of the Western Balkans is increasingly linked to institutional capacity, governance quality, and long-term public finance strategies, making them a key component of public finance sustainability in the coming decades.

3. Data Collection and Panel Construction

The empirical analysis is based on a panel dataset covering five Western Balkan countries: Serbia, North Macedonia, Montenegro, Albania, and Bosnia and Herzegovina. The observed period spans from 2008 to 2024, with available annual data for each country, forming a balanced panel with a total of 85 observations (5 countries × 17 years). All data were obtained from the official websites of the respective ministries of finance, ensuring a high level of reliability and comparability, as the study relies exclusively on primary official sources (Ministry of Finance of Albania; Ministry of Finance of the Republic of Serbia; Ministry of Finance of North Macedonia; Government of Montenegro; and the Central Bank of Bosnia and Herzegovina). Specifically, annual budget execution reports were used, and indicators were expressed as relative values in % of GDP, eliminating the influence of different economy sizes and enabling cross-country comparisons of fiscal aggregates.

The Western Balkans region represents a suitable choice for panel analysis due to the pronounced macroeconomic homogeneity of its countries and the existence of common fiscal patterns. According to the World Bank report for 2025, all Western Balkan economies share similar sources of growth, structural weaknesses, and continuous fiscal pressures—including economic slowdown, rising expenditures, and widening fiscal deficits in most countries of the region. The report also confirms that, despite fiscal inflows, public finances remain burdened by growing public spending, with the revenue side of the budget still predominantly reliant on taxes. Furthermore, the Western Balkans share a common development trajectory based on EU convergence and gradual alignment of fiscal rules with European standards, making the region coherent for research and relevant for assessing the role of alternative (non-tax) revenues in stabilizing the budget position. Therefore, the

Western Balkans constitute a logical and theoretically grounded group for empirical panel analysis of fiscal dynamics (WB, 2025).

4. Data Analysis

To preliminarily examine the relationship between the budget deficit and non-tax revenues in the Western Balkan countries, a descriptive analysis of the panel dataset covering five countries—Serbia, North Macedonia, Montenegro, Albania, and Bosnia and Herzegovina—was conducted for the period 2008–2024. The data are expressed as a percentage of GDP, which allows for cross-country comparability regardless of differences in absolute economic size and levels of development.

Table 1 – Trends in Budget Balance (BB) and Non-Tax Revenues (NTR) in Western Balkan Countries (2008–2024)[2]

Country	Min BB	Max BB	Mean BB	Min NTR	Max NTR	Mean NTR
Serbia	-7,68	1,06	-3,16	2,03	3,23	2,58
Montenegro	-10,20	0,49	-4,21	0,50	2,70	1,16
North Macedonia	-8,05	0,92	-3,51	1,67	4,43	2,47
Albania	-7,90	-1,30	-3,65	1,00	1,90	1,47
Bosnia and Herzegovina	-5,21	2,53	-0,93	2,01	3,02	2,49

Source: Author's elaboration based on Gretl statistical software.

Observation of aggregate values of the budget balance and non-tax revenues indicates that the Western Balkan countries are, on average, characterized by a negative fiscal position and a relatively low share of non-tax revenues in GDP throughout the observed period 2008–2024. The budget balance is, on average, negative in all economies, confirming the presence of chronic fiscal pressures and limited fiscal space in the region, while non-tax revenues are quantitatively low, ranging approximately from 1% to 3% of GDP. At the regional level, it can be observed that average non-tax revenue values remain consistently low within the structure of fiscal revenues, indicating the relatively limited fiscal significance of this source of public expenditure financing. A more detailed assessment of variability and the intensity of changes in the trajectories of both series will be conducted below through an analysis of standard deviations by country.

Table 2 - Standard Deviation of Budget Balance and Non-Tax Revenues by Country

Country	Standard deviation BB	Standard deviation NTR
Serbia	2,40	0,33
Montenegro	2,66	0,50
North Macedonia	1,65	0,77
Albania	1,89	0,27
Bosnia and Herzegovina	2,16	0,27

Source: Author's elaboration based on Gretl statistical software.

The results presented in Table 2 allow for the assessment of the variability of the observed fiscal series, i.e., the degree of deviation from their average values.

[2] Note: A positive value of the budget balance indicates a surplus, while a negative indicates a deficit.

Montenegro exhibits the highest volatility in the budget balance (SD=2.66), further confirming pronounced fiscal deviations and episodes of deep deficits, while Serbia and Bosnia and Herzegovina also show high variability in the balance (SD=2.40 and 2.16, respectively). The most stable fiscal position among the analyzed economies is observed in North Macedonia (SD=1.65), followed by Albania (SD=1.89), indicating a narrower range of deviations and relatively moderate dynamics in the budget balance.

Regarding non-tax revenues, the standard deviation values are low across all countries, confirming the previous observation that non tax revenues are relatively stable over time, with the highest variability in North Macedonia (SD=0.77) and Montenegro (SD=0.50), while Albania and Bosnia and Herzegovina are the most stable in terms of NTR sources (SD=0.27). These findings suggest that the volatility of the fiscal balance is primarily generated on the expenditure and tax revenue side of the budget, whereas non-tax revenues remain structurally stable and exhibit low fluctuations, further justifying the empirical testing of their economic strength and effect on the budget balance.

5. Model Specification and Research Description

The aim of the empirical part of the study is to examine the relationship between the budget balance and non-tax revenues in the Western Balkan countries in order to determine whether changes in the level of non-tax revenues have the potential to influence fiscal balance dynamics. The underlying assumption of the research stems from the theoretical expectation that the growth of alternative public revenues can contribute to reducing the budget deficit and strengthening fiscal sustainability, particularly in countries with high dependence on the tax base. Accordingly, the hypothesis is formulated that a higher level of non-tax revenues positively affects the budget balance, i.e., contributes to deficit reduction.

The empirical approach was implemented in several steps. The first part of the analysis involves estimating a basic model using the Ordinary Least Squares (OLS) method to determine the direction and magnitude of the relationship between non-tax revenues and the budget balance across the entire panel. The model specification can be expressed in the following form (Gujarati & Porter, 2009):

$$BB_{it} = \alpha + \beta NTR_{it} + \varepsilon_{it}$$

Where:

BB_{it} - The budget balance in the i-th country at time t,

NTR_{it} - The non-tax revenue in the i-th country at time t,

α – intercept (constant term),

β – The coefficient of the explanatory variable and

εit – The error term.

After the initial OLS estimation, the model is further developed through panel specifications, including the Random Effects Model (REM) and the Fixed Effects

Model (FEM), which allow for controlling unobserved country-specific characteristics that do not vary over time. The choice between REM and FEM will be determined using the Hausman test, while the appropriateness of applying the panel approach will be assessed with the Breusch–Pagan LM test and the F-test.

The validation of empirical findings also includes testing key assumptions of the econometric model. In particular, autocorrelation and heteroskedasticity tests will be performed, and if detected, robust standard errors will be applied. Since the study is based on the impact of a single regressor on the dependent variable, testing for multicollinearity is not necessary.

In the final stage of the analysis, the Granger causality test will be conducted to examine whether changes in the level of non-tax revenues precede changes in the budget balance, and vice versa. The causality testing is based on the panel VAR approach, with the null hypotheses formulated as follows:

H_0: *Non-tax revenues do not affect the budget balance*

H_0: *The budget balance does not affect non-tax revenues*

Rejection of the null hypothesis at a significance level of $p<0.05$ indicates the existence of a causal relationship between the series. Thus, the econometric analysis allows not only the confirmation of correlation but also the identification of the potential direction of influence between the fiscal variables. The results of the OLS, REM, and FEM models, as well as the diagnostic tests and the Granger causality test, are presented in the following chapter.

6. Results of Applied Models and Economic Interpretation

The starting point of the empirical analysis is the estimation of the Pooled OLS model, which examines the basic relationship between non-tax revenues and the budget balance in a panel of 85 observations. The model treats all observed units as a homogeneous structure, without distinguishing the specific characteristics of individual countries. The aim of the initial estimation is to preliminarily establish the existence of a statistical relationship between changes in the level of non-tax revenues and movements in the budget deficit, which subsequently provides the basis for comparison with panel models (REM and FEM).

Table 3 – Results of the Pooled OLS Model

Variable	coefficient	standard error	T-Statistic	p-value
Const	-5,77	0,69	-8,34	0,000
Non-tax revenues	1,32	0,32	4,13	0,000

Source: Author's elaboration based on Gretl statistical software.

The results of the Pooled OLS model indicate that the model as a whole is statistically significant, as the F-statistic ($F = 17.09$) with $p < 0.001$ shows that non-tax revenues, as the explanatory variable, significantly contribute to explaining the variability of the budget balance. Since the model contains only one explanatory

variable, the F-test in this case is practically equivalent to the t-test for the coefficient β, indicating that changes in the level of non-tax revenues significantly affect the variations in the budget balance within the observed sample.

The coefficient of determination, $R^2 = 0.17$, and the adjusted $R^2 = 0.16$, indicate that approximately 17% of the variation in the budget balance can be explained by changes in non-tax revenues. Although the percentage of explained variance is not high, this level of determination is expected in macroeconomic panel studies, given that the budget position depends on multiple factors (GDP growth, public expenditure, tax revenues, debt burden, political cycles), while this study considers only a single regressor. Therefore, the OLS results serve as a starting point, with a more precise assessment of the impact expected in panel models that account for country heterogeneity and temporal dynamics.

The positive and statistically significant coefficient of non-tax revenues ($\beta = 1.32$; $p < 0.001$) indicates that an increase in the share of non-tax revenues in GDP by one percentage point leads, on average, to an improvement in the budget balance of approximately 1.32 percentage points, i.e., to a reduction of the budget deficit (considering that deficits are expressed as negative values). The results of the REM model are presented in Table 4.

Table 4 – Results of the REM Model

Variable	coefficient	standard error	T-Statistic	p-value
Const	-5,77	0,69	-8,34	0,000
Non-tax revenues	1,32	0,32	4,13	0,000

Source: Author's elaboration based on Gretl statistical software.

The results of the REM estimation show that introducing a panel structure with countries as random effects does not change either the direction or the magnitude of the impact of non-tax revenues on the budget deficit. The coefficient β remains almost identical to that in the OLS model (1.32 compared to 1.32), while its statistical significance remains high ($p < 0.01$). In other words, treating the data as a panel with constant but unobservable country-specific characteristics does not provide additional explanation of the relationship, implying that fixed heterogeneity between countries does not significantly affect the estimation of β.

The REM estimation suggests that differences between countries cannot be explained solely by individual fixed characteristics, but that most of the variability is present within the time series (within-variance 5.10 vs. between-variance 0). This indicates that the NTR → BB relationship predominantly changes over time within countries rather than across them.

Table 5 – Results of the FEM Model

Variable	Coefficient	Standard error	T-Statistic	p-value
Const	-5,72	0,71	-8,04	0,000
Non-tax revenues	1,30	0,33	3,94	0,000

Source: Author's elaboration based on Gretl statistical software.

The results of the FEM model, presented in Table 5, show that non-tax revenues remain a statistically significant determinant of the budget balance ($p < 0.01$) even in the FEM specification. The estimated coefficient is $\beta = 1.30$, which is very close to the values obtained in the OLS (1.32) and REM (1.32) models, indicating that after accounting for time-invariant country-specific characteristics, both the direction and the strength of the impact remain stable. In other words, the panel transformation that absorbs unobserved fixed differences between countries did not lead to changes in the estimates, supporting the robustness of the relationship between non-tax revenues and the budget balance.

The coefficient and its significance are almost identical to those in the OLS and REM models, suggesting that individual country-specific characteristics (institutional differences, public finance structure, fiscal rules) do not systematically affect the relationship between the observed variables. All models convey a consistent message: an increase in the share of non-tax revenues is associated with an improvement in the budget balance (i.e., a reduction in the deficit), and the effect remains stable across the transition from classical OLS to panel specifications.

Table 6 – Diagnostic Tests for the Selection of the Optimal Model

Test	Test statistic	p-value	Interpretation	Implications for model selection
F test	0,17	0,95	Fail to reject H0	OLS
LM test	1,95	0,16	Fail to reject H0	OLS
Hausman test	0,32	0,57	Fail to reject H0	REM
Wooldridge test	0,24	0,82	Autocorrelation within acceptable/boundary limit	OLS without robust standard error
White test	0,33	0,85	Absence of heteroskedasticity	OLS without robust standard error

Source: Author's elaboration based on Gretl statistical software.

Based on the results presented in Table 6, it can be concluded that the Pooled OLS represents the most appropriate specification for economic interpretation.

The F-test ($F = 0.17$; $p = 0.95$) indicates that there is no significant difference between group intercepts, i.e., the inclusion of fixed effects does not contribute to explaining the variability of the budget balance. This finding is further confirmed by the LM test ($LM = 1.95$; $p = 0.16$), which does not reject the null hypothesis of equal variance across panel components, confirming that the panel structure does not add statistical value compared to standard OLS. The White test ($p = 0.85$) confirms the absence of heteroskedasticity in the residuals, while the Wooldridge test ($p = 0.82$) indicates no presence of autocorrelation. These results suggest that the key assumptions of the classical OLS model are satisfied, eliminating the need for robust standard errors or alternative specifications.

The optimal model shows that the increase in non-tax revenues has a statistically significant effect on the budget balance, with the estimated coefficient remaining stable across all tested specifications (OLS, REM, and FEM). The estimated value of $\beta \approx 1.3$ implies that a one-percentage-point increase in non-tax revenues as a share of GDP is associated, on average, with a reduction in the budget deficit of

approximately 1.3 percentage points of GDP, indicating an improvement in fiscal position.

The stability of the coefficient across all models indicates that the effect of non-tax revenues on the budget balance does not change when accounting for panel effects, confirming that this impact is both robust and economically meaningful. In other words, an increase in non-tax revenues represents a sustainable channel for fiscal consolidation in a region heavily reliant on tax revenues. This conclusion is further supported by the Granger causality test, which shows that changes in non-tax revenues precede changes in the budget outcome—implying that the growth of non-tax revenues not only coincides with, but also causes, improvements in fiscal position in subsequent periods.

7. Conclusion

The study, conducted on a panel of five Western Balkan countries over the period 2008–2024, aimed to examine whether non-tax revenues represent a sustainable mechanism for fiscal consolidation and whether their growth can contribute to reducing the budget deficit. Using OLS, REM, and FEM models, along with a series of diagnostic tests, the results consistently indicate that non-tax revenues have a statistically significant and positive effect on the budget balance; in other words, their increase is associated with a reduction in the budget deficit. The Pooled OLS specification emerged as the most appropriate, as the conducted tests (LM, F, and Hausman) provided no justification for switching to REM or FEM. The stability of the coefficient across all three models ($\beta \approx 1.3$) confirms that the estimation is robust to methodological changes, lending additional empirical weight to the findings. The estimated coefficient implies that a one-percentage-point increase in the share of non-tax revenues in GDP improves the budget balance by approximately 1.3 percentage points, representing a direct indicator of fiscal relief.

The Granger causality test complements the static model results by showing that the growth of non-tax revenues not only coincides with fiscal improvements but also precedes them, suggesting that it can act as a causal factor in enhancing fiscal outcomes in subsequent periods. This finding is particularly relevant in a region where tax revenues remain the dominant source of public finance, while alternative budgetary revenues are structurally underutilized and undervalued.

Overall, the results support the initial hypothesis of the study: non-tax revenues can serve as an effective instrument for fiscal stabilization and deficit reduction in the Western Balkans. While the explanatory power of the model leaves room for incorporating additional determinants of the budget balance—such as public expenditure, GDP growth, tax revenues, or cyclical factors—the identified effect of non-tax revenues provides a strong foundation for further developing a fiscal strategy based on diversification of public revenue sources.

The key takeaway from this research is that strengthening non-tax revenues, alongside maintaining fiscal discipline and implementing structural reforms, can contribute to a more resilient and sustainable budgetary system in the region. This is

particularly crucial in the context of high fiscal demands, limited tax capacity, and the ongoing goal of convergence with European fiscal standards.

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ULOGA NEPORESKIH PRIHODA U FISKALNIM SISTEMIMA ZEMALJA ZAPADNOG BALKANA

Apstrakt: *Ovo istraživanje se bavi procenom uticaja neporeskih prihoda na budžetski saldo u zemljama Zapadnog Balkana, sa ciljem utvrđivanja da li ovaj segment javnih prihoda može predstavljati održiv mehanizam fiskalne konsolidacije. Analiza obuhvata pet zemalja (Srbija, Severna Makedonija, Crna Gora, Albanija i Bosna i Hercegovina) u periodu od 2008. do 2024. godine, pri čemu su korišćeni godišnji panel podaci izraženi u procentu BDP-a. Istraživački postupak realizovan je primenom Pooled OLS, Random Effects i Fixed Effects modela koji omogućavaju upoređivanje uticaja neporeskih prihoda uz različite pretpostavke o heterogenosti zemalja. Dodatno su sprovedeni F test, Breusch-Paganov LM test, Hausmanov test, kao i provera autokorelacije i heteroskedastičnosti, što je omogućilo izbor optimalne model-specifikacije. Rezultati panel testova ukazuju da nema statističkih razloga za primenu REM ili FEM pristupa, te je Pooled OLS identifikovan kao najadekvatniji model. Koeficijent uz neporeske prihode ostaje stabilan i značajan kroz sve modele (β≈1,3), što potvrđuje robusnost nalaza i ukazuje da rast neporeskih prihoda doprinosi smanjenju budžetskog deficita. Grangerov test uzročnosti pokazuje jednosmerni odnos - neporeski prihodi uzrokuju promene u budžetskom saldu, dok obrnuti pravac nije statistički potvrđen. Time se empirijski potvrđuje da diversifikacija prihodne strane budžeta može predstavljati efikasan kanal fiskalne konsolidacije u regionu koji se dominantno oslanja na poreske prihode. Dobijeni rezultati ukazuju da potencijal jačanja neporeskih prihoda zaslužuje veću pažnju u izradi fiskalnih strategija Zapadnog Balkana, budući da može doprineti stvaranju otpornijeg, održivijeg i fiskalno uravnoteženijeg budžetskog sistema.*

Ključne reči: *Neporeski prihodi, budžetski deficit, panel analiza, fiskalni sistemi, Zapadni Balkan.*

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BENCHMARKING AS A MECHANISM FOR ENHANCING THE HUMAN CAPITAL PERFORMANCE OF HIGHER EDUCATION INSTITUTIONS

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Abstract: *In an increasingly knowledge-based economy, higher education institutions (HEIs) play a vital role in generating and disseminating intellectual capital. However, many European HEIs continue to exhibit low levels of innovativeness, weak connections with the business sector, and insufficient strategic management of human resources. This paper examines benchmarking as a managerial mechanism for improving the human capital performance of HEIs within the broader framework of intellectual capital management. Drawing on the concept of the Intellectual Capital Report, the study identifies dimensions of human capital performance, each represented by specific measurable indicators. Using a benchmarking analysis of human capital performance across selected HEIs in Serbia, Montenegro, Croatia, and Slovenia, the paper compares outcomes to determine best practices and performance gaps. The results reveal significant interinstitutional differences in academic productivity,*

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staff structure, and international openness, highlighting areas where managerial interventions are needed to achieve benchmark performance. The findings underscore the importance of benchmarking not only as a comparative tool but also as a continuous learning and improvement process that supports evidence-based decision-making, enhances transparency, and fosters the development of innovative, entrepreneurial academic environments.

Keywords: *Benchmarking, higher education institutions, human capital, performance measurement, indicators.*

1. Introduction

Certain European higher education institutions (HEIs) are generally characterized by low level of innovativeness, weak links with the business sector, and insufficient attention to commitment to human resource management and other intellectual resource policies (Krstić & Krstić, 2018). Consequently, there is a growing need to adopt innovation-based approaches. Indeed, certain changes have become inevitable. One such innovation involves the adoption of the concept of intellectual capital management within HEIs by their leadership, along with a transformation of organizational culture - from a traditional, bureaucratic model toward a more entrepreneurial, and innovative organizational culture that facilitates change and innovation in key processes.

In the context of the knowledge-based economy, HEIs play a pivotal role as creators, transmitters, and disseminators of knowledge, skills, and innovation (O'Neill & Bagchi-Sen, 2023). Their capacity to generate value increasingly depends not only on physical or financial resources but also on the effective management of intangible assets—particularly human capital. As universities face growing accountability pressures, global competition, and demands for transparency from governments, students, and the business sector, the measurement and strategic management of their intellectual capital have become essential prerequisites for sustainable institutional development.

However, many HEIs still lack systematic approaches to identifying, evaluating, and reporting on the performance on their intellectual resources (Petković, Krstić, & Rađenović, 2020). The absence of structured frameworks and standardized indicators makes it difficult for policymakers, funding agencies, and institutional managers to assess the effectiveness of knowledge creation and transfer processes within academia. Traditional accounting and reporting systems fail to capture the full spectrum of intangible assets such as competencies, expertise, collaboration networks, organizational culture and many other, that underpin organizational performance and competitiveness. Therefore, the implementation of intellectual capital management models in HEIs has emerged as a crucial innovation in higher education governance and strategic management.

Within the theoretical framework of intellectual capital, human capital is recognized as its core component and the most significant determinant of value creation in HEIs (Golikov et al., 2018; García-Carbonell et al., 2021). The quality,

motivation, labor productivity, and mobility of academic and non-academic staff fundamentally shape an institution's intellectual output and its capacity for innovation, teaching excellence, and societal impact. Consequently, managerial efforts aimed at improving human capital performance in HEIs require the implementation of best practices in continuous analysis (Bucăţa & Tileagă, 2023), benchmarking, and the regular preparation of so-called intellectual capital reports. These reports, among other elements, include the presentation of measured human capital performance indicators that serve as a foundation for evidence-based management (Krstić, 2014).

Despite the increasing interest in intellectual capital reporting within the public and academic sectors, empirical research that applies benchmarking methods to evaluate human capital performance in HEIs remains limited, particularly in Central and Southeastern Europe (Krstić, Stanisavljević, & Stanišić, 2014; Krstić, Radivojević, & Stanišić, 2016). This research gap highlights the need for systematic comparative analyses that can identify key areas for improvement and guide the design of targeted managerial interventions.

Accordingly, this paper aims to examine benchmarking as a managerial mechanism for improving the human capital performance of HEIs within the broader framework of intellectual capital management. The study applies benchmarking analysis to identify the key human capital dimensions in which managerial action can enhance institutional performance and align it with the best practices observed among comparable institutions (Faculty of Economics, University of Niš; Faculty of Economics and Business, University of Rijeka; University of Montenegro; Polis University, Tirana, Albania; Faculty of Civil Engineering and Geodesy, University of Ljubljana). By integrating quantitative indicators and qualitative insights, the research seeks to provide a comprehensive understanding of how HEIs can develop more effective strategies for human resource development, knowledge management, and overall organizational learning.

The structure of this paper is as follows. Following the introduction, Section 2 provides the theoretical background and defines the key determinants of intellectual capital and IC reporting in HEIs, with particular emphasis on the role of human capital. Section 3 presents the methodology and data basis for the benchmarking analysis. Section 4 reports and interprets the benchmarking results, while Section 5 discusses managerial implications and strategic recommendations for enhancing the human capital performance of HEIs.

2. Theoretical background

2.1. Key determinants of intellectual capital and intellectual capital reporting of HEIs

The term intellectual capital of higher education institutions (HEIs) is used to encompasses all tangible and intangible assets and resources, including their processes, innovation capacities, patents, and the tacit knowledge of their members, as well as their networks of collaborators and contacts. Intellectual capital (IC) is defined as a

combination of intangible resources and activities that "enable an organization to transform a set of material, financial, and human resources into a system capable of creating value for its stakeholders" (Benzhani, 2010). Intellectual capital consists of three fundamental and closely interrelated components: human capital, structural capital, and relational capital (Krstić, 2009; Krstić & Rađenović, 2017; Krstić & Rađenović, 2018; Secundo et al., 2010).

In the context of HEIs, the components of IC can be understood as follows (Krstić & Rađenović, 2018; Krstić & Rađenović, 2019, Pedro et al., 2019): human, structural, and relational.

Human capital refers to the set of explicit and tacit knowledge possessed by HEI staff (professors, researchers, assistants, and non-academic personnel) acquired through formal and informal learning processes and continuous professional development. This knowledge is expressed through teaching, research, administrative, and other academic activities (Krstić & Rađenović, 2019).

Structural capital represents explicit knowledge related to internal processes of dissemination, exchange, and management of scientific and technical knowledge within the organization (Krstić & Rađenović, 2018). Structural capital may be divided into two main categories: 1) Organizational capital, which refers to the operational environment resulting from the interaction between research, management, and organizational processes, including routines, culture, values, internal procedures, and the quality of information systems; and 2) Technological capital, which includes technological resources available at the university, such as bibliographic resources, archives, technical achievements, patents, licenses, software, and databases.

Relational capital encompasses a wide range of economic and institutional relationships between HEIs and their non-academic partners - such as enterprises, non-profit organizations, local and national government institutions, and society at large. It also includes the external perception of HEIs in terms of their image, attractiveness, credibility, and reputation.

Existing accounting standards (e.g., International Accounting Standard 38) limit the recognition and reporting of intangible assets (O'Dwyer, 2010). Only externally acquired intangible assets can be presented as balance sheet items. Consequently, numerous international regulatory bodies, agencies, and academic institutions - aware of the challenges of valuing internally generated intellectual capital recommend the development and publication of intellectual capital reports to make such assets visible and understandable to stakeholders (Krstić, 2014).

Intellectual capital reports should include a set of indicators that enhance the comprehensiveness and quality of available accounting information within organizations. Improving the accounting systems of HEIs can also be achieved through the preparation and presentation of an Intellectual Capital Report as a complement to traditional financial statements (Petty & Guthrie, 2000). A set of intellectual performance indicators contained in such a report provides essential information required by different HEI stakeholders regarding intangible resources. The obligation to prepare and publish intellectual capital reports in higher education represents a key step toward a new management approach in HEIs, achieving a dual objective (Krstić, 2014): a) to identify

and measure the needs related to the management of intangible resources, and b) to provide useful information to stakeholders for decision-making purposes.

In practice, the intellectual capital report represents a specific instrument for the creation and management of intellectual capital (Krstić & Rađenović, 2022) and for the successful implementation of IC development strategies across various sectors (commercial, non-profit, and public). Its main purpose is to help institutions identify and disclose information on strategies, objectives, visions, activities, and resources, based on financial and non-financial indicators (Mouritsen et al., 2004). The management and reporting of intellectual capital thus aim to identify, measure, manage, and control different forms of IC, and to support both managers and external stakeholders in making informed decisions based on relevant information. Information on intellectual capital is not necessarily designed for a comprehensive evaluation of HEI performance, although it can serve that purpose (Leitner et al., 2005). As in any evaluation process, the criteria for assessing HEI performance must be clearly prioritized. Institutional objectives should be explicitly defined and incorporated into IC reports through the selection, measurement, and presentation of relevant indicators, thereby allowing managers and external stakeholders to verify the achieved results.

The main reasons for reporting on the intellectual capital of HEIs include (Dzinkowski, 2000; Krstić & Rađenović, 2019): a) Improving the transfer of best practices among universities through greater transparency in IC reporting; b) Strengthening university -industry linkages, since intellectual capital serves as the connective medium between academia and business; c) Ensuring transparency and objectivity in performance evaluation by selecting appropriate indicators of intellectual performance that reveal - rather than obscure - results across the main dimensions of human, structural, and relational intellectual capital.

Complex institutions such as HEIs - with multiple missions and societal roles - cannot be fully represented through numerical indicators alone (Piber & Pietsch, 2006). The intellectual capital framework, therefore, functions as a communication tool, where individual performance values may have limited meaning without appropriate contextualization. A detailed description is thus necessary to accompany quantitative measures. The purpose of such a framework - which combines indicators with their qualitative interpretation - is to encourage internal reflection on what should be measured, how it should be methodologically measured, and how measurement outcomes can be further developed to enhance organizational value creation.

The evaluation of HEI intellectual capital should therefore be aligned with clearly defined objectives for IC growth and development (Krstić et al., 2021). Moreover, the assessment involves verifying the effectiveness of achieving these objectives (i.e., planned IC performance) by comparing actual HEI performance with predetermined targets over a defined time horizon (e.g., annual or triennial, depending on the nature of the performance dimension).

2.2. Human Capital as a Determinant of the Intellectual Capital of HEIs

Human resources form the foundation of the value referred to as human capital (Krstić, 2007). Human capital is one segment of the so-called invisible intellectual

capital of an organization, alongside structural and relational intellectual capital. It constitutes the basis for creating, enhancing, and developing other intellectual-and even material-resources of the enterprise (Petrović et al., 2025).

The human resources of HEIs consist of all employees-those engaged in teaching and non-teaching positions-who possess professional knowledge (qualifications), skills, work habits, professional experience, levels of training, motivation, commitment to the job/HEI, learning and adaptation abilities, as well as various other performance attributes. Human resources, as a set of employee competencies (knowledge, skills, experience) and commitment, determine the organization's work potential and its innovative (creative) capacity. Human (intellectual) potential can be expressed as (Ulrich, 1998):

$$Competence \times Commitment,$$

meaning that only the simultaneous presence of both competence and commitment can generate strong individual performance and favorable organizational outcomes.

By increasing individuals' knowledge, competencies, commitment, and skills within the organization's workforce, the organization's productive (service) potential grows, positively influencing its overall business success and competitive advantage. The knowledge that all employees must possess and continuously develop includes general knowledge necessary for performing work tasks, typically acquired through formal education systems or work experience. In addition, specific knowledge - unique to particular jobs and/or acquired through specialized training and long-term experience - is also crucial. Beyond knowledge, personal abilities are equally important. Employees may possess various types of abilities: communication, organizational, rapid learning, adaptability, teamwork, knowledge sharing, building personal contacts and social networks, problem-solving, conflict mitigation, and abilities grounded in emotional intelligence, among others.

According to several authors (Pasban & Nojedeh, 2016; Krstić & Rađenović, 2018; Angrist et al., 2019; Deming, 2022), human capital comprises not only individual and organizational knowledge, competencies, employee skills, experience, and commitment, but also the individual characteristics of people in the organization, such as creativity, innovativeness, motivation, diligence, responsibility, perseverance, initiative, critical thinking, learning capacity, flexibility, etc.

Human resources endowed with knowledge, information, and skills that are generally available to the wider public and accessible to any organization - i.e., resources that can be easily acquired or "rented" - represent generic human resources, which do not necessarily have significant strategic value for a given enterprise (Veselinović et al., 2022). In contrast, employees who have developed specific, experience-based, and routine knowledge within the organization-through learning processes, practical problem-solving, accumulation of specific experiences, and interaction among organizational members - represent highly valuable, organization-specific human resources. Their knowledge and skills have strategic

relevance for that particular organization, although they may not hold substantial value for others.

To maximize the value of human resources, it is essential to systematically and continuously apply the concept of knowledge management - both individual and collective, tacit (implicit, uncodified) and explicit (codified) knowledge. Knowledge management emphasizes the conversion of individual tacit knowledge into collective, organizational, explicit, and visible knowledge. In this way, individual knowledge becomes embedded in the so-called organizational memory, remaining available even after employees leave the organization, and forming the basis for the development of structural intellectual capital (Diab, 2021).

Human resources exhibit their own performance outcomes; therefore, the performance of human resources within an enterprise must be measured and controlled. For every successful organization, the productive use of human resources is particularly important, giving rise to the concept of human-resource-use performance, such as the efficiency of utilizing human potential or the productivity of their work (Veselinović et al., 2021). Human potential is also visible and generated through various interaction patterns - among employees, between employees and managers, among managers themselves, and between owners and employees. Consequently, human capital also encompasses employee- manager relationships within the organization. These relationships further determine the financial value of a company's human capital. Such value may be calculated based on total labor-related costs (wages, salaries), investments in employee training and development, and other benefits and compensations provided to employees. Human resources are one of the most important success factors in contemporary circumstances, often described as the knowledge society and knowledge economy. Hence, human resources cannot be viewed merely as a cost factor or expenditure; rather, they must be treated as "human capital" or as "assets" embodied in people (Krstić & Bonić, 2016).

2.3. Selecting key performance measurement dimensions of human capital and key human capital performance indicators as a management tool for HEIs

Most managers in contemporary organizations strive to measure all available resources, provided that such measurement is feasible (Amidon, 2002). Accordingly, the intellectual capital of HEIs should be measured for several key reasons:

1) Enhanced transparency of public institutions. - In a knowledge-based economy and society, citizens demand continuous and adequate access to information regarding the allocation and utilization of public funds.

2) Facilitation of good-practice transfer. - The exchange and dissemination of good practices among universities could be significantly improved if HEIs have access to accurate and detailed information about their intellectual capital. Strengthening the relationship between academia and the business sector is not possible without establishing a common language for them. Such a framework, grounded in intellectual capital information, allows both parties to develop sustainable and mutually beneficial relationships.

3) Accountability and visibility of performance. - Measuring intellectual capital through clearly defined indicators and standardized reporting methodologies makes it more difficult to conceal poor performance by individual researchers or staff compared with generalized, non-transparent activity reports.

4) Promotion of collaboration and network creation. - The introduction of a common framework derived from measurable intellectual performance can serve as the foundation for creating research networks and consortia across different HEIs.

The measurement of intellectual capital should consider various outputs - both organizational outputs (e.g., publications, training programs) and user or client-related outputs (e.g., problem-solving results). Consequently, intellectual capital measurement serves as a stimulus for enhancing the productivity of knowledge-based work. Such a system should help organizations that rely on intellectual capital to identify which activities yield desired outcomes and which do not.

When designing instruments for intellectual capital measurement, the following potential challenges should be considered (Kannan & Aulbur, 2004; Jurczak, 2008; Dumay, 2009):

1) Complexity and data overload. - Excessive detail or an overabundance of indicators may render the measurement system cumbersome and impractical.

3) Short-term bias. - Indicators that emphasize short-term performance can have unintended long-term consequences, as employees may focus on easily measurable activities while neglecting those that are harder to measure yet strategically significant.

4) Cultural barriers within the organization. - Resistance to measurement, insufficient understanding of the importance of certain indicators, and a lack of appreciation for performance monitoring and control can impede implementation.

5) Insufficient involvement of key personnel. - Limited participation by essential employees across institutional structures can compromise the reliability of measurement.

6) Conceptual ambiguities. - The absence or inconsistency of definitions for key terms, categories, or methodologies may undermine the credibility of the measurement processes.

7) Weak strategic alignment. - Poorly defined or disconnected visions and strategies, and their lack of integration with individual actions, reduces the effectiveness of intellectual capital measurement systems.

HEIs are entities whose capital is predominantly intangible and rely heavily on human resources and the knowledge embedded within them. The role of HEIs is especially significant in national and regional economic systems, as they generate added value, which contributes to broader economic and social development (Krstić & Krstić, 2018).

In the context of knowledge-based economies and societies, advanced universities increasingly recognize the critical role of intellectual capital in institutional development and applying knowledge to industry. Therefore, universities must

actively manage knowledge flows and processes creating and sustain their knowledge-based resources. In doing so, universities must also recognize the need to measure the value of their intangible assets and disclose information about their intellectual performance to key stakeholders.

Table 1. Dimensions of Human capital performance and measurement indicators in HEIs

Dimension	Indicator	Formula
Efficiency / productivity	1. Academic productivity in the provision of literature to students in HEI	Formula Total number of books for the subject divided by Total number of professors in HEI*
	2. Total academic productivity of HEI	Formula: Total number of results (papers, articles) divided by the Total number of teaching staff in HEI Note: The total number of papers consists of a number of published articles in SCI impact journals and other journals*
	3. Academic productivity 1 of HEI	Formula: Total number of published articles in SCI impact journals divided by Total number of teaching staff in HEI*
	4. Academic productivity 2 of HEI	Formula: Total number of articles in other journals divided by Total number of teaching staff in HEI*
Structure, characteristics and quality	5. The structure of teaching staff	Formula: The number of teaching staff with permanent employment divided by the total number of teaching staff employed in HEI*
	6. Quality of library and other administrative staff in HEI*	
	7. The structure of staff	Formulae: The number of permanently employed non-teaching staff divided by the number of permanently employed teaching staff
	8. The share of full professors and associate professors	Formula: The number of full professors and associate professors divided by the total number of teaching staff *
	9. The share of assistant professors	Formula: The number of assistant professors divided by the total number of teaching staff*
	10. The share of teaching assistants and teaching fellows	Formula: The number of teaching fellows, teaching assistants, and teaching assistants holding a PhD divided by the total number of teaching staff*

	11. Index of satisfaction of teaching staff	Formula: Methodology for measuring teaching staff satisfaction Note: This methodology is implemented by conducting a survey, in which every teacher answers a question about satisfaction of a particular dimension of satisfaction. One of the models for measuring the satisfaction of the teaching staff is based on the following dimensions of employee satisfaction: 1. Wage; 2. Working conditions in HEI; 3. Satisfaction with adequate equipment for teaching and scientific research activities; 4. Availability of databases and internet services in HEI and through remote access; 5. Timeliness and adequacy of informing all faculty professors about decisions made at university bodies by representatives of faculties in these university bodies; 6. Collaboration between professors and assistants regarding teaching and scientific research activities. The number of dimensions of satisfaction can be bigger than the proposed six in the methodology model for measuring the satisfaction of teaching staff. The essence is in the sum of relative scores that surveyed teaching staff give about particular dimensions of the total satisfaction of teaching staff. Note: This methodology and measurement guidelines would later be elaborated in detail, presented and delivered to consortium partners
	12. Number of employees with PhD*	
	13. Number of additionally educated professors (postdoctoral studies, sub-specializations, etc.)*	
	14. Number of rewards for teaching staff in the area of expertise*	
	15. Number of citations in WOS for all teaching staff in HEI at the end of the year*	
	16. Number of citations in Scopus of all teaching staff in HEI at the end of the year*	
	17. Number of staff who fulfill the roles in scientific journals*	
	18. Number of presentations at scientific conferences (national and international)*	
	19. Professor-Student Ratio	Formula: Number of professors/Number of enrolled students

Teaching competencies and their improvement	20. Number of months of teaching staff specialization	
	21. Number of internally organized education programs for professors and assistants in HEI	
	22. Number of externally organized education programs for administrative staff in HEI	
	23. Number of seminars, workshops, and additional education programs attended by professors and assistants at the HEI	
Teaching staff experience and stability	24. Average length of service (work) of professors (researchers) in the concrete HEI, measured by the number of years	Formula: Sum of the length of service of all professors (researchers) in the concrete HEI/The number of professors (researchers) in the HEI
	25. Total number of years of all academic staff in the academic profession in the HEI	Formula: Sum of the years of all professors (researchers) in the academic profession in the HEI
	26. Average number of years in an academic profession	Formula: The sum of the years of all professors (researchers) in the academic profession/The number of professors (researchers) in the HEI*
	27. Fluctuation of teaching staff	Formula: The number of teaching (research) staff leaving the HEI during the year + the number of teaching (research) staff coming to the HEI during the year*
Openness	28. Number of visiting fellows from other international universities	
	29. Number of PhD students from other universities	
	30. Number of scientific papers with researchers from other universities	
Mobility of professors and researchers	31. Number of visiting professors at foreign universities	
	32. Time spent by visiting professors abroad	

Note:* This indicator can be disaggregated by gender.

Source: Krstić & Rađenović (2019)

Accordingly, universities must select a set of indicators, drawn from traditional metrics and supplemented with newly developed ones, when necessary, to measure and report on their intellectual capital in a standardized format. In doing so, each university can develop its own intellectual capital measurement and reporting system, which serves as a strategic management tool that supports competitiveness in the higher education and research markets. Such systems of intellectual capital management and reporting enable HEIs to (Sanchez & Elena, 2006): ensure transparency in the use of public resources; present and explain the achievements of academic staff, researchers, continuing education programs, and innovations, as well as their benefits for stakeholders; illustrate the development and growth of the institution's intangible resources; and demonstrate their level of competitiveness within the higher education market.

Indicators describing the intellectual capital of HEIs should be presented as indicators of human, structural, and relational capital. Each dimension represents a key segment of intellectual performance, and comprises several specific domains in which indicators are grouped.

Table 1 presents a comprehensive classification of the human capital performance indicators used for measuring the human intellectual capital of HEIs. Based on the framework proposed by Krstić & Rađenović (2019), the table groups individual indicators into key performance dimensions, each representing a distinct aspect of human capital within HEIs.

The table first lists each dimension of human capital performance - such as human resource efficiency i.e. labor or work productivity, staff structure and quality, teaching competencies, experience and stability of academic staff, openness, and mobility of staff. Within each dimension, the table provides a set of specific quantitative and qualitative indicators designed to measure that aspect of human capital. For every indicator, Table 1 includes a precise formula or methodological guideline describing how the indicator should be calculated or assessed.

3. Data basis, Research Questions, and Methodology

The objective of this study is to identify, through the application of benchmarking analysis, the key areas and dimensions of human capital that the management of a given higher education institution should improve to achieve the highest level of performance - the benchmark. The research conducted in this study encompassed four benchmarking subjects, specifically from Serbia, Montenegro, Slovenia, and Croatia. The participating institutions identified a set of key human capital performance indicators that could be measured based on the framework proposed by Krstić & Rađenović (2019), organized across five measurement dimensions for 2024. The selected, specially designed set of human capital indicators (21 in total) within these dimensions is smaller than the number originally proposed in the Krstić & Rađenović (2019) framework.

The analysis includes the following HEIs:

1) Faculty of Economics, University of Niš (FEUN) from Serbia and is one of the leading higher education and research institutions in the field of economics and business in Serbia. Founded in 1960, it offers undergraduate, master's, and doctoral programs aligned with European educational standards. The faculty is recognized for its strong academic staff, diverse research activities, and active cooperation with national and international universities, businesses, and public institutions, fostering innovation, entrepreneurship, and regional economic development.

2) University of Montenegro (UOM), founded in 1974, is the oldest and largest public higher education institution in Montenegro. It consists of numerous faculties and research institutes offering programs across various disciplines (including economics, law, political science, natural sciences, engineering, medicine, humanities, arts, education, and maritime studies). The university is committed to academic excellence, scientific research, and international collaboration, playing a key role in the country's educational, cultural, and economic development. Due to the complexity of collecting and consolidating the necessary information at the level of the entire University of Montenegro (UoM), the analysis was conducted based on the available information, and the human capital performance indicators were calculated only for one unit of the UoM - namely, the Faculty of Economics in Podgorica.

3) Faculty of Civil and Geodetic Engineering (UL FGG) is a public higher education institute and a member of the University of Ljubljana (Slovenia). Educational and scientific research activities are mainly financed by the Republic of Slovenia. UL FGG is divided into eight scientific areas: geodesy, municipal economics and spatial planning, materials and structures, construction management, traffic and transportation constructions, hydraulic engineering, construction IT and basic subjects. The work is carried out in 21 educational-research units, 2 laboratories and 3 institutes.

4) Faculty of Economics and Business, University of Rijeka (EFRI) from Croatia, is a prominent Croatian institution dedicated to higher education and research in economics, business, and management. Established in 1961, it offers a wide range of undergraduate, graduate, and doctoral programs in accordance with the Bologna Process. The faculty is known for its commitment to academic excellence, international collaboration, and research supporting sustainable economic development and innovation at both the regional and European context.

The application of benchmarking analysis, combined with the examination of qualitative information provided by HEI staff, is intended to provide answers to critical questions regarding enhancement of the effectiveness and efficiency of human capital within HEIs, specifically:

RQ1. What are the factors influencing academic productivity in the observed HEIs?

RQ2. How can the structure, characteristics, and quality of human resources in HEIs be improved?

RQ3. How can teaching competencies be enhanced at the analyzed HEIs?

RQ4. Which aspects within the dimension of openness need to be improved or can be enhanced?

RQ5. What is the mobility of professors and other academic and research staff at HEIs?

These research questions were defined in such a way that each of them places a specific focus on one of the five selected measurement dimensions of human capital in HEIs.

This study employs the benchmarking method (Krstić 2001, 2001 a, 2001 b). The term "benchmark" denotes a standard for comparison - a reference point for measurement, evaluation, and analysis. Benchmarking, therefore, refers to the pursuit of higher standards of organizational performance through contrast with the best-performing entities (Brownlie, 1999).

The primary rationale for HEIs to adopt benchmarking is not merely its significance for assessing and controlling performance; rather, benchmarking should be considered an integral part of the performance management system of HEIs. The motivations and arguments for conducting various benchmarking studies are manifold and can generally be summarized as follows (Tasopoulou & Tsiotras, 2017; Shawyun, 2017; Williams, 2018; Radivojević et al., 2019; Nugroho & Jaqin, 2021; Krstić, 2022)

1. Benchmarking is directly linked to performance improvement initiatives within HEIs.

2. Benchmarking identifies opportunities for improvement across various segments and domains, including educational, research, and so-called "third mission" (entrepreneurial) activities.

3. Benchmarking facilitates and supports HEIs in their efforts to become sector leaders.

4. Benchmarking helps reduce errors and omissions in strategic and operational decision-making by management.

5. Benchmarking contributes to maintaining and enhancing the existing position of HEIs in the higher education market, even in the context of intense or informal competition.

6. Benchmarking addresses specific challenges in HEI development by promoting the principle of learning from other HEIs that perform better in certain dimensions of organizational performance, both financial and non-financial, thereby contributing to the effective formulation of institutional objectives.

4. Benchmarking Analysis and Results

Benchmarking performance represents a methodological process for improving the performance of an organization, rather than merely a comparison of its outputs (Krstić et al., 2014). Although the essence of benchmarking lies in comparative measurement and analysis, it requires specific preparatory activities prior to

execution and targeted actions after measurement and analysis to achieve meaningful conclusions and improvements (Krstić et al., 2016; Tasopoulou & Tsiotras, 2017; Shawyun, 2017). Benchmarking should be approached either as a discrete project or as a continuous activity; in this study, it is conducted analytically and systematically. Each HEI should develop its own benchmarking model based on its unique understanding, needs, and organizational structure (Krstić, 2022). The principal stages of the benchmarking process applied in this research serves to support managerial efforts aimed at more effective and more efficient decision-making are outlined as follows (Watson, 1993; Krstić, 2022):

1. Planning (design) of the benchmarking process for human capital performance in HEIs.

2. Collection of necessary data to establish an information base.

3. Analysis of data and identification of performance gaps (deviations).

4. Definition of measures and implementation of potential performance improvements.

Table 2. Selected and specially designed HC performance indicators according to the performance measurement dimension and formulae for calculating HC performance indicators

Dimensions	Indicators	Formula
Efficiency - productivity	1. Total academic productivity of HEI	Total number of scientific/research results (conference papers, articles in journals, monographs, handbooks) divided by the Total number of academic/teaching staff in HEI.
	2. Academic productivity 1 of HEI	Total number of scientific/research results in SCI-indexed journals divided by the Total number of academic/teaching staff in HEI.
	3. Academic productivity 2 of HEI	Total number of scientific/research results in other journals divided by the Total number of academic/teaching staff in HEI.
Structure, characteristics and quality	4. The share of full professors	The number of full professors divided by the Total number of academic/teaching staff in HEI
	5. Non-academic to academic staff ratio	The number of employed non-teaching staff divided by the Total number of employed academic/teaching staff in HEI.
	6. The share of full professors and associate professors	The number of full professors and associate professors divided by the Total number of academic/teaching staff in HEI
	7. The share of assistant professors	The number of assistant professors divided by the Total number of academic/teaching staff in HEI.
	8. The share of teaching assistants, teaching assistants holding a PhD and teaching fellows	The number of teaching fellows, teaching assistants, and teaching assistants holding a PhD divided by the Total number of academic/teaching staff in HEI.
	9. The share of employees with a PhD	The number of employees with a PhD divided by the Total number of academic/teaching staff in HEI.
	10. The share of additionally educated professors and other academic staff (postdoctoral studies, sub-specializations, courses, workshops, etc.)	The number of additionally educated professors and other academic staff divided by the Total number of academic/teaching staff in HEI.

	11. Citations in Scopus of teaching staff in HEI at the end of the year, per teaching staff member	The total number of Citations in Scopus of teaching staff in HEI at the end of the year, divided by the Total number of academic/teaching staff in HEI.
	12. Professor-Student Ratio (at the level of undergraduate courses)	Number of professors divided by the Total number of enrolled students in the undergraduate program
Teaching competencies and their improvement	13. Time spent on specialization of academic / teaching staff (number of days) per employee staff member	Time spent on specialization of academic / teaching staff (number of days), divided by the Total number of academic/teaching staff in HEI.
	14. Number of internally organized education programs for academic/teaching staff in HEI per academic staff member	Number of internally organized education programs for academic/teaching staff in HEI, divided by the Total number of academic/teaching staff in HEI.
	15. Average number of years in the academic profession	The sum of the of years of all academic/teaching staff (full professors, associate professors, assistant professors, teaching assistants holding a PhD, teaching assistants holding an MBA, and teaching fellows holding an MBA) in the academic profession, divided by the Number of academic/teaching staff at the HEI.
Openness	16. Number of visiting fellows from other international universities per academic/teaching staff member of the domestic university/faculty	Number of visiting fellows from other international universities, divided by the academic/teaching staff of the domestic HEI.
	17. The share of students at the undergraduate course coming from other universities	Number of students at the undergraduate program coming from other universities, divided by the Total number of active students at the undergraduate programs.
	18. The share of students at the master's course coming from other universities	Number of students at the master program coming from other universities, divided by the Total number of enrolled students in the master program in one year.
	19. The share of PhD students coming from other universities	Number of PhD students coming from other universities, divided by the Total number of enrolled PhD students over the last four years.
	20. The share of published co-authored scientific papers with researchers from other universities	The number of published co-authored scientific papers with researchers from other universities, divided by the Total number of results (conference papers, journal articles, monographs, handbooks) for one year (2024) for all academic/ teaching staff in HEI.
Mobility of professors and researchers	21. The share of Faculty professors who visited foreign universities	The number of Faculty professors who visited foreign universities, divided by the Total number of academic/teaching staff in HEI.

Source: Authors, according to Krstić & Rađenović (2019)

Planning and designing the benchmarking study for the human capital performance of HEIs entails defining the subject of the benchmarking analysis, determining the instrument for measuring and comparing human capital performance indicators, and specifying the procedures and methodologies by which each indicator will be calculated for all benchmarking subjects included in this study (Table 2).

The collection of necessary data to establish an information base for a benchmarking study is the second step. For this study, measured human capital performance indicators were selected and organized as a segment of the Intellectual Capital Report of HEIs. This report also measured the performance of structural intellectual capital, relational intellectual capital, and green intellectual capital within the institutions.

Analysis of data and identification of performance gaps (deviations) is the third step. Table 3 presents the HC performance indicators, that were compared to determine the benchmark HEI, i.e., the institution demonstrating the highest observed performance.

Table 3. Ranking and benchmark determination of HC performance for FEUN, UOM, ULFGG and EFRI for 2024

Measurement Dimensions of HC	Indicator (I)	FEUN	Rank of HEI 1	UOM-Faculty of Economics	Rank of HEI 2	UL FGG	Rank of HEI 3	EFRI	Rank of HEI 4
Efficiency - productivity	I1. Total academic productivity of HEI	5,61	1	2	3	3,97	2	1.35	4
	I2. Academic productivity 1 of HEI	0,28	4	0,45	3	0,76	1	0,66	2
	I3. Academic productivity 2 of HEI	1,48	2	0,60	3	1,95	1	0,47	4
Structure, characteristics and quality	I4. The share of full professors	0,66	1	0,42	2	0,20	4	0,32	3
	I5. Non-academic to academic staff ratio	0,49	3	0,67	4	0,29	1	0,40	2
	I6. The share of full professors and associate professors	0,78	1	0,47	3	0,27	4	0,58	2
	I7. The share of assistant professors	0,03	4	0,27	1,2	0,27	1,2	0,11	3
	I8. The share of teaching assistants, teaching assistants holding a PhD and teaching fellows	0,18	3	0,27	2	0,10	4	0,38	1
	I9. The share of employees with a PhD	0,86	1	0,82	3	0,85	2	0,79	4
	I10. The share of additionally educated professors and other academic staff (postdoctoral studies, sub-specializations, courses, workshops, etc.)	0,28	3	0,47	2	0,11	4	0.81	1
	I11. Citations in Scopus of teaching staff in HEI at the end of the year, per teaching staff member	5,68	4	109,31	1	9,69	3	9,91	2
	I12. Professor-Student Ratio (undergraduate level)	0,024	4	0,030	3	0,080	1	0,050	2
Teaching compete	I13. Time spent on specialization of academic / teaching staff (number of	5,54	3	8,8	2	12,04	1	0,03	4

	days) per employee staff member								
	I14. Number of internally organized education programs for academic/teaching staff in HEI per academic staff member	0	4	0,11	1	0,07	2	0,03	3
	I15. Average number of years in the academic profession	22,65	3	19,49	4	32,38	2	43,14	1
Openness	I16. Number of visiting fellows from other international universities per academic staff member of the domestic university/faculty	0,35	3	0,51	1	0,03	4	0,47	2
	I17. The share of students at the undergraduate program coming from other universities	0,0004	4	0,014	3	0,06	1	0,030	2
	I18. The share of students at master program coming from other universities	0	3,4	0	3,4	0,38	1	0,16	2
	I19. The share of PhD students coming from other universities	0	4	0,025	3	0,079	2	0,92	1
	I20. The share of published co-authored scientific papers with researchers from other universities	0,17	3	0,29	2	0,62	1	0	4
Mobility	I21. The share of Faculty professors who visited foreign universities	0,015	4	0,155	2	0,04	3	0,40	1

Source: Authors

The definition of measures and the implementation of potential performance improvements constitute the core of benchmarking studies. All preceding phases of the benchmarking process must be fully realized through the benefits that benchmarking is expected to generate for HEI management - specifically, through more effective and efficient human resource management, as the most important resource of HEIs which function as educational, creative, innovative, and intellectual organizations.

5. Discussion and implications for HEIs' management

Table 4 presents the critical human capital performance indicators for the observed HEIs, classified according to three levels of priority for improvement (first, second, and third), as well as the indicators on which each institution already achieves benchmark performance. In this way, the table simultaneously identifies the key areas where managerial intervention is most urgently needed and the dimensions in which individual HEIs can serve as models of good practice for others.

Table 4. Critical human performance indicators of HEIs according to priority levels and benchmark

HEI	The first priority for human performance improvement	The second priority for human performance improvement	The third priority for human performance improvement	Benchmark	Total number of critical human capital performances
1	2	3	4	5	6
FEUN	I2, I7, I11, I12, I14, I17, I18, I19, I21	I5, I8, I10, I13, I15, I16, I20	I3	I1, I4, I6, I9	17
UOM – Faculty of Economics - Podgorica	I5, I15, I18	I1, I2, I3, I6, I9, I12, I17, I19	I4, I8, I10, I13, I20; I21	I11, I14, I16	18
UL FGG	I4, I6, I8, I10, I16	I11, I21	I1, I9, I14, I15, I19	I2, I3, I5, I12, I13, I17, I18, I20	13
EFRI	I1, I3, I9, I13, I20	I4, I7, I14	I2, I5, I6, I11, I12, I16, I17, I18	I8, I10, I15, I19, I21	16

Source: Authors

In addressing RQ1, Table 5 presents the measures for improving the efficiency–productivity dimension of HEIs.

Table 5. Measures for improving the efficiency–productivity dimension of HEIs

HEIs	Measures
FEUN	Stimulative measures for increasing the number of publications indexed in the SCI list
UOM – Faculty of Economics – Podgorica	Stimulative measures for increasing outputs indexed in the SCI list and for enhancing scientific/research results in other journals, conference papers, monographs, and handbooks
UL FGG	Stimulative measures for increasing research outputs in terms of conference papers, monographs, and handbooks
EFRI	Stimulative measures for increasing scientific/research results in other journals, as well as conference papers, monographs, and handbooks

Source: Authors

In addressing RQ2, Table 6 presents the measures for improving the (a) structure and (b) characteristics and quality of human resources in HEIs.

Table 6. Measures for improving the (a) structure and (b) characteristics and quality of human resources in HEIs

HEIs	Measures
FEUN	(a) Measures to increase the share of assistant professors within the total number of academic staff and enabling the career advancement of young scholars in associate positions after obtaining their doctoral degree; measures for rationalizing the number of administrative staff; measures for recruiting young professionals - teaching fellows - and engage teaching demonstrators in instructional activities.

	(b) Incentive measures for academic staff to publish in SCI-indexed journals in order to increase citation impact; measures for improving the Professor–Student Ratio through the recruitment of additional academic staff and the engagement of teaching demonstrators.
UOM – Faculty of Economics – Podgorica	(a) Measures for improving the ratio between academic and non-academic staff, including the rationalization of administrative positions; the high share of full and associate professors may indicate a need for more effective human resource management with respect to the age structure of the academic workforce, particularly through the recruitment of younger staff; incentive measures for the professional development of non-academic staff aimed at increasing their competencies and enabling them to obtain a doctoral degrees. (b) Measures for improving the Professor-Student Ratio through the recruitment of additional academic staff and the engagement of teaching demonstrators in instructional activities.
UL FGG	(a) Measures for improving the age structure of academic staff by increasing the number of young scholars, specifically through the recruitment of teaching fellows. (b) Measures for increasing the share of additionally trained and professionally upgraded professors and other academic staff (postdoctoral studies, sub-specializations, courses, workshops, etc.); incentive measures for academic staff to publish in SCI-indexed journals to increase citation impact.
EFRI	(a) Incentive measures for the professional development of non-academic staff aimed at increasing their competencies and enabling them to obtain a doctoral degrees; measures for improving the age structure of the workforce, particularly through generational rejuvenation.

Source: Authors

In addressing RQ3, RQ4, and RQ5, Table 7 presents the measures for improving the (a) structure and (b) characteristics and quality of human resources in HEIs.

Table 7. Measures for improving the (a) teaching competencies, (b) openness, and (c) mobility of human resources in HEIs

HEIs	Measures
FEUN	(a) Measures for implementing internally organized education and training programs for academic/teaching staff, as well as measures for increasing the time spent on the specialization and professional development of academic/teaching staff. (b) Measures for attracting students to undergraduate, master's, and PhD programs from other universities; measures for increasing the share of co-authored scientific papers published with researchers from other universities. (c) Incentive measures for increasing the share of faculty members who conduct visits to foreign universities.
UOM – Faculty of Economics – Podgorica	(b) Measures for attracting students to undergraduate, master's, and PhD programs from other universities; measures for increasing the share of published co-authored scientific papers with researchers from other universities.
UL FGG	(b) Measures for increasing the number of visiting fellows from other international universities. (c) Measures for increasing the share of faculty professors who have visited foreign universities.
EFRI	(a) Measures for implementing internally organized education and training programs for academic/teaching staff, as well as measures for increasing the time spent on the specialization and professional development of academic/teaching staff. (b) Measures for increasing the share of co-authored scientific papers with researchers from other universities.

Source: Authors

The benchmarking analysis of human capital performance conducted for the observed HEIs in 2024 enables their comparison and ranking according to:

(a) *Indicators on which each institution already achieves benchmark performance.*
As shown in Table 4, column 5, it can be observed that all HEIs have achieved at least some indicators that meet benchmark performance standards. Based on this criterion, the HEI with the highest number of benchmark indicators is UL FGG (8), followed by EFRI (5), FEUN (4), and UOM - Faculty of Economics, Podgorica (3).

(b) *Critical indicators that require the implementation of stimulating and corrective measures, as well as the specific human capital (HC) dimensions to which they belong* (Table 4, column 2). According to this criterion, the best-performing institution is UL FGG, which has only 13 first-priority indicators requiring improvement. It is followed, with minor differences, by EFRI (16) in second place, FEUN (17) in third place, and UOM – Faculty of Economics - Podgorica (18) in fourth place.

Furthermore, the benchmarking analysis allowed the identification of stimulating and corrective measures (presented in Tables 5, 6, and 7) that each HEI can implement within its critical performance areas to enhance human resource management in the upcoming year.

5. Conclusion

This paper has shown that benchmarking, when embedded within the broader framework of intellectual capital management, is a useful managerial mechanism for identifying strengths, weaknesses, and development priorities in the human capital performance of higher education institutions. By applying a set of specially designed human capital performance indicators across four HEIs in Serbia, Montenegro, Slovenia, and Croatia, the study confirms substantial inter-institutional differences in academic productivity, staff structure and quality, teaching competencies, openness, and mobility. These differences reveal clear performance gaps, as well as concrete opportunities for targeted managerial intervention.

First, regarding to efficiency–productivity, the analysis indicates that HEIs need to systematically increase the volume and quality of scientific outputs, particularly in SCI-indexed journals and other recognized outlets. This requires not only stronger individual effort but also institutionalized incentive schemes and supportive research environments. Second, in the dimension of structure, characteristics, and quality of human resources, the results point to structural imbalances: in some HEIs, an excessive share of full and associate professors is combined with a low proportion of younger staff and assistant professors, as well as suboptimal ratios of academic to non-academic personnel. Third, the dimension of teaching competencies and their improvement reveals an insufficient level of internally organized education and specialization programs for academic staff, as well as a need for more systematic investment in lifelong learning. Fourth, the dimensions of openness and mobility demonstrate underutilized potential for internationalization, both in terms of incoming and outgoing academic flows and co-authored outputs with external partners.

Based on these findings, several action-oriented guidelines and recommendations for HEI management can be formulated:

- Institutionalize human capital benchmarking as a regular management tool.
- HEIs should not treat benchmarking as a one-off exercise but as a recurring component of their performance management system.
- Human capital indicators should be integrated into strategic and operational plans, annual reporting, and internal evaluation processes (e.g., as part of an Intellectual Capital Report).
- Strengthen research productivity and impact through targeted incentives.
- Design and implement stimulative schemes (both financial and non-financial) for publishing in SCI-indexed and other high-quality journals, as well as for producing monographs, handbooks, and conference papers.
- Link part of academic promotion and evaluation criteria to demonstrable improvements in human capital performance indicators (e.g., academic productivity, citations, co-authorship with external partners).
- Rebalance the structure and age profile of both academic and non-academic staff.
- Gradually increase the share of assistant professors and early-career academics by recruiting teaching fellows and junior researchers, while ensuring succession planning for an ageing professoriate.
- Optimize the non-academic to academic staff ratio by rationalizing administrative positions and upgrading non-academic staff competencies, including support for doctoral studies where relevant.
- Monitor staff structure indicators (Professor–Student Ratio, share of PhD holders, share of additionally educated staff) and use them as triggers for corrective action in recruitment and promotion policies.
- Invest in teaching competencies and continuous professional development programs.
- Systematically develop and deliver internally organized education and training programs for academic staff (pedagogy, digital skills, research methods, project management, etc.).
- Increase time and resources dedicated to staff specialization (postdoctoral studies, sub-specializations, courses, workshops), treating them as strategic investments in human capital rather than costs.
- Enhance openness and international integration of human resources.
- Introduce concrete measures to attract students from other universities and countries at all levels of study (undergraduate, master's, and PhD).

- Support and reward co-authored publications with researchers from other universities, using this indicator as a key proxy for external integration and engagement.
- Increase both incoming and outgoing mobility by expanding the number of visiting fellows, faculty exchanges, and short-term research stays at foreign universities, with clear institutional targets for the share of staff participating in such activities.
- Align human capital management with broader intellectual capital strategies.
- Human capital initiatives should be explicitly linked to the development of structural and relational capital (e.g., improved processes, digital infrastructures, and long-term partnerships with industry and public institutions).
- Results from human capital benchmarking should feed into strategic dialogues on university mission, positioning in the higher education market, and contribution to national and regional development.
- Use benchmarking results to prioritize interventions and allocate resources.
- Classifying indicators of indicators into priority levels (first, second, and third priority) provides a clear basis for sequencing reforms and focusing limited resources where they can generate the greatest marginal improvements.
- Each HEI should translate identified critical indicators into institution-specific action plans with defined timelines, responsible units, and measurable targets.

Finally, this study has certain limitations that open avenues for future research. The analysis is based on a relatively small number of HEIs, with data for Montenegro limited to a single faculty. Moreover, the benchmarking analysis conducted is static in nature, as it refers exclusively to the year 2024. This allowed only for the assessment of the current performance levels of the HEIs in achieving HC outcomes for this year and their comparison, accompanied by the identification of stimulating and corrective measures within critical areas of human resource management.

In addition, substantial differences were observed among the HEIs included in the study: they operate in different countries; they are governed by different regulatory frameworks; they have different organizational structures; they vary in their academic staff profiles, qualification structures, study programs, and administrative units responsible for supplying the data used in this research. All these factors made it particularly challenging to develop a unified framework for measuring HC performance indicators and to consolidate it into a set of 21 indicators.

Despite these limitations, the findings provide a robust empirical basis for HEI managers and policymakers who seek to enhance human capital as the central pillar of intellectual capital and to build more innovative, open, and competitive academic institutions.

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BENČMARKING KAO MEHANIZAM UNAPREĐENjA PERFORMANSI HUMANOG KAPITALA INSTITUCIJA VISOKOG OBRAZOVANjA

Apstrakt: *U ekonomiji koja je sve više zasnovana na znanju, visokoobrazovne institucije imaju ključnu ulogu u stvaranju i širenju intelektualnog kapitala. Ipak, mnoge evropske visokoškolske institucije i dalje pokazuju nizak nivo inovativnosti, slabe veze sa poslovnim sektorom i nedovoljno strateško upravljanje ljudskim*

resursima. Ovaj rad koristi benčmarking kao menadžerski mehanizam za unapređenje performansi humanog kapitala visokoškolske institucije u okviru šireg koncepta upravljanja intelektualnim kapitalom. Polazeći od koncepta Izveštaja o intelektualnom kapitalu, istraživanje identifikuje dimenzije performansi humanog kapitala, od kojih je svaka predstavljena specifičnim merljivim indikatorima. Korišćenjem benčmarking analize performansi humanog kapitala na odabranim visokoškolskim institucijama u Srbiji, Crnoj Gori, Hrvatskoj i Sloveniji, rad upoređuje rezultate performansi radi utvrđivanja najboljih praksi i identifikacije razvojnih razlika. Rezultati ukazuju na značajne međuinstitucionalne razlike u akademskoj produktivnosti, strukturi osoblja i stepenu međunarodne otvorenosti, ističući oblasti u kojima su neophodne menadžerske intervencije radi dostizanja ciljnog nivoa performansi. Rezultati naglašavaju značaj benčmarkinga, ne kao instrumenta za komparaciju, već i kao alata za proces kontinuiranog učenja i unapređenja koji podržava donošenje odluka zasnovanih na dokazima, povećava transparentnost i podstiče razvoj inovativnog i preduzetničkog akademskog okruženja.

Ključne reči: : *Benčmarking, institucije visokog obrazovanja, humani kapital, merenje performansi, indikatori.*

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REGENERATIVE AGRICULTURE AS A FACTOR OF ECONOMIC SUSTAINABILITY: PERSPECTIVES AND CHALLENGES IN EUROPEAN CONTEXT

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Abstract: *The growth of the world's population and the increase in food and energy consumption bring agricultural production to an unfavourable situation. The problem stems from the need for rapid growth in food production, which takes place through specialized operations of the conventional way of agricultural production. However, conventional agricultural production entails negative impact on natural resources and represents a huge challenge for the future sustainability of food production. In order for agricultural production not to be at a traditional crossroads, in recent years, a transition to an alternative approach has been advocated. Regenerative agriculture is an approach based on the sustainable use of natural resources without harmful effects on the environment by relying significantly less on production inputs (chemicals and machinery). The subject of the paper is the analysis of the economic effects of the application of regenerative agricultural practices in Europe with a special focus on its long-term benefits. The research includes economic indicators such as productivity, profitability of agricultural practices, costs and benefits of introducing regenerative methods, as well as the impact on rural development. The goal of the research is to determine how regenerative agriculture can contribute to the economic sustainability of the agricultural sector in Europe.*

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1. Introduction

In the last few decades, two simultaneous trends with the potential to threaten social, economic and ecological sustainability have been taking place with much attention, namely the growth of the world population and agricultural production. The world population, which numbered around 8.06 billion in 2023 (World Bank, 2024), continues to grow rapidly and it is expected to continue growing in the coming decades at a progressively slower pace. According to the United Nations projections, the global population could increase to nearly 11 billion by the end of the 21st century. Adding about 83 million people per year, the global population would stabilise around the year 2100, which would end the current era of rapid growth that began around 1800 in some regions, that is, in the middle of the 20th century on a global level (United Nations, 2021). Agricultural production is increasing at the same time as the world's population grows to meet the increased global demand for food, together with rising incomes and opportunities to buy more. Along with expanding and diversifying the goals of the agricultural production system to meet demand, the ultimate goal remains the sustainable security of food production. In this sense, a critical question that constantly arises is whether agricultural production systems, especially in developing countries, can continue to meet their goals sustainably. Due to the various pressures imposed on agricultural production, efforts are being made to switch to more sustainable ways of food production.

The conventional method of agricultural production, which has been applied for many years, can no longer be acceptable in the future due to its serious consequences for nature. This is mainly due to the fact that more than half of the global agricultural land is already degraded (Glover et al., 2010). In addition, conventional agriculture causes the loss of biodiversity, the destruction of natural habitats, soil degradation and the depletion of natural resources (Miralles-Wilhelm & Iseman, 2021).

In order to avoid destructive phenomena caused by the conventional way of agricultural production, two scenarios are possible. The first scenario aims at further intensification of scientific and technological agricultural research. More precisely, the application of the second green revolution implies the application of high technology in agriculture. The focus is on technological interventions to support plant growth, use degraded land to increase food production while preventing the further loss of biodiversity and the destruction of natural habitats. The second scenario aims at a radical transition to agricultural practices based on nature. There are many types of nature-based farming systems: agroecology, organic farming, ecology-based farming, agroforestry, permaculture, and others. One of the agricultural systems based on nature that has been increasingly mentioned in the literature in recent years is regenerative agriculture, which focuses on soil fertility, not plant growth (Gremmen, 2022).

In accordance with the aspirations of the second scenario and the ever-present turning of agricultural practices towards achieving the long-term sustainability of

food production, the subject of this scientific work is the analysis of the economic effects of the application of regenerative agricultural practices in Europe. The aim of the research is to determine how regenerative agriculture can contribute to the economic sustainability of the agricultural sector in Europe.

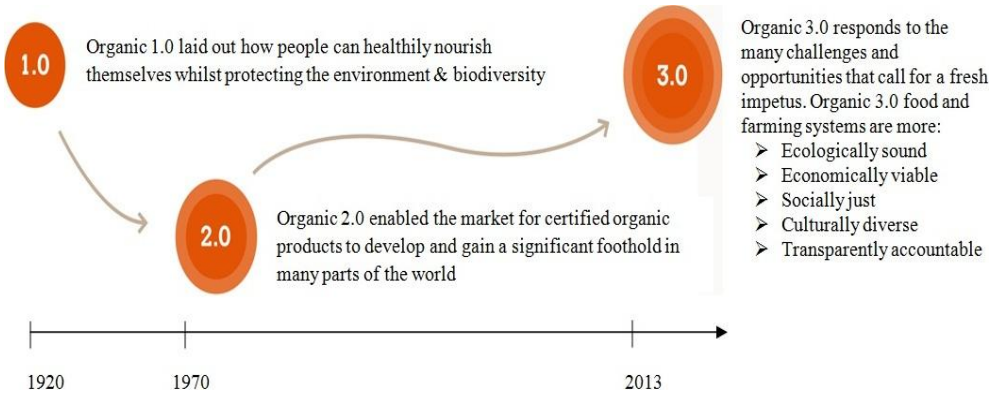
2. Key future model – Organic 3.0

The world's population relies on agricultural production to provide food and other products such as textiles and body care products to meet the most basic human needs. Unfortunately, hunger, food insecurity and obesity threaten billions of people across the planet. The most commonly applied agricultural practice, centuries ago, significantly contributed to the deterioration of the environment and the emergence of climate changes, but its application concerning the principles of sustainable development can be a source of solutions to former problems.

Far-reaching changes in agriculture are needed without delay if future generations are to have equal or improved conditions for prosperity. The positive and multiple environmental, social and economic benefits of truly sustainable agriculture can significantly reduce current problems and help to respond as adequately as possible to the prevailing challenges. The principles of health, ecology, equity and care can be used to shape any agricultural practices and ecosystems, whether they provide food, textiles, body care products, energy or other products. These principles alone are the basis for the implementation of the Organic 3.0 concept.

In 2013, the International Food and Agriculture Organization (IFOAM) presented the Organic 3.0 concept, which represents the third phase in the development of the organic production model. The overall goal of Organic 3.0 is to enable the wide acceptance of sustainable agricultural systems and markets based on organic principles and imbued with innovation, progressive improvement towards the best agricultural practice, transparent integrity, inclusive cooperation, holistic systems and fair prices (Arbenz et al., 2016). Organic 3.0 expands participation options and positions the organic production model as a modern, innovative agricultural system that holistically integrates ecology, economy, society, culture and responsibility at the local and regional levels. The values of the Organic 3.0 concept are reflected in the regeneration of resources, responsibility in production, and sufficiency for consumption, along with the ethical and spiritual development of human values, practices and habits, with the ultimate goal of initiating social development.

Figure 1. Three phases of organic production model



Source: Author`s presentation according to Arbenz, M. et al. (2016)

At the core of the Organic 3.0 concept are living relationships between consumers and producers, highlighting the multiple benefits of organic agriculture to overcome the enormous challenges the planet faces. The forerunner of this concept is Organic 2.0, created in the seventies of the 20th century, with a focus on clearly defining minimum requirements and organic product claims, Organic 3.0 shifts the centre of gravity of the conceptualization towards the entire system of agricultural production. The achievements and approaches of the first two phases (Organic 1.0 and Organic 2.0) of the development of the organic production model have not been abandoned; Organic 3.0 retains the basic original concept of Organic 1.0 and expands the progress made within Organic 2.0 (Figure 1)

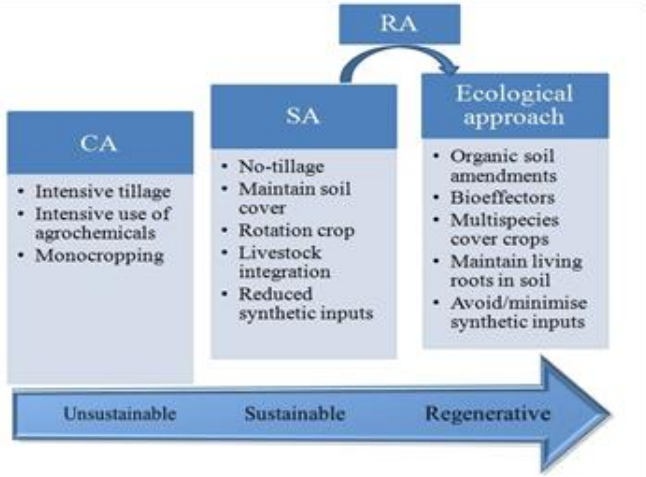
The Organic 3.0 concept includes a strategy of dynamic and continuous improvement. The organic narrative of Organic 3.0 deepens from the previously achieved certified agricultural production (Organic 2.0) into the smartest, most authentic and completely regenerative way of producing and consuming food, ecological textiles and natural body care products. The basis of the concept is "the more, the better" approach, which aims to increase the relevance and credibility of not only the organic niche but also, in general, the integral part of society (Leu, 2020). Closely aligned with the basic principles of sustainable agriculture and the characteristics of the Organic 3.0 concept, a system of agricultural production has been developed that affects the improvement of the resources it uses, instead of destroying or depleting them. In fact, it is about regenerative agriculture.

3. Regenerative agriculture

At a time when the world's population is facing significantly more environmental, social and economic problems, it is not enough for agricultural systems to be sustainable. Understanding sustainability only as meeting the needs of the present generation without compromising future generations' ability to meet their own needs, probably is not a concept that is acceptable in the future. The reason for this is the increasingly pronounced global warming, climate change, uncertainty in food production, pandemics, migration crises, increasing poverty, the collapse of entire ecosystems and the unsustainable use of natural resources. Therefore, the concept of regeneration is much more than the concept of sustainability (Figure 2).

The regenerative agriculture movement originated in the 1980s, but in the recent years has grown into a veritable "soil revolution" as producers and consumers increasingly support regenerative products (Montgomery, 2017). The concept was formed at the United Nations climate change meeting in New York in 2014. The gathering recognized the need for a concept that would not only "sustain" dysfunctional approaches to food production that destroy and deplete resources, but rather improve and regenerate the resources they use. Therefore, regenerative agriculture is seen as a holistic, systems approach to agriculture that encourages continuous innovation for ecological, social, economic, and spiritual well-being (Francis & Harwood, 1985). Robert Rodale is the creator of the concept and defined regenerative agriculture as ,,one that, at increasing levels of productivity, increases our land and soil biological production base. It has a high level of built-in economic and biological stability. It has minimal to no impact on the environment beyond the farm or field boundaries. It produces foodstuff free from biocides. It provides for the productive contribution of increasingly large numbers of people during a transition to minimal reliance on non-renewable resources" (Rodale, 1983).

Figure 2. Conceptualization of Regenerative Agriculture in relation to sustainability levels



Source: Author`s presentation according to Musto et al. (2023)

Regenerative agriculture, while lacking a universally agreed-upon definition and encompassing various components, is generally characterized by two key features. First, it focuses on the restoration of soil health, particularly enhancing soils' ability to capture and store carbon, which is essential for mitigating climate change. "The consequences of climate change in agriculture are observed through their effects on plants and animals, leading to functional shifts and alterations in their abundance and distribution." (Martić Bursać et al. 2024) Second, it aims to reverse the ongoing loss of biodiversity. These two elements are central to the concept of regenerative agriculture.

System-based regenerative agriculture meets the need to produce adequate food, with the necessity of restoring the environment, making agriculture the solution, not the cause of problems in the environment (Lal, 2020b). Concerning the above, regenerative agriculture is a set of approaches that emphasise and maximise the natural beneficial

interactions between soil and plants, relying less on external inputs and taking advantage of ecological agricultural practices (Perry, 1995). It has been proposed as an alternative means of food production that can have lower, or even net positive environmental and social impacts (Rhodes, 2017). At the same time, regenerative agriculture is the latest phase in the sustainable agriculture movement (Merfield, 2019). It claims to be at its core intended to improve soil health or restore highly degraded land, which symbiotically improves water quality, vegetation and soil productivity. As well as regenerative agriculture improves and maintains soil health by restoring its carbon content, which in turn improves productivity, contrary to conventional agriculture (Newton et al., 2020). It encompasses a wide range of agricultural practices, which aim to restore and sustainably manage soil through the sequestration of organic carbon in the soil.

Regenerative agriculture aims to work the soil in harmony with nature. It improves the soil by using technologies that regenerate and revitalize the soil and the environment. The primary goal of regenerative agriculture is to increase the level of organic matter in the soil. Therefore, the overarching goal is to create, support and maintain the natural biogeochemical cycle and interdependence in order to improve the sustainability of agricultural and food systems (Lacanne & Lundgren, 2018). Considering the objectives of regenerative agriculture, it leads to multiple positive outcomes such as: 1) better resistance to extreme weather conditions; 2) increased soil efficiency in water retention; 3) less disease due to beneficial pathogens controlling soil biota and 4) increased availability of nutrients needed by plants, animals and humans (Rodale Institute, 2018).

The significance of regenerative agriculture is that it ensures sustainability through recycling and conserving water and nutrients. The reduced depletion of natural resources resulting from the application of regenerative agriculture increases the provision of services to ecosystems and local economies. Another important requirement for regenerative agriculture is the integration of agricultural processes for environmental management, which is crucial for a sustainable future of food production and security (McLennon et al., 2021).

Following on from the goals of regenerative agriculture, it applies the concept of "more from less" in production: less land area, less chemical input, less water use, less greenhouse gas emissions, less risk of land degradation and less use of energy-based inputs (McAfee, 2019). The idea is to preserve land and natural resources, with food waste and environmental degradation being characterized as "crimes against nature." In this sense, the green revolution of the XXI century is based on regenerative agriculture, as the most acceptable and suitable agricultural system for nature and the living beings in it.

Agricultural practices such as crop rotation, cover crops, and livestock integration are generally considered "good agricultural practice" and remain an integral part of conventional agriculture, which is also applied in regenerative agriculture. Practices characteristic of regenerative agriculture are permaculture, which has rather limited application for the production of many agricultural products, while minimal or no tillage, composting, carbon sequestration and the application of organic material increase total microbial biomass. The aspiration is to establish a mutual relationship between plants and soil through these practices in that the soil feeds the plants and the plants feed the

soil (Quarles, 2018). All these contribute to carbon sequestration and retention of atmospheric carbon dioxide in soil organic matter (Lorenz & Lal, 2012).

Regenerative agriculture focuses on the soil, not the seed, and is based on the premise that "the health of soil, plants, animals, and people is one and indivisible" (Howard & Howard, 2010). In the current context of climate change and environmental conservation, it is appropriate to expand the concept by accepting the stated premise of the indivisibility and unity of soil, plant, animal, human and environmental health. The expanded concept, based on the realization of living soil, is precisely reflected in regenerative agriculture.

3. Economical implications and challenges of regenerative agriculture in Europe

While regenerative agriculture is often discussed in terms of environmental and ecological benefits, its economic effects are increasingly becoming a focal point of academic and policy discussions (Table 1). The economic benefits of applying regenerative agriculture derive from the environmental benefits achieved. The environmental benefits of regenerative agriculture, in addition to mitigating climate change, include improved soil health and fertility, increased biodiversity on land, water and air, better water quality and its rational use, as well as successfully coping with extreme weather events.

Table 1. The economic effect of regenerative agriculture

Effects	Important components
Reducing production costs	no-till farming, reducing synthetic inputs
Increasing profitability	increasing yields, reducing irrigation, improving crop resilience
Productivity	healthier soil → more productive land more resistant crops →increasing yields
Income	crop climate resistance, increasing yields, carbon credits
Subsidies production	carbon sequestration, environmentally friendly
Revitalizing rural economies	increasing farm profitability, creating new jobs, keeping young people in rural areas
Increasing investments	↑aspiration to invest in sustainable business

Source: Author`s presentation

One of the most widely cited economic advantages of regenerative agriculture is the potential for reducing input costs. Several studies have found that regenerative practices, like no-till farming and reduced synthetic inputs (e.g. fertilisers and pesticides), lower production costs. For example, Pimentel et al. (2005) demonstrated that integrated pest management and reduced chemical inputs result in significant savings for farmers. Likewise, Duffy (2017) found that regenerative systems often lead to lower costs for inputs such as herbicides and fertilisers, translating into improved profit margins for farmers.

Regenerative agriculture has also been shown to improve farm profitability in the long run. Gliessman (2016) and Giller et al. (2015) argue that through better soil health and resilience, regenerative practices can lead to higher yields over time,

especially during periods of drought or climate variability. As soils improve, they store more water, reducing the need for irrigation and improving crop resilience, which can reduce financial risks associated with crop failure. For instance, medium-sized farms adopting regenerative techniques can expect initial profits of €20,000–€30,000 in the first year, with annual profits increasing to €55,000–€75,000 in subsequent years. Regenerative farming is up to 60% more profitable after six years (Kurth et al., 2023).

Estimates from the Food and Land Use Coalition suggest that a transition to regenerative agriculture could contribute up to $1.2 trillion to the global economy by 2030. Over the past year, five pilot farms in France have conducted experiments using a no-deep soil tillage method across three distinct potato varieties. These trials led to an approximate 11% increase in yield, along with a notable proportion of significantly larger potatoes (Goffart et al., 2022).

The relationship between soil health and long-term agricultural productivity is a major component of regenerative agriculture's economic impact. Healthy soils increase water retention, reduce erosion, and boost nutrient cycling, which ultimately can lead to more productive land. Regenerative practices such as cover cropping and crop rotation significantly improve soil organic matter, thereby enhancing soil fertility and increasing farm productivity in the long run (Lal, 2020a). Additionally, Baumgarten et al. (2021) suggest that farms adopting regenerative techniques can see enhanced crop resilience and higher yields, which translate into better economic returns.

Regenerative agriculture's ability to mitigate climate-related risks provides significant economic value. Regenerative practices reduce vulnerability to climate extremes such as droughts and floods (Shennan, 2008). Farms that invest in improving soil organic matter through regenerative practices tend to exhibit greater drought resilience, which can stabilize yields in the face of climate variability. Moreover, regenerative agriculture's focus on carbon sequestration in soil not only helps combat climate change, but also can generate additional income through carbon credits, creating new revenue streams for farmers (Kissinger et al., 2021).

The literal meaning of "regeneration" is aligned with the concept of soil resistance to climate change. Regenerative agriculture represents the transition to climate-smart agricultural practices that mitigate climate change and facilitate adaptation to it (Gosnell et al., 2011). In this sense, regenerative agriculture aims to reverse global climate change (Ikerd, 2021), i.e. the impacts of greenhouse gas emissions can be controlled through conscious guidance of climate practices. According to estimates, annual, regenerative agricultural production could reduce 14.5 to 22 gigatons of carbon dioxide by 2050 (Project Drawdown, 2020). More precisely, regenerative agriculture is associated with claims that it has the potential to mitigate climate change (Kastner, 2016) with the possibility of sequestering more than 100% of current annual carbon dioxide emissions by switching to widely available and cheaper regenerative agriculture practices (Rodale Institute, 2014). For instance, pilot programs company Bayer has demonstrated that regenerative practices can reduce agriculture's carbon footprint by up to 56% in Poland and 65% in the UK. Additionally, integrating livestock with crop production has been shown

to store about one-third more carbon in the soil compared to crop-only systems, while also promoting greater biodiversity (Hartmann, 2024). The World Economic Forum estimates that if a fifth of farmers in the European Union adopted regenerative farming techniques, greenhouse gas emissions from agriculture could be 6% lower a year by 2030 (WEF,2022). It is clear that regenerative agriculture, as a diverse portfolio of practices that can be adapted to specific regions and crop types, can and should play a major role in the fight against climate change. (Teal et al., 2022).

While regenerative practices can offer long-term economic benefits, the transition from conventional to regenerative farming can be financially burdensome for farmers. The initial cost of transitioning, such as investment in new equipment, education, and changes to land management practices, can be prohibitive. Moyer et al. (2020) discuss the financial barriers of adopting regenerative agriculture, noting that while farmers may experience reduced costs in the long term, the upfront expenses can be a significant hurdle. In many cases, access to credit or government subsidies is essential to support the transition. The income from leasing and service provision, such as Agri-PV installations, is especially valuable during the transition phase, helping to compensate for revenue that may be lost during the early stages of transformation.

During the initial years of adopting regenerative practices, there may be a period of yield instability or lower-than-expected crop production. Farmers may face a temporary decline in yields as they transition to practices like no-till farming, as soils need time to recover and stabilize (Kremen et al., 2012). This period of lower yields can impact the economic viability of regenerative practices for some farmers. Miller et al. (2021) echo these concerns, noting that while soil health improves over time, it may take several years before yield improvements become evident.

Once regenerative agriculture practices are effectively implemented, research conducted in the United States on wheat production has shown that these methods can either sustain or enhance crop yields. This results in a return on investment ranging from 15-20% and yields profits up to 120% higher than those achieved through conventional farming practices. Such findings suggest that regenerative agriculture not only benefits environmental sustainability, but also proves economically advantageous for farmers (Petry et al., 2023).

The economic success of regenerative agriculture is also influenced by access to markets that value products grown using sustainable practices. Regenerative agriculture may not be economically viable for farmers if they do not have access to premium markets or sufficient compensation for the environmental services they provide (Lovell et al., 2020). In other words, without proper financial incentives, farmers might not see enough economic benefit to adopt these practices. Meanwhile, Wolfe et al. (2020) highlight the crucial role of education and extension services in ensuring farmers have the necessary knowledge to implement regenerative practices successfully. Without these supports - market incentives and proper knowledge, the full economic potential of regenerative agriculture might not be achieved.

The role of government policies in supporting the transition to regenerative agriculture is critical. Smith et al. (2021) highlight the importance of policy interventions, such as subsidies, tax incentives, and cost-sharing programs, to help

farmers bear the transition costs. Governments can also play a significant role by facilitating access to information, research, and development, which can accelerate the adoption of regenerative practices.

In the U.S., for example, the Natural Resources Conservation Service (NRCS) offers financial incentives for farmers adopting conservation practices under the Environmental Quality Incentives Program (EQIP), which helps offset the costs of transitioning to regenerative techniques. Similarly, the EU Common Agricultural Policy (CAP) includes support for agri-environmental measures that promote regenerative practices like crop rotation, organic farming, and soil conservation.

Financial analyses suggest that approximately €24 billion in public and private funds are available to support the transition to regenerative practices in Europe (WBCSD, 2024). However, challenges remain in aligning funding and incentives to effectively address farmers' financial needs during this transition. The European regenerative agriculture market is experiencing substantial growth, with projections indicating a Compound Annual Growth Rate (CAGR) of 14.1% from 2023 to 2029 (Kuhn et al.,2024). Within this context, Germany is poised to establish itself as a leading player in the European regenerative agriculture market, with projections indicating a substantial market value of $329.3 million by 2029. The United Kingdom is expected to experience a notable compound annual growth rate (CAGR) of 13.1% from 2023 to 2029, while France is anticipated to achieve an impressive CAGR of 14.9% over the same timeframe (Research and Markets, 2023). Europe is globally the second-largest region in terms of market share of regenerative agriculture in 2023 (29%), with North America leading at 37%. The Asia-Pacific region holds a slightly smaller market share of regenerative agriculture compared to Europe in 2023, while other regions have significantly lower participation.

Another avenue for promoting the economic benefits of regenerative agriculture is through market-based incentives such as eco-labelling, carbon credits, and premium pricing. Rigby et al. (2020) argue that certification programs such as the Regenerative Organic Certified (ROC) label can provide farmers with higher prices for their products, helping to offset the initial costs of adopting regenerative practices. Farms with organic certification, which often incorporate regenerative components, account for less than 10% of production in Europe (EASAC, 2022). Additionally, carbon markets, which compensate farmers for carbon sequestration in soils, represent a growing area of economic potential for regenerative agriculture.

On a macro level, regenerative agriculture has the power to drive rural economic development. There is a concept of regenerative economies that goes beyond agriculture and includes a larger food supply network. The very idea of regenerative agriculture is to generate life and wealth through linking processing, infrastructure, distribution and food supply (Soloviev & Landua, 2016). Regenerative agriculture has the potential to revitalize rural economies by increasing farm profitability, creating jobs in agroecological research, and attracting investment in sustainable businesses. Schreefel et al. (2020) suggest that by adopting regenerative agriculture, rural areas can diversify their economies, reduce dependence on subsidies, and create a more resilient food system. Boulanger et al. (2021) further argue that regenerative

agriculture can help retain young people in rural areas, who are often attracted by the prospect of more sustainable, diversified, and profitable farming systems.

4. Conclusion

The literature highlights that regenerative agriculture has the potential to provide substantial economic advantages, such as lower input costs, increased profitability through improved soil health and climate resilience, and the creation of new market opportunities. However, the economic shift towards regenerative agriculture presents several challenges, including significant initial investment requirements, yield uncertainties during transition phases, and the necessity for robust policy support. To fully realize the economic benefits of regenerative agriculture, targeted policy interventions, market incentives, and educational initiatives will be crucial in assisting farmers throughout the transition process.

It is important to emphasize that although the initial costs of transitioning to regenerative agriculture may be high, the long-term benefits, such as increased resilience to climate change, reduced water and energy costs, and more stable yields, can significantly outweigh the initial expenditures. Given that regenerative agriculture has the potential to remove carbon dioxide from the atmosphere and sequester it in the soil, which is urgently needed, is considered one of the leading agricultural systems in the fight against climate change and the preservation of soil health. In this context, economic sustainability may be more long-term, even in cases where short-term yields are not optimal. In addition to the direct economic benefits for farmers, regenerative agriculture can offer broader economic advantages for society, such as reduced costs for land remediation, the preservation of biodiversity and ecosystems, and a reduction in pressure on the healthcare sector through a decreased use of chemicals and pesticides.

Policy measures and incentives play a crucial role in guiding the agricultural sector toward the adoption of regenerative practices. In order to facilitate the transition to regenerative agriculture, it is essential to provide financial support, a favourable regulatory framework, and a conducive environment that reduces barriers to the transition process. Additionally, knowledge exchange and capacity building are key elements for the successful implementation of regenerative practices. This includes sharing best practices, providing training on sustainable agricultural techniques, and fostering collaboration among farmers, researchers, and policymakers. By enhancing farmers' access to relevant information and practical tools, the effectiveness and sustainability of regenerative agriculture can be significantly improved. Furthermore, continuous research and innovation in agricultural practices are necessary to further refine techniques, mitigate risks, and ensure that regenerative agriculture remains economically viable and environmentally beneficial in the long term.

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PAMETAN URBANI RAZVOJ KAO OKVIR REGENERATIVNE EKONOMIJE

Apstrakt: *Rast svetske populacije i povećanje potrošnje hrane i energije dovode poljoprivrednu proizvodnju u nepovoljan položaj. Problem proizlazi iz potrebe za brzim rastom proizvodnje hrane, koji se ostvaruje kroz specijalizovane operacije konvencionalnog načina poljoprivredne proizvodnje. Međutim, konvencionalna poljoprivredna proizvodnja ima negativan uticaj na prirodne resurse i predstavlja veliki izazov za buduću održivost proizvodnje hrane. Kako poljoprivredna proizvodnja ne bi ostala na tradicionalnoj raskrsnici, poslednjih godina se zagovara prelazak na alternativni pristup. Regenerativna poljoprivreda je pristup zasnovan na održivom*

korišćenju prirodnih resursa bez štetnih efekata po životnu sredinu, uz znatno manje oslanjanje na proizvodne inpute (hemikalije i mehanizaciju). Predmet rada je analiza ekonomskih efekata primene regenerativnih poljoprivrednih praksi u Evropi, sa posebnim fokusom na njihove dugoročne koristi. Istraživanje obuhvata ekonomske pokazatelje kao što su produktivnost, profitabilnost poljoprivrednih praksi, troškovi i koristi uvođenja regenerativnih metoda, kao i uticaj na ruralni razvoj. Cilj istraživanja je da se utvrdi kako regenerativna poljoprivreda može doprineti ekonomskoj održivosti poljoprivrednog sektora u Evropi.

Ključne reči: *Regenerativna poljoprivreda, održivost, ekonomske koristi, Evropa, životna sredina, klimatska neutralnost.*

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INTEREST RATE AS A DETERMINANT OF FISCAL SUSTAINABILITY IN THE SOUTHEAST EUROPEAN REGION

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Abstract: *This paper analyzes the impact of the interest rates on public debt sustainability in Southeast European countries during the 2008–2024, using a panel of eight countries with a total of 136 annual observations. The methodological approach is based on panel regression models (OLS, FEM, and REM), accompanied by diagnostic tests for autocorrelation, multicollinearity, and heteroskedasticity. Due to the presence of autocorrelation and heteroskedasticity, the pooled OLS model with robust standard errors was selected as the most reliable specification. The results show that the interest rate is by far the most significant determinant of public debt: an increase in the average interest rate by one percentage point raises the debt-to-GDP ratio by approximately 6.9–7.3 percentage points. Real GDP growth and the primary balance are not statistically significant, while inflation exhibits a mildly negative effect on debt, which becomes more pronounced with time lags. The originality of the paper lies in the empirically isolation of the interest rate effect in a region characterized by post-transition structural legacies, limited fiscal capacities, post-crisis instability, and pronounced pressures on public finance sustainability. This provides a new empirical interpretation of debt sustainability, according to which the cost of borrowing is the key mechanism shaping the debt trajectory—stronger than either fiscal consolidation or economic growth. The findings carry important implications for fiscal policy design: stabilizing public debt requires reducing refinancing risk, extending bond maturities, strengthening credibility, and controlling exposure to changes in the international interest rate environment and heightened market volatility.*

Keywords: *Interest rate, public debt, fiscal sustainability, panel analysis, Southeast Europe.*

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1. Introduction

The sustainability of public debt in modern economies is increasingly determined by interest rate dynamics, with the cost of debt servicing emerging as a key transmission channel of fiscal risk. Blanchard (2019) shows that periods of low interest rates significantly reduce the fiscal burden, as governments can refinance their debt without increasing tax pressure, temporarily shifting the sustainability threshold to levels higher than traditionally assumed. However, the empirical findings of Egert (2013) indicate that the negative effect of debt on economic growth appears even at much lower levels of indebtedness when interest rate pressures rise, confirming that sustainability depends more on the price of debt than on its nominal amount. Lian et al. (2020) further conclude that high-debt countries experience shorter episodes of favourable (negative) borrowing costs and that rising interest rates more rapidly deteriorate their debt positions, particularly under the influence of external shocks. In line with this, Wyplosz (2023) and Heimberger (2023) emphasize that the return to higher interest rates after 2021 marks the end of the era of cheap financing, and that the fiscal consequences of rising interest rates will be most visible in countries with limited fiscal space and concentrated debt-servicing obligations.

In this context, examining public debt in Southeast European countries becomes particularly important because the region is characterized by a specific growth model in which economic expansion relies heavily on private consumption and investment, while the capacity for long-term productivity gains is constrained by structural weaknesses in the labour market, export capacities, and technological development (European Commission, 2025a; 2025b; 2025c). Although countries differ in their debt levels—from those with relatively low debt and stable fiscal balances (e.g., Bulgaria, Bosnia and Herzegovina) to those with more pronounced debt-servicing burdens and high dependence on external financing (e.g., Croatia, Montenegro, Albania)—they share the common feature that rising interest rates directly narrow fiscal space, increasing refinancing costs and reducing room for development-oriented expenditures. For this reason, the present study examines the extent to which rising interest rates erode public debt sustainability in the region, and whether factors such as inflation, GDP growth, and fiscal balances can mitigate or delay this effect.

2. Theoretical Framework of the Role of the Interest Rate as a Regressor of Public Debt Dynamics

The interest rate on public debt represents one of the key determinants of debt dynamics. According to the 2020 report by the European Central Bank (ECB), the central issue of fiscal sustainability is the differential between the interest rate and real GDP growth (the i–g differential), adjusted for the value of the primary budget balance. The report suggests that a negative differential may contribute to a reduction in the public debt-to-GDP ratio even in the presence of a primary deficit. This implies that the interest rate is not merely a mechanical borrowing cost, but also an active channel through which financial markets influence the sustainability of public finances and the long-term fiscal position of the state (Checherita-Westphal and Domingues Semeano, 2020). A similar

conclusion is offered by Turner and Spinelli (2011), who show, using OECD countries as an example, that the low value of the i–g differential after the 2000s resulted from cautious monetary policy and inflation remaining within target ranges, thus preventing a dramatic increase in interest rates despite the 2008 global financial crisis.

According to Barrett (2018), currently low interest rates do not guarantee the sustainability of additional borrowing. Examining fiscal space during the global financial crisis, when interest rates fell sharply, the author concludes that the precondition for long-term sustainability lies in maintaining a balance between nominal GDP growth and nominal interest expenditures over time. Using the case of the United Kingdom, Barrett demonstrates that a drastic drop in interest rates during the crisis opened space for an increase in the public debt-to-GDP ratio of only about 5%, while an increase in the interest–growth differential of merely 2.5% caused an equivalent reduction in the sustainable debt threshold. In other words, the author emphasizes that fiscal sustainability depends on the persistence of low interest rates, rather than merely their current level.

A substantial body of recent research shows that capital markets do not form interest rates solely on the basis of the current fiscal position, but also in relation to the institutional framework underlying sovereign debt. During the European debt crisis, adverse interest rate conditions emerged primarily in the "periphery" of the euro area—precisely where confidence in monetary institutions had weakened and uncertainty regarding European Central Bank intervention was present. This implies that interest rates are particularly sensitive to institutional support and to the credibility signals that governments provide to markets, while in periods of crisis the gap between countries with strong and weak institutional capacity manifests itself through greater differentiation in borrowing costs (Heimberger, 2023). Furthermore, studies projecting long-term public debt sustainability from the perspective of interest rate dynamics highlight the importance of technological progress, unemployment fluctuations, demographic trends, and addressing income inequality (Heylen et al., 2024). These findings further justify treating the interest rate as the primary channel through which financial market shocks are transmitted to public debt dynamics.

The latest developments in global debt markets indicate that the favorable financing conditions typical of the pre-2022 period have not re-emerged. Despite reductions in policy rates, yields on government bonds in major economies have continued to rise, while public and corporate debt levels have also increased. This combination of higher borrowing costs and rising indebtedness narrows fiscal space, particularly at a time when investment related to the energy transition, infrastructure, and public policy fields are greater than ever. Debt accumulated after the 2008 financial crisis and the COVID-19 pandemic was used predominantly to cushion shocks and support short-term recovery, leaving unresolved questions regarding long-term investment capacity. Simultaneously, developing economies and the corporate sector face reduced access to financing, confirming that the current environment cannot be interpreted as a stable return to an era of cheap debt. These trends clearly indicate that the interest rate has once again become a binding constraint on fiscal capacity, with borrowing costs potentially becoming a key determinant of debt sustainability in the coming years (OECD, 2025).

Macroeconomic projections for Western Balkan countries (members of the Southeast European region outside the EU) indicate moderate but stable growth over the next three-year period, with an expected average annual growth rate of around 3% annually. Across all observed economies, key drivers of growth remain private consumption, rising real wages, and investment—particularly in infrastructure and energy—alongside substantial public expenditure, including major capital projects financed from budgetary and external sources. Although supportive of short-term progress, this growth structure implies a greater dependence of development sustainability on fiscal conditions and the cost of borrowing. Since the global trend of low interest rates from the previous decade has not returned and financing costs remain elevated, rising interest rates may act as a destabilizing channel, limiting future investment capacity and fiscal space. This suggests that the sustainability of public finances in the region depends not only on the pace of growth, but also on the ability to finance that growth under higher bond yields, making the interest rate one of the central determinants of long-term public debt stability in the region (WB, 2025).

In contrast to the Western Balkan countries, although Romania, Bulgaria, and Croatia also maintain stable medium-term growth—averaging around 3% annually—its structure is more closely shaped by the EU's fiscal framework and budgetary discipline rules. In Romania, accelerated inflation is anticipated in 2025 and 2026, alongside gradual fiscal consolidation, but also an increase in the public debt ratio from roughly 55% to about 63% of GDP by 2027, largely due to higher primary deficits and rising debt-servicing costs. In Bulgaria, the deficit remains within the range of 3–4% of GDP, with increased public spending on wages, pensions, and defense, while public debt rises from 23.8% of GDP in 2024 to more than 32% by 2027, with borrowing costs remaining the primary source of fiscal risk. Croatia projects a mild increase in the deficit to 2.8–2.9% of GDP in 2025–2026 and stabilization at around 2.8% one year later, while the public debt ratio declines toward 56% of GDP under a strong nominal growth scenario. A common denominator across these economies is that fiscal space is shrinking under the pressure of rising expenditures, demographic obligations, energy transition needs, and rising defense costs—implying that borrowing costs and interest rate dynamics will exert increasingly strong influence on public finances. In other words, even in EU member states outside the Western Balkan region, economic growth persists, but its sustainability increasingly relies on fiscal discipline and the ability to service debt in a high-interest-rate environment (European Commission, 2025a; 2025b; 2025c).

3. Data Sources and Descriptive Statistics of the Panel

The data used in this research were retrieved directly from the IMF (2025) website, specifically from the World Economic Outlook (WEO) database, ensuring high source relevance and full methodological consistency in their evaluation. Data on the public debt-to-GDP ratio, inflation, real GDP growth, and the primary balance—expressed as percentages—were directly included in the panel, while the interest rate (annual average) was calculated as a composite measure derived from interest expenditures and the share of public debt in GDP across countries and years.

Interest expenditures were calculated as the absolute difference between the primary balance and the overall budget balance, in line with the methodology defined

in the Government Finance Statistics Manual (IMF, 2014). Data on the budget balance were also obtained from the same source (IMF, 2025).

Below is the formula used to calculate the average interest rate in this study:

$$\text{Interest rate} = \frac{|Primary\ balance - Budget\ balance|}{Public\ debt{-}to{-}GDP\ ratio} \times 100$$

Based on the above-mentioned time series, a balanced panel was constructed, covering eight Southeast European countries over the period 2008–2024, with a total of 136 observations. The balanced structure of the panel allows for the application of panel regression methods without loss of information and eliminates issues arising from an unequal number of observations per unit, thereby increasing the reliability of the coefficient estimates. The panel is temporally complete (T = 17 for each country), spatially homogeneous (N = 8), and methodologically stable, providing the necessary conditions for the application of OLS, FEM, and REM specifications in the subsequent empirical analysis.

Table 1 – Descriptive Statistics of Dependent, Independent, and Control Variables

Variable	Mean	Standard deviation	Minimum	Maximum	N
Public debt	48,08	19,11	13,00	107,30	136
Interest rate	2,86	1,12	0,00	5,82	136
Inflation	3,44	3,72	-1,60	14,20	136
GDP growth	2,32	3,69	-15,30	13,00	136
Primary balance	-1,66	2,47	-8,23	4,33	136

Source: Author's elaboration based on Gretl statistical software.

Descriptive statistics indicate that Southeast European countries during the observed period are characterized by significant differences in debt levels, fiscal positions, and macroeconomic performance. The average public debt stands at 48.08% of GDP, while a standard deviation of 19.11 reflects a high degree of dispersion, indicating the presence of countries with both significantly lower and higher debt levels. The range from 13% to 107.3% of GDP confirms the pronounced heterogeneity of fiscal positions, highlighting economies with low debt as well as cases approaching debt vulnerability thresholds.

The interest rate has an average value of 2.86%, with a relatively low standard deviation (1.12), suggesting limited dispersion and greater stability in debt-servicing costs over time and across countries. Inflation (average 3.44%) exhibits considerable volatility (Std. Dev. = 3.72), reflecting the presence of price shocks, differing monetary policy regimes, and asymmetric economic responses during the crisis and post-crisis recovery periods. Similarly, real GDP growth (2.32% on average) has a high standard deviation (3.69) and a wide range of values (from -15.3% to +13%), confirming cyclical fluctuations and the region's sensitivity to external economic cycles.

The primary balance has a negative average value of -1.66% of GDP, indicating that most countries in the region operate under a primary deficit in the majority of years. However, the standard deviation of 2.47 shows that fiscal outcomes vary significantly over time, ranging from high primary surpluses to deep deficits.

Table 2 – Descriptive Statistics of Public Debt Dynamics by Country over the Observed Period

Country	Mean	Standard deviation	Minimum	Maximum
Serbia	49,91	10,49	29,40	67,10
Montenegro	64,07	17,12	34,20	107,30
North Macedonia	38,79	10,67	20,60	54,80
Bosnia and Herzegovina	38,26	5,64	30,30	47,10
Albania	65,43	7,17	54,50	75,40
Croatia	69,00	13,19	38,90	86,50
Bulgaria	20,23	4,39	14,10	27,00
Romania	38,95	10,99	13,00	54,60

Source: Author's elaboration based on Gretl statistical software.

Table 2 presents the dynamics of public debt as a share of GDP across Southeast European countries during the observed period. It is evident that fiscal indebtedness differs significantly among countries, as reflected in the wide range of average values. The highest levels of public debt are observed in Croatia and Albania, with averages between 65–69% of GDP, while Montenegro exhibits the greatest volatility (Std. Dev. = 17.12), indicating a pronounced debt accumulation trend with strong year-to-year fluctuations. In contrast, Bulgaria records the lowest average debt (20.23% of GDP) along with the smallest deviation from the mean, making it the most fiscally stable country in the group.

Serbia, Romania, and North Macedonia fall within the middle range, with Serbia showing moderately high, yet not negligible, volatility, while Bosnia and Herzegovina displays the most stable public debt trajectory after Bulgaria, combined with low indebtedness. This profile of results indicates that the region is characterized by substantial heterogeneity in fiscal performance, with a clear contrast between countries with stable fiscal dynamics and those with pronounced debt growth, which has direct implications for debt sustainability and financing costs.

Table 3 – Descriptive Statistics of Average Interest Rate Dynamics by Country over the Observed Period

Country	Mean	Standard deviation	Minimum	Maximum
Serbia	3,49	0,79	1,90	4,41
Montenegro	2,93	0,53	1,94	3,61
North Macedonia	2,80	0,35	2,22	3,47
Bosnia and Herzegovina	1,91	0,42	1,40	2,93
Albania	3,93	1,07	2,57	5,82
Croatia	3,00	0,76	1,78	3,88
Bulgaria	1,12	0,76	0,00	2,56
Romania	3,70	0,61	2,66	4,64

Source: Author's elaboration based on Gretl statistical software.

Table 3 presents the average interest rates on public debt for Southeast European countries during the observed period. The values indicate significant differences in borrowing costs, with average interest rates ranging from approximately 1% to nearly 4% per year. Bulgaria exhibits the lowest debt-servicing cost (1.12% on average), along with one of the narrowest value ranges, reflecting a low initial debt level and favorable borrowing conditions. Bosnia and Herzegovina also records

relatively low interest rates (1.91%), with more stable dynamics compared to Bulgaria.

In contrast, Albania and Romania have the highest average interest rates (3.93% and 3.70%) and, together with Montenegro, Croatia, and Serbia, belong to the group of countries with above-average public debt financing costs. North Macedonia, on the other hand, achieves a lower financing cost (2.80%) with minimal fluctuations, suggesting greater predictability of fiscal obligations.

This distribution of values confirms that differences in fiscal position, market reputation, and risk exposure significantly affect the cost of public debt in the region. Countries with lower interest rates generally exhibit lower debt levels and a more stable macroeconomic environment, whereas countries with higher rates face greater servicing costs and potentially higher sensitivity to financial shocks.

4. Methodological Framework and Econometric Estimation of the Impact of Interest Rates on Public Debt in Southeast European Countries

The assessment of the impact of interest rates on public debt in this study is based on the application of panel data regression models, including OLS, REM, FEM. The panel is balanced and includes 136 observations. The temporal scope of the study covers the period from 2008 to 2024 and is based on annual data. The observed countries, according to the classification of the Organisation for Economic Co-operation and Development (OECD, n.d.), constitute the Southeast European region and include: Serbia, Montenegro, North Macedonia, Bosnia and Herzegovina, Albania, Croatia, Bulgaria, and Romania.

Given their shared history of transition processes, similar institutional challenges, and financing patterns, the region provides a suitable basis for a comparative analysis of the determinants of public debt dynamics. Moreover, the homogeneity of institutional frameworks, through full EU membership or EU candidacy, alongside shared macroeconomic challenges, makes this group appropriate for the application of a common-panel model, while differences among countries ensure sufficient variability for valid econometric estimation.

The specification of the applied regression model follows standard econometric practice and can be expressed as follows (Gujarati & Porter, 2009):

$$PUBLICT\_DEBT_{it}=\alpha+\beta_1 INTEREST\_RATE_{it}+\beta_2 INFLATION_{it}+ \beta_3 GDP\_GROWTH_{it}+\beta_4 PRIMARY\_BALANCE_{it}+ \upsilon_{it}$$

Where:

- $PUBLICT\_DEBT_{it}$ - public debt as a percentage of GDP for country i in year t
- $INTEREST\_RATE_{it}$ - average interest rate on public debt
- $INFLATION_{it}$ - annual inflation rate

- GDP_GROWTH_{it} - real GDP growth
- $PRIMARY\_BALANCE_{it}$ - primary budget balance
- α - intercept term
- $\beta_1\beta_2\beta_3\beta_4$ - coefficients of the regressors
- υ_{it} - error term

To account for potential lagged effect of inflation on public debt, since inflationary impacts are not necessarily immediate, the study also tests the effect of inflation with a one-year time lag.

4.1. The Impact of Interest Rates on Public Debt in the Region

Before proceeding with the econometric interpretation, it is necessary to conduct a diagnostic validity check of the model. In accordance with standard panel econometric procedures, the presence of autocorrelation, multicollinearity, and heteroskedasticity is examined, as their occurence can lead to biased or inefficient parameter estimates and incorrect statistical inferences. Therefore, appropriate diagnostic tests are applied to the estimated panel model to ensure the reliability of the regression results.

Table 4 – Diagnostic Tests of the Panel Model

Test	Purpose of the Test	Test Statistic	p-value	Conclusion
Wooldridge test for autocorrelation	Autocorrelation Test	5,51	0,00	Autocorrelation is present
Variance inflation factor (VIF)	Multicollinearity Test	max VIF = 1,31	/	No multicollinearity detected
White test	Heteroskedasticity Test	85,38	0,00	Heteroskedasticity is present

Source: Author's elaboration based on Gretl statistical software.

Based on the conducted tests and the results presented in Table 4, it can be concluded that no multicollinearity among the regressors is present in the model, as the maximum VIF value is 1.31, well below the critical threshold. However, the model exhibits the presence of autocorrelation (p-value = 0.00 < 0.05) and heteroskedasticity (p-value = 0.00 < 0.05), indicating that robust standard errors should be applied to ensure the validity of the estimated results.

The selection of the appropriate model was carried out using standard econometric tests: the F-test, the LM Breusch–Pagan test, and the Hausman test. The F-test was used to choose the optimal model between OLS and FEM approaches, the LM Breusch–Pagan test for selection between OLS and REM models, and the Hausman test to determine the appropriate specification between REM and FEM. The application of these complementary tests is an integral part of the panel econometric procedure and allows for the identification of the model that is most consistent with the structure of the observed panel data.

Table 5 – Results of model selection tests

Test	p-value	Conclusion
F-test (OLS vs FEM)	0,99	OLS is preferred
LM test (OLS vs REM)	0,08	OLS is preferred
Hausman test (REM vs FEM)	0,94	REM is preferred

Source: Author's elaboration based on Gretl statistical software.

Based on the presented results, it can be concluded that statistical criteria clearly favor the use of the OLS model. The F-test comparing the OLS and FEM specifications shows an extremely high p-value ($p \approx 1$), unequivocally rejecting the need to introduce fixed effects. Similarly, the LM test (OLS vs. REM) yields a p-value of 0.08, which is above the conventional significance threshold (0.05), indicating that panel effects are not strong enough to justify the use of a random effects model. Finally, although the Hausman test formally indicates the consistency of the REM model ($p=0.94$), this finding has little practical relevance in a situation where the LM test has already shown that the REM model is not statistically justified.

When all tests are considered together, the methodologically most consistent and econometrically justified approach is to use the pooled OLS model with robust standard errors for further analysis. Neither the FEM nor the REM specifications are statistically necessary in this panel structure, while previous tests indicated the presence of autocorrelation and heteroskedasticity. The following section presents the results of the OLS model with robust standard errors, including variants with current and lagged inflation.

Table 6 – Results of the OLS model with robust standard errors

Variable	Model with Current Inflation	p-value	Model with Lagged Inflation	p-value
INTEREST_RATE	6,92	0,00	7,26	0,00
INFLATION	-0,70	0,04	/	/
INFLATION_L1	/	/	-1,05	0,01
GDP growth	-0,11	0,91	-0,45	0,62
Primary balance	0,03	0,98	0,11	0,90
F-statistic	7,63	0,00	8,83	0,00
R2	0,19	/	0,21	/
Adj. R2	0,16	/	0,19	/

Source: Author's elaboration based on Gretl statistical software.

The results presented in Table 6 indicate that the interest rate on public debt is a statistically highly significant determinant of the public debt levels in all model specifications, with a positive and economically strong effect. In contrast, real GDP growth and the primary balance do not show statistical significance during the observed period.

Inflation in the current year has a negative and statistically significant coefficient, while in the model with INFLATION_L1 the negative effect becomes even more pronounced, and this occurs under a stricter criterion of statistical significance (p-value = 0.01). The F-statistic is significant at the 1% level, confirming the joint statistical significance of the regressors, while the explained variance (R^2, Adj. R^2) is relatively moderate, which is typical for macroeconomic panel models of this type.

4.1. Economic Interpretation of the Research Results

The results of the estimated OLS model with robust standard errors indicate that the interest rate on public debt is by far the most significant individual factor explaining the dynamics of the public debt-to-GDP ratio in Southeast European countries. In the model with current-year inflation, the coefficient for the variable INTEREST_RATE is 6.92 (p-value = 0.00), while in the alternative specification with lagged inflation (INFLATION_L1) the coefficient increases to 7.26 (p-value = 0.00). This implies that a one-percentage-point increase in the average interest rate is associated with an increase in the public debt-to-GDP ratio of approximately 6.9 to 7.3 percentage points. For example, if a country with a 50% debt-to-GDP ratio and an average interest rate of 3% moves to a 4% rate, the model suggests that its debt ratio could rise to approximately 57% of GDP in the medium term, assuming other variables remain unchanged. This result clearly indicates that borrowing costs are a far stronger driver of public debt dynamics than any individual real or fiscal indicator included in the model.

The robustness of this finding is further confirmed by the fact that the interest rate coefficient remains stable in magnitude and highly statistically significant in both model specifications—whether inflation is considered in the current year or with a one-year lag. In other words, regardless of whether price effects are captured immediately or with a delay, the main message remains unchanged: higher interest rates accelerate debt accumulation and reduce fiscal space. This is particularly important for countries with already elevated debt levels.

In comparison to the interest rate, other variables in the model play a secondary, control role. Current-year inflation shows a negative and statistically significant effect on public debt (coefficient = –0.70; p = 0.04), suggesting that rising prices slightly reduce the relative debt burden in the short term. However, this effect is moderate and much weaker than the impact of interest rates.

When inflation is included with a one-year lag, its negative effect becomes more pronounced (INFLATION_L1 = –1.05; p = 0.01), consistent with the expectation that inflation fully impacts debt only when it is reflected in nominal GDP and the tax base. Nevertheless, in neither specification does inflation nullify or substantially reduce the effect of interest rates—instead, it acts as a mitigating factor that partially offsets the negative impact of high borrowing costs.

Real GDP growth and the primary balance were included in the model primarily as control variables, to isolate the "pure" effect of interest rates on public debt. Their coefficients are not statistically significant in the observed period, suggesting that neither growth nor temporary primary surpluses were strong enough to reverse the debt trend under conditions of variable but generally elevated borrowing costs. The lack of significance of these control variables does not imply that growth and fiscal policy are unimportant for long-term sustainability, but rather that in the studied sample and period, they were not the main mechanisms driving changes in the debt-to-GDP ratio.

5. Conclusion

The conducted empirical analysis confirms that the interest rate is the key determinant of public debt dynamics in Southeast European countries. The results indicate that a one-percentage-point increase in the interest rate raises the public debt-to-GDP ratio by approximately 7 percentage points. This finding remains robust even when inflation, real GDP growth, and the primary balance are included in the model as control variables, indicating that the interest rate effect is structural, robust, and independent of cyclical economic fluctuations.

Inflation moderately alleviates the debt burden within the same year, but its effect becomes significantly stronger with a time lag. In contrast, GDP growth and the primary balance are not strong enough to statistically or economically alter the debt trajectory. In other words, fiscal sustainability in the region largely depends on the cost of borrowing, while other variables play a secondary role—more as modifiers of the trend than as its primary drivers.

Overall, the results suggest that rising interest rates pose the greatest risk to the long-term stability of public finances, particularly in economies that frequently refinance their debt. Inflation may temporarily ease the debt burden, but primarily with a lag, whereas economic growth and fiscal consolidation remain important but insufficient channels in the absence of favorable borrowing conditions. This implies that debt sustainability in Southeast European countries is determined not only by fiscal discipline, but above all, by capital costs and market access.

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KAMATNA STOPA KAO DETERMINANTA FISKALNE ODRŽIVOSTI REGIONA JUGOISTOČNE EVROPE

Apstrakt: *Ovaj rad analizira uticaj kamatne stope na održivost javnog duga u zemljama Jugoistočne Evrope u periodu 2008–2024. godine, primenom panela od osam država sa ukupno 136 godišnjih posmatranja. Metodološki pristup zasnovan je na panel regresionim modelima (OLS, FEM i REM), uz sprovedene dijagnostičke testove autokorelacije, multikolinearnosti i heteroskedastičnosti. Zbog identifikovane autokorelacije i heteroskedastičnosti, kao najpouzdanija specifikacija odabran je Pooled OLS model sa robusnim standardnim greškama. Rezultati pokazuju da je kamatna stopa ubedljivo najznačajnija determinanta javnog duga: povećanje prosečne kamate za jedan procentni poen povećava udeo duga u BDP-u za oko 6,9–7,3 procentna poena. Realni rast BDP-a i primarni bilans nisu statistički značajni, dok inflacija pokazuje blago negativan uticaj na dug koji postaje izraženiji sa vremenskim odlaganjem. Originalnost rada ogleda se u empirijskom izdvajanju efekta kamatne stope u regionu sa post-tranzicionim strukturnim nasleđem, ograničenim fiskalnim kapacitetima, postkriznom nestabilnošću i izraženim pritiscima na održivost javnih finansija. Time se pruža novo empirijsko tumačenje održivosti duga, prema kome je trošak zaduživanja ključni mehanizam koji određuje dugovnu putanju, snažniji od fiskalne konsolidacije ili privrednog rasta. Dobijeni nalazi imaju značajne implikacije za kreiranje fiskalne politike: stabilizacija javnog duga zahteva smanjenje rizika nepovoljnog refinansiranja, produženje ročnosti obveznica, jačanje kredibiliteta i kontrolu izloženosti promenama u međunarodnom kamatnom okruženju i izraženoj tržišnoj nestabilnosti.*

Ključne reči: *Kamatna stopa, javni dug, fiskalna održivost, panel analiza, Jugoistočna Evropa.*

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BUILDING SUSTAINABLE CAREER IN THE ERA OF THE CIRCULAR ECONOMY

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Abstract: *The transition toward a circular economy represents a profound transformation of contemporary economic systems and labour markets, creating new conditions for career development and sustainability. In this context, the concept of sustainable careers has gained increasing relevance, emphasizing long-term employability, adaptability, well-being, and productivity throughout he lifespan. This paper aims to explore how the circular economy influences the formation of sustainable careers and to identify key competencies and organizational practices required to support career sustainability under changing labour market conditions. Drawing on a qualitative literature review, the study integrates insights from sustainable human resource management, sustainable career theory, and circular economy research. The analysis highlights that the circular economy reshapes skill requirements, job structures, and career paths, thereby increasing the importance of continuous learning, career adaptability, and employee well-being. Furthermore, the paper emphasizes the critical role of sustainable human resource management in enabling individuals and organizations to respond effectively to these transformations. By conceptually linking circular economy principles with sustainable career development, the study contributes to a deeper understanding of career sustainability in times of economic and environmental transition and provides a foundation for future empirical research and policy development.*

Keywords: *Sustainable careers, circular economy, sustainable human resource management, employability, career adaptability.*

1. Introduction

In today's business landscape, marked by globalization, technological advancements, and diverse work arrangements, sustainable human resource

management has become essential for fostering long-term resilience and success for both organizations and their employees. In contrast to conventional human resource management, which primarily concentrates on immediate outcomes and organizational objectives, sustainable human resource management focuses on harmonizing economic, social, and human dimensions of work. The core idea is that nurturing employee development, health, well-being, and employability serves not only individual interests but also is a key factor in maintaining the long-term competitiveness of organizations.

While studies in sustainable human resource management mainly focus on employees as assets that organizations should develop for their long-term viability, it is important to recognize that employees have their own resources that form the basis of their individual career sustainability (Schweitzer et al., 2023). Within this context, employees who are "equipped" with the right competencies serve as the foundation not only for the long-term sustainability of organizations but also for employees' personal adaptability to shifts in the job market, thus leading to the emergence of the concept of a sustainable career.

A sustainable career refers to a professional journey that aligns with individuals' values and personal needs, as well as with broader social contexts. It is supported by organizations through effective (sustainable) human resource management policies and practices (De Vos & Van der Heijden, 2017). Within this framework, sustainable human resource management acts as a "transportation tool," helping employees maintain their employability and fostering meaningful long-term professional growth through training, skill development, and employer assistance. This mutual support leads to advantages for both organizations and employees. Organizations foster a resilient and engaged workforce through sustainable human resource management, while employees, in turn, achieve continuity, adaptability, and enduring value for both themselves and their employers.

The concept of the circular economy plays a crucial role in nurturing an environment conducive to building sustainable careers in today's world. Commonly referred to as a "closed-loop economy," this model aims for comprehensive sustainability by promoting a zero-waste culture (De los Rios & Charnley, 2017). However, the intricate demands of this model present challenges across all economic sectors, including the labour market. If the changes in the labour market driven by the circular economy are not integrated into human resource management strategies, the diverse skill sets essential for thriving in this new economic era, as well as the pursuit of sustainable development goals, may be overlooked, ultimately hindering organizations from achieving long-term sustainability.

Recognizing that the circular economy alters the labour market dynamics and establishes new competency demands, this research aims to explore how this model facilitates the growth of sustainable careers. It also seeks to identify the essential skills that both individuals and organizations require throughout this transformation. The study particularly highlights the relationship between sustainable human resource management, the concept of a sustainable career, and the shifts initiated by the transition to a circular economy.

The following research question arises from the above-mentioned research objectives:

Research question: How does the transition to a circular economy shape the conditions for sustainable career development, and what role does sustainable human resource management play in supporting career sustainability under these conditions?

To address the research question, this paper adopts a qualitative literature review that integrates insights from sustainable career theory, sustainable human resource management, and circular economy research. The paper is structured as follows. First, the conceptual foundations of sustainable careers are examined, with particular attention to their defining characteristics, core dimensions, and relevance to long-term employability, well-being, and productivity across the lifespan. Second, the circular economy is analysed as a broader economic and labour market context, focusing on how the transition from linear to circular production and consumption models reshapes job structures, skill requirements, and career trajectories. Building on this, the paper explores the role of sustainable human resource management as a key enabling mechanism that supports the development of sustainable careers under circular economy conditions, emphasizing practices related to lifelong learning, career adaptability, and employee well-being. The paper then discusses the main challenges and future perspectives associated with career sustainability in the era of the circular economy, highlighting risks related to skill mismatches, job quality, and labour market inequality, as well as opportunities for inclusive and resilient career development. Finally, the paper concludes by summarizing the key conceptual insights, outlining implications for individuals, organizations, and policymakers, and suggesting directions for future research.

2. The conceptual basis for sustainable careers

Sustainable careers represent a relatively recent conceptual approach within career research that extends traditional understandings of career development by emphasizing long-term viability and adaptability. Growing scholarly and practical interest in this concept has largely been driven by demographic changes, particularly the transition of a substantial proportion of the baby boomer generation into the later stages of their careers, including retirement (Newman, 2011). This shift entails potentially significant economic and social costs, such as increased employee replacement costs for organizations and heightened pressure on pension systems at the societal level. As a result, the sustainability of careers together with the necessity to prolong working lives and enhance their adaptability across the lifespan has emerged as a central concern in contemporary career theory and practice. Accordingly, the following Table 1 outlines key definitions of the sustainable career concept as developed in the academic literature.

Table 1. Sustainable career definitions

Source	Definition
(Russo et al., 2025)	"The concept of a sustainable career reflects a non-linear sequence of individual work experiences spanning various life domains, social contexts and the lifespan,

	facilitating the development of health, happiness, productivity, and ensuring social integration and empowerment."
(Curado et al., 2023)	"Sustainable careers are regarded as a cyclical process characterized by mutually beneficial consequences for both the individual and the environment from a long-term perspective."
(Curado et al., 2023)	"Sustainable careers can be defined as a form of human sustainability aligned with the ability of individuals to create, test, and maintain their adaptive capacity."
(Heslin et al., 2020)	"A sustainable career is one in which individuals enjoy at least a moderate degree of productivity, health, and happiness across their lifespan."
(Van der Heijden & De Vos, 2015)	"Sustainable careers are defined as 'the sequence of an individual's different career experiences, reflected through a variety of patterns of continuity over time, crossing several social spaces, and characterized by individual agency, thereby providing meaning to the individual'"
(Van der Heijden & De Vos, 2015)	"Sustainable careers are characterized by three broad indicators: health, happiness, and productivity, suggesting that people who have a sustainable career are more productive in terms of work performance, are more employable, have less stress, better physical and mental health and report being more satisfied with their career progress as well as with life in general."
(Newman, 2011)	"Sustainability implies preserving and enhancing human capital rather than depleting it."

Source: Authors' presentation.

Across the reviewed definitions in Table 1, sustainable careers are consistently framed as long-term, dynamic, and adaptive processes that evolve across the lifespan and multiple work and social contexts. Rather than being linear, careers are conceptualized as non-linear sequences of experiences, shaped by individual agency and the capacity to continuously adapt to changing personal and environmental conditions. A central commonality is the emphasis on career outcomes that integrate health, happiness, and productivity, reflecting the alignment of individual well-being with sustained work performance and employability. Moreover, several definitions underscore the principle of human capital preservation and development, highlighting that sustainable careers enable individuals to maintain and enhance their capabilities instead of exhausting them over time. Collectively, these perspectives position sustainable careers as mutually beneficial for individuals, organizations, and society, ensuring long-term career viability through the balanced interplay of adaptability, well-being, and productive engagement.

The four core elements underpinning the concept of sustainable careers, such as time, social space, agency, and meaning, highlight important directions for both theory and research. As career trajectories become increasingly fragmented and less predictable, greater scholarly attention must be paid to the temporal dimension of careers, which calls for a shift away from predominantly cross-sectional research designs toward more longitudinal approaches. The expansion of careers across multiple social spaces further necessitates consideration of the risks and challenges individuals encounter when transitioning between work contexts. In addition, the element of agency points to the need for more dynamic career models that account for ongoing adult identity development rather than static career stages. Closely related to this, the notion of meaning in careers requires a developmental perspective that recognizes how individuals' interpretations of their career experiences evolve over time. While significant progress has been made in advancing the sustainable career framework, these considerations underscore the need for continued conceptual refinement and methodological innovation (Lawrence et al., 2015).

These elements give rise to specific implications for human resource management in organizations when viewed from the perspective of employees' sustainable career development. In this context, organizations are expected to implement measures and practices aimed at aligning employees' skills and interests with the content of their jobs, thereby enabling employees to realize their full potential. Furthermore, organizations should devote adequate attention to harmonizing employees' work-related demands with their non-work lives in order to reduce turnover resulting from conflicts between job requirements and family responsibilities. Beyond serving as a mechanism for employee retention, such practices also contribute to strengthening employees' organizational commitment.

The existing body of research on sustainable careers suggests that this model shares several common features with other contemporary career concepts, while also exhibiting important distinctions. In the literature, the sustainable career model is most frequently examined in comparison with the protean career and the boundaryless career frameworks.

Compared with other contemporary career models, the concept of a sustainable career adopts a broader and more integrative perspective. Similar to the *protean career*, it emphasizes individual agency, adaptability, and continuous learning, recognizing that individuals actively shape their careers in response to changing contexts (De Vos et al., 2020; Hall, 2004). Likewise, it shares common ground with the *boundaryless career* model in acknowledging non-linear career paths that transcend organizational boundaries and involve mobility across roles, organizations, and life domains (Sullivan & Arthur, 2006). However, unlike protean and boundaryless careers, which primarily focus on self-direction, mobility, and subjective or objective career success, the sustainable career framework explicitly incorporates a long-term, lifespan perspective and places central emphasis on career sustainability outcomes, namely health, happiness, and productivity. Moreover, sustainable careers adopt a systemic view, considering not only individual agency but also organizational, societal, and contextual factors that enable or constrain career continuity over time. In this sense, the sustainable career model extends earlier contemporary career concepts by integrating adaptability and mobility with concerns for long-term well-being, employability, and the preservation of human capital.

The concept of sustainable careers emphasizes long-term career viability through the balanced development of health, happiness, and productivity across the lifespan. It highlights the dynamic, non-linear nature of careers shaped by individual agency, continuous learning, and changing social and organizational contexts. As such, sustainable careers represent a shift from short-term employment outcomes toward preserving and enhancing human capital over time.

3. The role of the circular economy in the development of sustainable careers

The increasing shortcomings of the traditional linear economic model, characterized by intensive resource extraction, short product life cycles, and waste generation, have highlighted the urgent need for alternative approaches to production and consumption. In the context of finite natural resources and escalating environmental pressures, the circular economy has emerged as a central principle of contemporary economic development. This systemic shift not only transforms production processes but also significantly reshapes labour market dynamics, creating both new

challenges and opportunities, particularly in relation to the emergence and development of sustainable careers.

At its core, the circular economy seeks to minimize resource use and environmental impact by redefining how materials and energy are managed throughout the economic system. Instead of following a linear trajectory of extraction, production, and disposal, this model promotes closed-loop processes in which products, components, and materials are continuously reused, repaired, recycled, or regenerated. By extending the lifespan of resources and reducing waste generation, the circular economy supports long-term sustainability while fostering new skill requirements and career pathways aligned with these principles.

The transition toward a circular economy is increasingly reshaping the global labour market by altering employment structures, transforming job content, and redefining skill requirements across sectors. Moving away from the traditional linear model of production and consumption, circular economic systems emphasize resource efficiency, product longevity, reuse, and regeneration, which have implications for both job creation and job transformation rather than simple job substitution (De los Rios & Charnley, 2017; Prashant et al., 2025). Empirical evidence suggests that circular economy activities already account for a substantial share of global employment, particularly in sectors such as recycling, repair, remanufacturing, and waste management, although a significant proportion of these jobs remain informal and characterized by precarious working conditions, especially in developing economies (Prashant et al., 2025). Importantly, the circular transition does not primarily generate entirely new occupations but rather modifies existing roles by expanding their task profiles and competency demands, requiring workers to integrate circular principles into established professional practices (The International Institute for Sustainable Development, 2020). As a result, skill requirements are shifting toward a combination of technical skills related to materials, repair, and sustainable production processes, digital skills for tracking resource flows and managing product life cycles, and transversal competencies such as systems thinking, collaboration, and problem-solving (Buyukyazici & Quatraro, 2025; European Commission, 2018; OECD, 2023). Studies further highlight growing demand for sustainability-related expertise, including lifecycle assessment, eco-design, and environmental management, underscoring the need for continuous upskilling and reskilling throughout the working life (De los Rios & Charnley, 2017). Without targeted investments in education, vocational training, and lifelong learning systems, skill mismatches may emerge that risk slowing the circular transition and exacerbating labour market inequalities, thereby emphasizing the importance of coordinated policy responses to ensure a just and inclusive transformation of work (OECD, 2023; Prashant et al., 2025).

The transition to a circular economy provides an important contextual foundation for the development of sustainable careers by reshaping how work is organized, how skills are developed, and how employability is maintained over time. By prioritizing resource efficiency, product longevity, and regenerative production systems, the circular economy encourages continuous learning, adaptability, and long-term workforce engagement as core elements of sustainable career theory (De Vos & Van der Heijden, 2017; Van der Heijden & De Vos, 2015). Rather than promoting short-

term employment trajectories, circular business models emphasize ongoing value creation through repair, reuse, remanufacturing, and recycling activities, which require workers to regularly update their competencies and remain employable across changing labour market conditions (De los Rios & Charnley, 2017). Empirical research suggests that these dynamics foster career sustainability by supporting skill renewal, enhancing job mobility, and reducing the risk of career obsolescence, particularly in sectors undergoing ecological and technological transformation (Curado et al., 2023; Prashant et al., 2025). In this sense, the circular economy aligns closely with the sustainable career perspective, as both stress the preservation and development of human capital, individual agency, and the integration of economic, social, and environmental objectives over the lifespan (Heslin et al., 2020; Newman, 2011).

While the circular economy creates new opportunities for skill development, employability, and long-term workforce engagement, it also introduces significant challenges related to job quality, skill mismatches, and unequal access to learning opportunities, which have important implications for the sustainability of careers and are examined in the following section.

4. Reframing career sustainability in the era of the circular economy – challenges and perspectives

The transition toward a circular economy fundamentally reshapes the conditions in which careers are developed and sustained, presenting both significant challenges and promising perspectives for individuals, organizations, and labour market institutions. Although the circular economy is increasingly promoted as a pathway toward environmental sustainability and economic resilience, its implications for career sustainability remain complex and uneven across regions, sectors, and occupational groups. Sustainable careers, understood as career trajectories that enable individuals to maintain health, happiness, productivity, and employability over time, are deeply influenced by the structural transformations induced by circular economic models (De Vos & Van der Heijden, 2015; Heslin et al., 2020). One of the central *challenges* in this context lies in the rapid pace of change in skill requirements, as circular business models demand new combinations of technical, digital, and sustainability-related competencies that many workers currently lack (De los Rios & Charnley, 2017; Prashant et al., 2025). Without adequate access to continuous learning opportunities, workers risk skill obsolescence, which threatens long-term employability and undermines the sustainability of their careers.

Another major challenge concerns labour market polarization and inequality. Although the circular economy has the potential to generate employment in activities such as repair, recycling, remanufacturing, and resource recovery, empirical evidence indicates that a substantial share of these jobs is characterized by informality, low wages, and limited social protection, particularly in developing economies (Prashant et al., 2025). Such conditions pose serious risks to career sustainability, as precarious employment undermines workers' ability to plan, invest in skill development, and maintain well-being over the life course (Newman, 2011).

Moreover, transitions toward circular production systems may lead to job displacement in linear industries, creating uncertainty for workers whose skills are closely tied to declining sectors. In the absence of effective reskilling policies and inclusive transition strategies, these workers may face fragmented and unstable career paths, contrary to the principles of sustainable career development.

From an organizational perspective, the implementation of circular economy principles requires a rethinking of human resource management practices to support long-term career sustainability. Sustainable human resource management plays a crucial role in enabling employees to adapt to changing job demands by fostering continuous learning, internal mobility, and employee well-being (De Vos & Van der Heijden, 2017). However, many organizations struggle to align short-term performance pressures with long-term investments in human capital, which may limit their ability to fully support sustainable careers in circular contexts. Additionally, the interdisciplinary nature of circular economy work often requires collaboration across organizational boundaries and value chains, challenging traditional career structures and progression models that are based on linear advancement within a single organization.

Despite these challenges, the circular economy also offers important *perspectives* for strengthening sustainable careers. By emphasizing resource efficiency, innovation, and long-term value creation, circular systems create demand for adaptive, learning-oriented workers who can navigate diverse roles and transitions over time. This aligns closely with contemporary sustainable career frameworks, which highlight individual agency, adaptability, and meaningful work as key dimensions of career sustainability (Curado et al., 2023; Van der Heijden & De Vos, 2015). Furthermore, international policy initiatives increasingly recognize the importance of linking circular economy strategies with skills development, lifelong learning, and just transition frameworks. Organizations such as the OECD and the ILO stress that coordinated investments in education, vocational training, and active labour market policies can help transform circular economy transitions into opportunities for inclusive and sustainable career development (OECD, 2023; Prashant et al., 2025).

In this regard, the circular economy can be seen not only as a technological or environmental transformation but also as a social and career-related one. When supported by appropriate institutional frameworks, the circular economy has the potential to foster careers that are more resilient to economic shocks, more aligned with societal sustainability goals, and more conducive to long-term employability. However, realizing this potential requires addressing existing labour market inequalities, ensuring decent working conditions, and embedding considerations of career sustainability into circular economy policies and organizational practices. Ultimately, the development of sustainable careers under circular economy conditions depends on the ability of stakeholders to balance economic efficiency, environmental responsibility, and social inclusion throughout individuals' working lives.

5. Conclusion

The transition toward a circular economy represents a profound transformation of contemporary labour markets, with significant implications for the development of sustainable careers. This paper has highlighted that sustainable careers are no longer shaped solely by individual choices or organizational practices, but increasingly by broader economic and environmental contexts that reshape work, skills, and employability. By linking the concepts of sustainable human resource management, sustainable careers, and the circular economy, the study emphasizes that long-term career sustainability depends on the ability of individuals and organizations to adapt to continuous change while preserving human capital, well-being, and productivity over time.

The findings suggest that the circular economy creates both opportunities and challenges for sustainable career development. On the one hand, it fosters new forms of work and skill requirements that encourage lifelong learning, adaptability, and meaningful employment aligned with sustainability goals. On the other hand, it exposes risks related to skill mismatches, job insecurity, and unequal access to training and career opportunities, particularly for vulnerable groups in the labour market. These challenges underline the critical role of sustainable human resource management in supporting employees through targeted training, career development initiatives, and policies that promote health, engagement, and employability across the lifespan.

From a broader perspective, the development of sustainable careers in circular economy conditions requires coordinated action among individuals, organizations, and policymakers. Individuals must actively invest in their own competencies and career adaptability, while organizations are expected to integrate sustainability principles into their human resource strategies. Policymakers, in turn, play a key role in creating institutional frameworks that support lifelong learning, decent work, and inclusive labour market transitions. By addressing these interconnected dimensions, the circular economy can serve as a supportive context for building sustainable careers that contribute to long-term economic resilience, social inclusion, and environmental sustainability.

This paper contributes to the literature by conceptually integrating the circular economy, sustainable human resource management, and sustainable careers, offering a comprehensive framework for understanding how contemporary labour market transformations shape long-term career sustainability. Despite its contributions, this study is limited by its reliance on a qualitative literature review, which does not allow for empirical testing, and by its broad perspective that may overlook sectoral and regional differences. Future research could address these limitations through quantitative, mixed-method, and comparative studies across industries and countries to empirically examine sustainable career development in circular economy contexts.

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GRAĐENJE ODRŽIVE KARIJERE U ERI CIRKULARNE EKONOMIJE

Apstrakt: *Prelazak na cirkularnu ekonomiju predstavlja značajnu transformaciju savremenih ekonomskih sistema i tržišta rada, stvarajući nove uslove za razvoj karijere i održivost. U tom kontekstu, koncept održive karijere dobija na značaju, naglašavajući dugoročnu zapošljivost, prilagodljivost, blagostanje i produktivnost tokom celog životnog veka. Cilj ovog rada je da istraži kako cirkularna ekonomija utiče na formiranje održivih karijera i da identifikuje ključne kompetencije i organizacione prakse potrebne za podršku održivosti karijere u promenljivim uslovima tržišta rada. Oslanjajući se na kvalitativni pregled literature, studija integriše uvide iz održivog upravljanja ljudskim resursima, teorije održive karijere i istraživanja cirkularne ekonomije. Analiza ističe da cirkularna ekonomija menja zahteve za veštinama, strukture poslova i karijerne puteve, čime se povećava značaj kontinuiranog učenja, prilagodljivosti karijere i blagostanja zaposlenih. Štaviše, rad naglašava ključnu ulogu održivog upravljanja ljudskim resursima u omogućavanju pojedincima i organizacijama da efikasno odgovore na ove transformacije. Konceptualnim povezivanjem principa cirkularne ekonomije sa održivim razvojem karijere, studija doprinosi dubljem razumevanju održivosti karijere u vremenima ekonomske i ekološke tranzicije i pruža osnovu za buduća empirijska istraživanja i razvoj politika.*

Ključne reči: *Održiva karijera, cirkularna ekonomija, održivo upravljanje ljudskim resursima, zapošljivost, prilagodljivost karijere.*

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SUSTAINABLE URBAN MOBILITY IN SERBIAN CITIES: STATUS, CHALLENGES, AND POLICY DIRECTIONS

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Abstract: *This paper examines sustainable urban mobility in Serbian cities within the broader context of European transport decarbonization imperatives and the country's EU accession process. Serbian cities are navigating the transition from car-centric transport paradigms toward more sustainable, inclusive, and multimodal mobility systems. This paper provides a state-of-the-art review of urban mobility in Serbia, covering the existing public transport infrastructure, active mobility conditions, policy frameworks, electric vehicle adoption, and walkability enhancement. Drawing on academic literature, institutional reports, and recent policy documents, the review identifies persistent structural challenges while highlighting significant momentum toward sustainable urban mobility planning. Serbian cities can substantially advance sustainable mobility by drawing on the best practices of developed cities; however, the effective transfer of these approaches requires their careful adaptation to local conditions through gradual implementation, intensive public awareness and education efforts, and consistent long-term political support.*

Keywords: *urban mobility, public transport, sustainable mobility, SUMP.*

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1. Introduction

Cities are the engines of national economies, and the manner in which people move within them is a fundamental determinant of economic productivity, environmental quality, and social equity (Newman & Kenworthy, 1999). Across the European continent, sustainable urban mobility has become a policy priority of the first order, driven by climate commitments, public health imperatives, and the broader ambitions of the European Green Deal. Serbia, a candidate country for European Union membership, finds itself in a transitional moment, one where inherited post-socialist urban forms, rapidly growing car ownership, and insufficient public transport investment are simultaneously challenged and partially countered by a new wave of strategic planning frameworks and international financing.

With approximately 57% of its population residing in urban areas (World Bank, 2023), and with Belgrade anchoring a metropolitan region of nearly two million inhabitants, Serbia's urban mobility challenges are neither marginal nor abstract. They manifest daily in congested arterial roads, overcrowded and aging bus fleets, dormant rail infrastructure, and active transport networks that remain vastly inadequate by European standards. At the same time, the country is witnessing the gradual emergence of Sustainable Urban Mobility Plans (SUMPs), renewed investment interest in rail and metro infrastructure, and the initial rollout of electric vehicle charging networks representing all signals of a system in transition.

This paper surveys the state of the art of urban mobility in Serbia, organizing the analysis around five thematic pillars:

1) the structural context of Serbian urbanization and transport heritage;
2) public transport systems and their performance;
3) active mobility and micromobility;
4) policy and planning frameworks;
5) emerging trends and strategic investments.

Urban transport in Serbia stands at a crossroads. On one hand, the country is experiencing the same macro-level pressures that have driven sustainable mobility reform across Europe: growing urban populations, worsening air quality, rising transport-related greenhouse gas emissions, and the fiscal and public health costs of traffic congestion. On the other hand, Serbia's specific history as a post-socialist transition economy has shaped a distinctive urban mobility landscape, one marked by rapid motorization since the 1990s, inherited but underinvested public transport infrastructure, and limited institutional capacity for integrated transport planning. The urgency of reform has been compounded by Serbia's trajectory toward European Union membership.

Urban mobility in Serbian cities is undergoing a gradual but noticeable transformation, shaped by broader European sustainability agendas, technological advancements, and evolving societal preferences. While the transition remains uneven and context-dependent, several key trends can be identified.

2. Mobility Patterns in Serbian Urban Context

Understanding urban mobility in Serbia requires situating it within the country's distinct urban development trajectory. Unlike Western European cities, where compact, transit-oriented growth patterns were established over centuries, Serbian cities experienced a period of rapid, automobile-influenced spatial expansion during the late socialist era, followed by a disruptive post-1990 transition characterized by deindustrialization, informalization of land use, and weak planning governance (Nedović-Budić et al., 2011). The cumulative effect has been a built environment that is neither sufficiently compact to support efficient public transport nor adequately dispersed to accommodate car-based mobility without severe congestion.

Serbia's urban system is highly primate: Belgrade, the capital, concentrates approximately 1.7 million residents and functions as the dominant political, economic, and cultural centre (BFPE, 2020). The next tier of cities, Novi Sad (approximately 280,000 inhabitants), Niš (approximately 260,000), Kragujevac (approximately 165,000), and Subotica (approximately 100,000) are substantially smaller. Beyond these, Serbia has a network of medium-sized cities (Šabac, Pirot, Kruševac, Zrenjanin, Smederevo, Sremska Mitrovica, and others) that together account for a significant share of the country's urban population but receive comparatively little research attention in the sustainable mobility literature.

This urban hierarchy has direct implications for transport planning. While Belgrade generates sufficient ridership density to support diverse public transport modes such as trams, trolleybuses, buses, and suburban rail, medium and smaller cities often rely almost exclusively on bus services, with lower frequencies and older fleets than those found in the capital. Peripheral urban areas and peri-urban zones face a particularly acute mobility gap, where low density and service infrequency make private car use structurally rational even for residents who might prefer sustainable alternatives.

Motorization has accelerated in tandem with rising incomes. Serbia currently has more than 2.5 million registered vehicles, the majority of which are passenger cars. Critically, the national vehicle fleet is aging, with an average vehicle age of approximately 15 years, a consequence of the prevalence of imported used cars, which are considerably more affordable than new ones. Older vehicles produce disproportionately higher emissions and are involved in more severe traffic incidents, compounding both environmental and safety challenges.

Air quality remains a high-salience driver for sustainable mobility in Serbian cities. Analyses summarizing the Serbian Environmental Protection Agency reporting indicate that in 2024 PM_{10} remained the dominant pollutant nationally, and that large cities experienced excessive pollution episodes; media summaries highlight exceedances in major urban areas and identify additional pollutants (e.g., NO_2) in the capital region. A limitation for comparative urban mobility research is that while air-quality reporting is systematic, linking air-quality outcomes to specific transport interventions requires higher-resolution emissions inventories and evaluation designs, which are not consistently published for Serbian cities.

3. Emerging Trends in Urban Mobility in Serbian Cities

The modernization and partial electrification of public transport systems are gaining momentum. Investments in cleaner vehicle fleets, including electric and hybrid buses, reflect increasing alignment with environmental objectives and EU policy standards. However, challenges related to infrastructure, financing, and operational efficiency remain.

Active mobility, especially cycling and walking, is receiving increasing attention. Cities have begun expanding cycling infrastructure and pedestrian zones, although these efforts are still fragmented and often lack network continuity. Nevertheless, changing attitudes, particularly among younger populations, indicate growing demand for these modes. Walking and cycling occupy a paradoxical position in Serbian urban mobility. They account for a significant share of total trips: particularly short-distance urban journeys, yet receive minimal infrastructure investment and are treated as marginal in most transport planning frameworks. Cycling infrastructure, where it exists, is fragmented and often discontinuous; pedestrian environments in many urban neighborhoods remain uncomfortable, unsafe, or inaccessible to people with limited mobility.

Nonetheless, pockets of best practice exist. Novi Sad, Subotica, and Pirot are consistently cited as cities with comparatively advanced cycling cultures and more developed cycling infrastructure relative to their size (BFPE, 2020). Novi Sad, in particular, has committed to expanding cycling lanes and has recently introduced electric bus procurement as part of a broader sustainable urban development agenda, positioning itself as a model for other Serbian cities.

Shared mobility services remain embryonic. Prior to recent developments, the only ride-hailing service in Belgrade was Car:Go, while bike-sharing systems were available in a limited number of cities, with 15 stations in Belgrade, 10 in Novi Sad, and a handful in Niš and Subotica, largely concentrated around recreational areas rather than commuting corridors (GETS Report, 2020).

Another notable trend is the emergence of shared and smart mobility solutions. Services such as bike-sharing, e-scooter systems, and digital mobility platforms are becoming more visible, particularly in larger urban centers. These innovations contribute to the diversification of mobility options, although regulatory frameworks are still evolving. There is also a gradual shift toward data-driven and participatory approaches to urban mobility governance. The use of digital tools, mobility data, and stakeholder engagement processes is increasing, supporting more informed and inclusive decision-making.

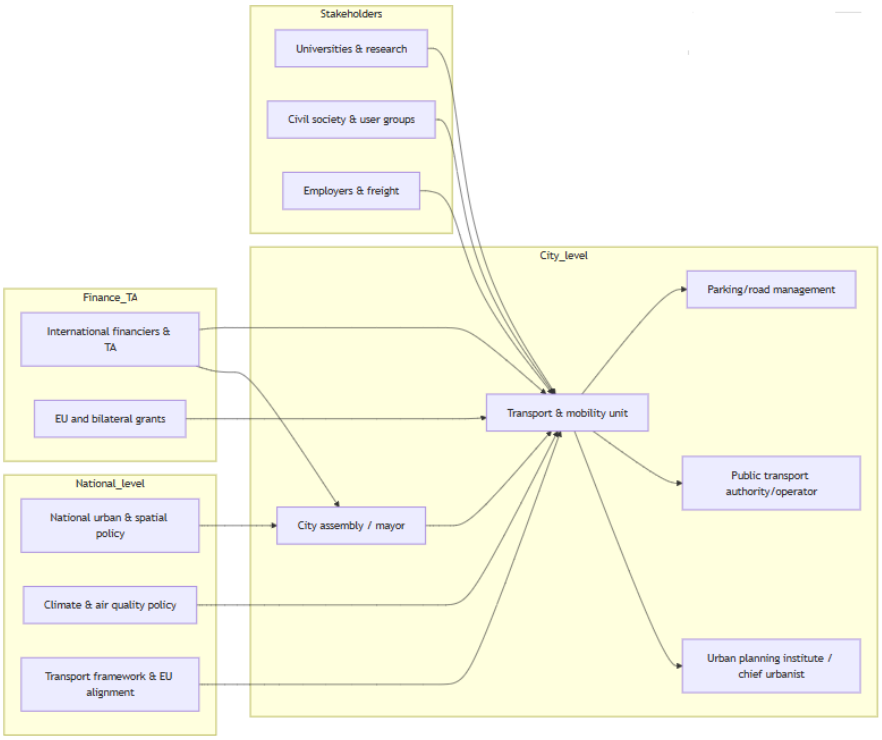
3. Policy Directions: Toward Sustainable Urban Mobility in Serbian Cities

Serbia has adopted major framework policies relevant to urban mobility. The Sustainable Urban Development Strategy of the Republic of Serbia until 2030 (adopted in 2019, Official Gazette) defines national priorities for sustainable urban

development, explicitly including urban mobility as a policy domain to be addressed alongside public spaces, inclusion, institutions, and finance.

The governance structure for sustainable urban mobility in Serbia typically spans national ministries, city governments, public transport operators, infrastructure and parking entities, academia, civil society, and international financiers. A city-level SUMP (City of Niš, 2025) often formalizes steering bodies and working units that include municipal departments, public companies, universities, and stakeholder organizations.

Figure 1: Conceptual framework for sustainable urban mobility model



Source: Authors

3. Implications and Recommendations for Enhancing Sustainable Urban Mobility

he findings indicate that advancing sustainable urban mobility in Serbia requires coordinated action across public institutions, the private sector, and citizens. Despite the existence of strategic frameworks, implementation remains limited, reflecting challenges commonly identified in transition economies, such as institutional fragmentation, insufficient funding, and car-dependent mobility patterns.

3.1. Recommendations for Public Policy Makers

Strengthening the regulatory and strategic framework is essential. Sustainable Urban Mobility Plans (SUMPs) should be legally recognized and integrated into formal spatial planning systems to ensure continuity and enforceability. International practice highlights that institutionalizing SUMPs significantly improves implementation outcomes (European Commission, 2023). In parallel, Serbia should adopt a dedicated national action plan to support local governments through co-financing mechanisms, technical assistance, and capacity building.

Improving regulatory coherence and enforcement is equally important. Clear standards for cycling infrastructure, pedestrian safety, and emerging mobility modes (e.g., e-scooters) should be established, accompanied by stronger monitoring mechanisms. Previous studies emphasize that regulatory gaps and weak enforcement often undermine sustainable mobility transitions in Southeast Europe.

Sustainable financing mechanisms must also be developed. Diversified funding sources, including national funds, public–private partnerships, and international financial instruments (e.g., EIB, EBRD), are critical for both infrastructure development and long-term maintenance. At the same time, strengthening institutional capacities and fostering intersectoral coordination can enhance policy effectiveness and support data-driven decision-making. Promoting intermodality and integrated transport systems through unified ticketing, multimodal hubs, and improved connections between transport modes can significantly increase the attractiveness of sustainable alternatives

3.2. Recommendations for Economic Actors

The private sector plays a crucial role in the development of sustainable mobility systems. Investments in green transport infrastructure and services should be encouraged, including electric vehicle charging networks, shared mobility systems, and digital platforms for smart transport management. Public–private partnerships represent a viable model, particularly in the public transport sector, where private operators can contribute to service provision under appropriate regulatory oversight.

Support for the transition toward electric mobility and domestic production capacities is also essential. Serbia has the potential to position itself within emerging value chains related to electric vehicles and associated technologies. Incentives for innovation and investment in this sector could yield significant environmental and economic benefits.

Companies should also adopt internal mobility policies aimed at reducing congestion and environmental impact. Measures such as promoting carpooling, supporting cycling infrastructure for employees, and subsidizing public transport use can contribute to broader systemic improvements. In addition, active participation of businesses in urban planning processes can foster innovative solutions, particularly in areas such as urban logistics and last-mile delivery.

3.3. Recommendations for Citizens and Local Communities

Citizens play a fundamental role in the transition toward sustainable mobility through their everyday travel behavior. A gradual shift away from private car use toward walking, cycling, and public transport can significantly reduce congestion and environmental impacts. Even partial behavioral changes, such as reducing car use several days per week, can generate substantial cumulative benefits. Active engagement in community initiatives is equally important. Local communities should participate in planning processes, advocate for safer and more inclusive transport infrastructure, and collaborate with public authorities in identifying and addressing local mobility challenges. Civic initiatives and grassroots movements have already demonstrated their capacity to influence policy outcomes.

Furthermore, citizens should support and participate in awareness campaigns aimed at improving traffic culture and safety. Educational activities, community events, and participation in initiatives such as European Mobility Week can contribute to broader societal shifts in mobility behavior. Acceptance of innovative mobility solutions is also critical. The adoption of shared mobility services, digital applications, and emerging transport technologies can enhance efficiency and accessibility. At the same time, users should provide feedback to ensure that such innovations are implemented in a safe and inclusive manner (OECD, 2024).

Responsible use and maintenance of existing infrastructure is essential for long-term sustainability. Citizens contribute to system resilience by respecting public space, reporting infrastructure issues, and supporting a culture of shared responsibility.

4. Conclusion

The transition toward sustainable urban mobility in Serbia represents a complex, multi-dimensional, yet ultimately attainable policy and development endeavor. Contemporary Serbian cities are increasingly confronted with pressures that many European metropolitan areas have faced over recent decades, such as persistent congestion, deteriorating air quality, high energy dependence, road safety risks, and unequal access to employment, education, and services. Against this backdrop, the strategic challenge is to shift from a long-standing car-dominant mobility paradigm to a more balanced and integrated transport system that prioritizes people, public space quality, and environmental performance, while maintaining economic efficiency and urban functionality. In practical terms, this implies strengthening multimodality and rebalancing the modal split in favor of walking, cycling, and high-quality public transport, complemented by measures that manage private car use more effectively.

The analysis indicates that Serbia has entered a formative stage in which planning frameworks and policy commitments are increasingly present, and initial implementation steps have been undertaken, most notably in Belgrade, Novi Sad, and Niš. These steps include the preparation of strategic documents, the introduction of selected public transport and active mobility interventions, as well

as growing incorporation of sustainability principles into local development agendas. However, the pace and scale of tangible change remain insufficient to produce systemic effects across the urban areas. In other words, while "planning readiness" is improving, the translation of plans into street-level transformation such as reallocation of road space, continuity of cycling networks, upgrades in public transport reliability and accessibility, and the consistent application of demand-management tools, has not yet reached the critical mass required for a decisive mobility transition.

Achieving measurable progress will depend on coordinated governance across levels of decision-making and on the alignment of institutional, financial, and regulatory instruments. At the national level, the state has a decisive role in establishing a coherent enabling framework through legislation, strategic guidance, funding mechanisms, and technical standards consistent with European best practices. This includes stable and predictable financing for public transport modernization and active mobility infrastructure, strengthened regulatory support for Sustainable Urban Mobility Plans (SUMPs), and improved capacity for monitoring and evaluation through standardized indicators. At the local level, municipal governments must assume a proactive implementation role, combining infrastructure delivery with policy experimentation and adaptive management. This approach can include pilot projects (e.g., temporary street redesigns), low-cost urbanism solutions, and iterative scaling based on evidence regarding safety, user satisfaction, and modal shift.

The private sector is likewise a critical stakeholder in the transition, both as a provider of technological and service innovations (e.g., digital ticketing, mobility-as-a-service solutions, micromobility systems) and as an investor and partner in the modernization of logistics and fleet management. Equally important, employers can contribute through workplace mobility plans that encourage sustainable commuting patterns. Finally, citizens are not merely end-users of mobility systems but co-producers of their long-term legitimacy and effectiveness: acceptance of change in the use of public space, shifts in travel behavior, and active participation in planning processes are essential to sustaining reforms over time. The transition is therefore not only a technical issue of infrastructure provision but also a social process shaped by trust, social norms, public communication, and perceptions of fairness, particularly regarding the distribution of mobility benefits and burdens.

Over the medium term, approximately within the next decade, Serbian cities could credibly approach the vision of *cities designed for pedestrians and cyclists*, characterized by cleaner air, reduced traffic-related stress, improved road safety, and more equitable access to mobility across socio-economic groups. Reaching this outcome requires a sustained commitment to implementation, the consistent prioritization of evidence-based measures, and the institutional capacity to coordinate across sectors (transport, environment, public health, urban planning, and economic development). The goal is not to eliminate car use altogether, but to ensure that private automobiles no longer define urban form and public space allocation at the expense of healthier, more inclusive, and environmentally responsible mobility options. With a coherent policy mix, adequate investment, and

strong stakeholder engagement, the transition to sustainable urban mobility is not only desirable but realistically achievable in Serbia.

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ODRŽIVA URBANA MOBILNOST U GRADOVIMA SRBIJE: STANJE, IZAZOVI I PRAVCI JAVNIH POLITIKA

Apstrakt: U ovom radu se analizira održivu urbanu mobilnost u gradovima Srbije u širem kontekstu imperativa dekarbonizacije transporta u Evropi i procesa pristupanja Srbije Evropskoj uniji. Gradovi u Srbiji suočavaju se sa kompleksnom tranzicijom od saobraćajnih sistema zasnovanih na dominaciji automobila ka održivijim, inkluzivnijim i multimodalnim modelima mobilnosti. Rad pruža pregled savremenih saznanja o urbanoj mobilnosti u Srbiji, sa posebnim fokusom na infrastrukturu javnog prevoza, uslove za aktivne vidove kretanja, institucionalne i planske okvire, usvajanje električnih vozila i inicijative usmerene ka unapređenju pešačenja. Polazeći od relevantne akademske literature, institucionalnih izveštaja i najnovijih strateških dokumenata, identifikuju se trajni strukturni i upravljački izazovi, ali i ukazuje na rastući zamah u planiranju održive urbane mobilnosti. Rezultati sugerišu da gradovi u Srbiji mogu ostvariti značajan napredak oslanjajući se na iskustva razvijenijih urbanih sistema mobilnosti; međutim, uspešan prenos ovih praksi zahteva njihovu pažljivu adaptaciju lokalnim socio-ekonomskim, institucionalnim i prostornim uslovima. Ovaj proces podrazumeva postepenu implementaciju, intenzivnu edukaciju i podizanje svesti javnosti, kao i kontinuiranu dugoročnu političku podršku.

Ključne reči: urbana mobilnost, javni prevoz, održiva mobilnost, SUMP, Srbija

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