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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° 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.

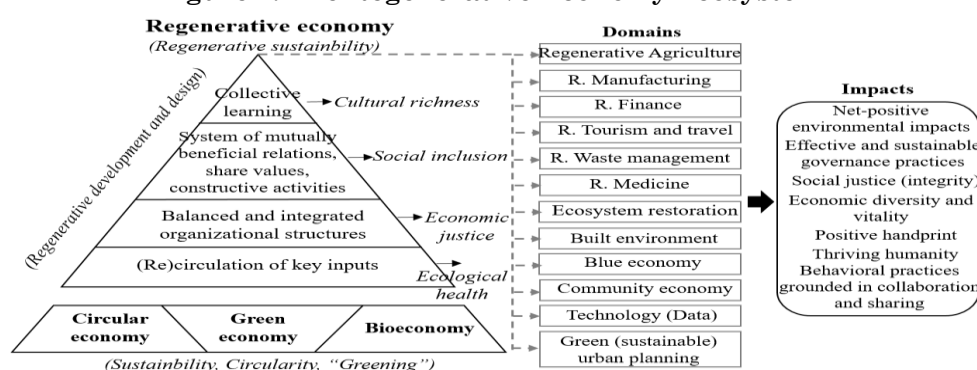
2. A Conceptual Framework and Practical Implications of the Regenerative Economy

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

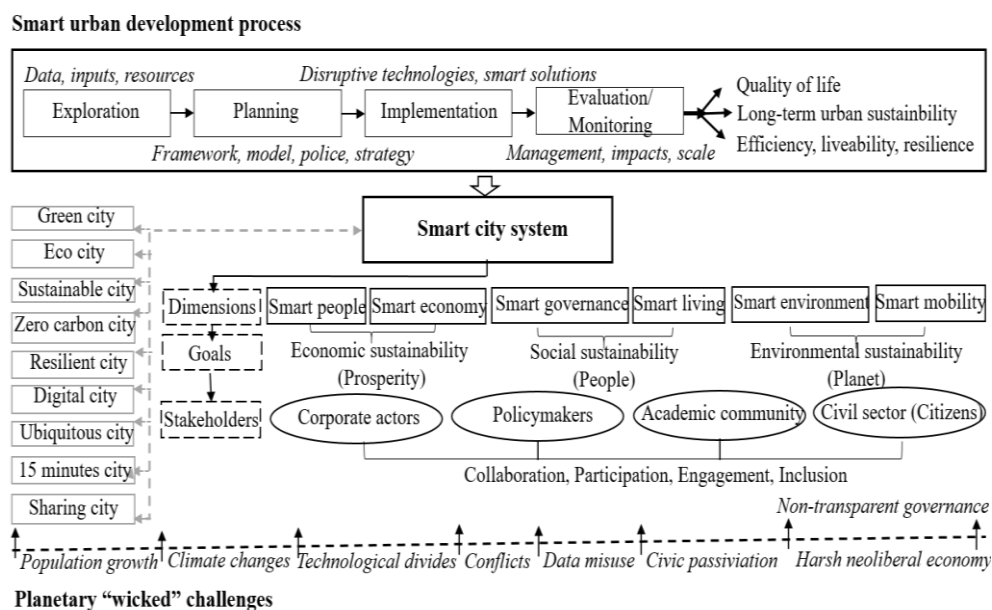
The 21st century belongs to cities. Urban areas are at the forefront of both natural population growth and mass migrations, with projections indicating that by 2050 there will be 12 metacities, 43 megacities, 66 large cities, 597 medium-sized cities, 710 cities with populations under one million, and 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.

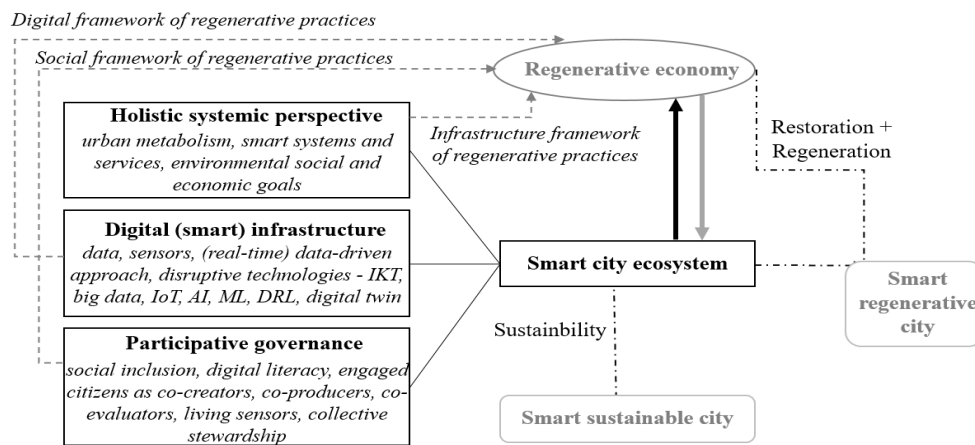
The regenerative economy and the smart city converge around a holistic vision of sustainability, a conviction in people and communities as agents of change, reflecting a bottom-up governance approach, and a proclivity for harnessing innovative technological solutions to optimise and restore ecological 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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References

- Allam Z. & Newman P., (2018). Redefining the Smart City: Culture, Metabolism and Governance, *Smart Cities*, 1(1):4-25
- Allam Z. & Newman P., (2023). Smart Cities and Regenerative Approaches: How Design with Smart City Tech Can Regenerate Cities. In: *Revising Smart Cities with Regenerative Design*. Cities and Nature, (pp. 55-76), Springer, Cham
- Anand, P.B. & Navio-Marco, J., (2018). Governance and economics of smart cities: Opportunities and challenges. *Telecommunications Policy*, 42(10):795-799.
- Anttiroiko A.V., (2023). Smart Circular Cities: Governing the Relationality, Spatiality, and Digitality in the Promotion of Circular Economy in an Urban Region, *Sustainability*, 15(17), 12680
- Avdokushin E.F. & Kuznetsova E.G., (2023). Regenerative economy as a component of the new economic system, *International Trade and Trade Policy*, 9(1).
- Balakrishna C., (2012). Enabling technologies for smart city services and applications. In: *Proceedings of the 6th International Conference on NGMAST*, Paris, France, 12-14 September 2012, pp. 223-227
- Bibri S.E., (2018). A foundational framework for smart sustainable city development: theoretical, disciplinary, and discursive dimensions and their synergies. *Sustainable Cities and Society*, Vol. 38, pp. 758-794.
- Blasi S., Ganzaroli A., De Noni I., (2022). Smartening sustainable development in cities: Strengthening the theoretical linkage between smart cities and SDGs, *Sustainable Cities and Society*, Vol. 80, 103793
- Bloomberg Intelligence, (June, 2023). Generative AI to become a \$1.3 trillion market by 2032. Retrieved from: <https://www.bloomberg.com/company/press/generative-ai-to-become-a-1-3-trillion-market-by-2032-research-finds> Accessed on 15 October 2025.
- Brown M., (2021). Foreword. In: Andreucci M.B., Marvuglia A., Baltov M., Hansen P. (eds), *Rethinking sustainability towards a regenerative economy. Future city*, Vol. 15, (pp. vii-xi). Cham: Springer International Publishing
- Buckton, S.J. et al., (2023). The Regenerative Lens: A conceptual framework for regenerative social-ecological systems. *One Earth*, 6(7):824-842
- Burns R., Fast V., Levenda A., Miller B., (2021). Smart cities: Between worlding and provincialising, *Urban Studies*, Urban Studies Journal Limited, 58(3):461-470
- Bvuma S., (2024). Understanding Citizen Engagement in the Era of Smart Cities. In: Chen Y. et Xu R. (eds), *Edge Computing - Architecture and Applications for Smart Cities* (pp. 115-129). IntechOpen, London, UK
- Camagni, R., (2008). Regional Competitiveness: Towards a Concept of Territorial Capital. In: Capello R., Camagni R., Chizzolini B., Fratesi U. (Eds), *Modelling Regional*

- Scenarios for the Enlarged Europe: European Competitiveness and Global Strategies. *Advances in Spatial Science* (pp. 33-47). Springer, Berlin, Heidelberg.
- Capello R. & Camagni R., (2000). Beyond Optimal City Size: An Evaluation of Alternative Urban Growth Patterns, *Urban Studies*, 37(9):1479-1496.
- Caragliu A. & Nijkamp P., (2012). The impact of regional absorptive capacity on spatial knowledge spillovers: the Cohen and Levinthal model revisited, *Applied Economics*, Vol. 44, pp. 1363-1374
- Čegar S., Drezgić S., Čišić D., (2024). Exploring the regenerative economy: A comprehensive review of literature, *Journal of Regenerative Economics*, 1(1):1-40.
- Čišić D., Drezgić S., Čegar S., (2025). Waste and the Urban Economy: A Semantic Network Analysis of Smart, Circular, and Digital Transitions, *Urban Science*, 9(10), 410
- Clement J., Manjon M., Crutzen N., (2022). Factors for collaboration amongst smart city stakeholders: A local government perspective, *Government Information Quarterly*, 39(4), 101746
- Crivello S., (2015). Urban Policy Mobilities: The Case of Turin as a Smart City, *European Planning Studies*, 23(5):909-921.
- Dameri, R.P, Benevolo, C., Veglianti, E., Li, Y., (2019). Understanding smart cities as a global strategy: A comparison between Italy and China. *Technological Forecasting and Social Change*, 142(C):26-41.
- Das A. & Bocken N., (2024). Regenerative business strategies: A database and typology to inspire business experimentation towards sustainability. *Sustainable Production and Consumption*, Vol. 49, pp. 529-544.
- Drupsteen L. & Wakkee I., (2024). Exploring characteristics of regenerative business models through a Delphi-inspired approach. *Sustainability*, 16(7), 3062
- East M., (2020). The transition from sustainable to regenerative development. *Ecocycles*, 6(1):106-109
- European Commission, (2023). European DATA Market Study 2021-2023, D2.4 Second Report on Facts and Figures. IDC Lisbon Council Research
- Fath B.D., Fiscus D.A., Goerner S.J., Berea A., Ulanowicz R.E., (2019). Measuring regenerative economics: 10 principles and measures undergirding systemic economic health. *Global Transitions*, Vol. 1, pp. 15-27
- Florida R., (2002). *The rise of the creative class: And how its transforming work, leisure, community and everyday life*. New York: Basic Books.
- Gagliardi A.R. & Albergo F., (2023). The rise of smart healthcare in smart cities: A Bibliometric Literature Review and avenue for a research agenda, *ITM Web of Conferences*, Vol. 51, 03002
- Giffinger, R, Fertner, C, Kramar, H, Kalasek, R, Pichler-Milanović, N, Meijers, E., (2007). *Smart Cities: Ranking of European Medium-Sized Cities*. Vienna, Austria: Centre of Regional Science (SRF), Vienna University of Technology, pp. 1-25.
- Glaeser, E.L. & Berry, C.R., (2006). *Why are Smart Places Getting Smarter?*. Taubman Centre Policy Brief 2006-2. Cambridge MA: Taubman Centre.
- Hajek, P., Youssef, A., Hajkova, V., (2022). Recent developments in smart city assessment: A bibliometric and content analysis-based literature review. *Cities*, Vol. 126, 103709

- Harrington K., (2017). Smart City Leaders, Champions, and Entrepreneurs-The People Part of Vibrant Smart Cities. In: Vinod Kumar T.M. (ed.), *Smart Economy in Smart Cities, Advances in 21st Century Human Settlements*, (pp. 1005-1012). Springer, Singapore
- Hinton, J.B., (2022). A Not-For-Profit Economy for a Regenerative Sustainable World. In: Künkel P. & Ragnarsdottir K.V. (eds.), *Transformation Literacy: Pathways to Regenerative Civilisations*, (pp. 187-201). Springer International Publishing
- Huston S., (2017). Introduction: Urban conundrums, In: Huston S. (Ed.), *Smart Urban Regeneration: Visions, Institutions and Mechanisms for Real Estate*, Routledge Taylor and Francis
- Ismagilova, E., Hughes, L., Rana, N.P., Dwivedi, Y.K., (2022). Security, Privacy and Risks Within Smart Cities: Literature Review and Development of a Smart City Interaction Framework, *Information System Frontiers*, 24(2):393-414
- Jain, Y. (2021). Regenerative Economies: A New Approach Towards Sustainability. In: Leal Filho W., Azul A.M., Brandli L., Lange Salvia A., Özuyar P.G., Wall T. (eds). *No Poverty. Encyclopedia of the UN Sustainable Development Goals* (pp. 761-771). Cham: Springer International Publishing.
- Janik, A., Ryszko, A., Szafraniec, M., (2020). Scientific Landscape of Smart and Sustainable Cities Literature: A Bibliometric Analysis. *Sustainability*, 12(3), 779
- Järvenpää A.M., Jussila J., Henttonen K., Helander N., Kunttu I., (2023). Contrasting restorative economy and regenerative economy in circular economy context. In: XXXIV ISPIM Innovation Conference, 04 June to 07 June 2023, Ljubljana, Slovenia
- Joss, S., Sengers, F., Schraven, D., Caprotti, F., Dayot, Y., (2019), The smart city as global discourse: storylines and critical junctures across 27 cities, *Journal of Urban Technology*, 26(1):3-34.
- Jovanović Vujatović M., Krstić B., Bonić Lj., (2024). Key aspects of regenerative business model: Concept, principles and strategies, *Journal of Regenerative Economics*, 1(2):161-175
- Kaiser Z.R.M.A., (2024). Smart governance for smart cities and nations, *Journal of Economy and Technology*, Vol. 2, pp. 216-234
- Kresl, P.K. & Singh, B., (1999). "Competitiveness and the Urban Economy: Twenty-Four Large US Metropolitan Areas." *Urban Studies*, 36(5/6):1017-1027.
- Künkel P. & Ragnarsdottir K.V. (eds.), (2022). *Transformation Literacy: Pathways to Regenerative Civilisations*, Springer International Publishing
- Künkel P., (2022). Collective Stewardship Towards Life Economies. In: Künkel P. & Ragnarsdottir K.V. (eds.), *Transformation Literacy: Pathways to Regenerative Civilisations*, (pp. 307-331). Springer International Publishing
- Lalević Filipović A., Raičević M., Lipovina-Božović M., (2024). Regenerative economy through the prism of Montenegro - Challenges and limitations, *Journal of Regenerative Economics*, 1(1): 97-111
- Martin R. & Simmie J., (2008). The theoretical bases of urban competitiveness: Does proximity matter?, *Revue d'Économie Régionale & Urbaine*, Vol. 3, pp. 1-19.
- Mirović V., Mitrović-Simić J., Miličić M., Ruškić N., (2024). Smart Mobility in Smart Cities, *Journal of traffic and transport theory and practice (JTTP)*, 9(2):83-89

- Molnar A., (2021). Smart cities education: An insight into existing drawbacks, *Telematics and Informatics*, Vol. 57, 101509
- Mordor Intelligence, (June, 2025). Smart Cities Market Size - Industry Report On Share, Growth Trends & Forecasts Analysis (2025-2030). Retrieved from: <https://www.mordorintelligence.com/industry-reports/smart-cities-market>, Accessed on 11 October 2025.
- Morseletto P., (2020). Restorative and regenerative: Exploring the concepts in the circular economy, *Journal of Industrial Ecology*, 24(4):763-773.
- Mwaniki D., Kinyanjui M., Opiyo R., (2017). Towards Smart Economic Development in Nairobi: Evaluating Smart City Economy Impacts and Opportunities and Challenges for Smart Growth. In: Vinod Kumar T.M. (ed.), *Smart Economy in Smart Cities, Advances in 21st Century Human Settlements* (pp. 749-790). Springer, Singapore
- Mylonas G., Kalogeras A., Petersen S.A., Muñoz L., Chatzigiannakis I., (2024). When circular economy meets the smart city ecosystem: Defining the smart and circular city. In: *Proceedings of the 10th IEEE International Smart Cities Conference (ISC2 2024)*, Pattaya, Thailand.
- Nauwelaers, T., Reekmans, L., Van Acker, R., Luna Quintanilla, D., (2024). Regenerative neighbourhoods - where people and nature flourish: Urban Insight by Sweco. SWECO.
- OECD, (2024). *OECD Digital Economy Outlook 2024 (Vol. 1): Embracing the Technology Frontier*, OECD Publishing, Paris
- Paskaleva K., Evans J., Watson K., (2021). Co-producing smart cities: A Quadruple Helix approach to assessment, *European Urban and Regional Studies*, 28(4):395-412.
- Peponi A. & Morgado P., (2020). Smart and Regenerative Urban Growth: A Literature Network Analysis, *Int. J. Environ. Res. Public Health*, 17(7), 2463
- Peponi A. & Morgado P., (2021). Transition to Smart and Regenerative Urban Places (SRUP): Contributions to a New Conceptual Framework. *Land*, 10(2):1-18.
- Perkins S. & Jessup A., (2021). Cybernetics, design and regenerative economics, *Technoetic Arts*, 19(1-2):123-137.
- Radziejowska A. & Sobotka B., (2021). Analysis of the Social Aspect of Smart Cities Development for the Example of Smart Sustainable Buildings. *Energies*, Vol. 14, 4330
- Salleh M.S.M., Fahmy-Abdullah M., Sufahani S.F., Bin Ali M.K., (2022). Smart Cities with Smart Environment, In: Kaiser M.S. et al. (eds.), *Proceedings of the Third International Conference on Trends in Computational and Cognitive Engineering, Lecture Notes in Networks and Systems* (pp. 273-283), Vol. 348, Springer, Singapore
- Shannon, G., Issa, R., Wood, C., Kelman, I., (2022). Regenerative economics for planetary health: A scoping review. *International Health Trends and Perspectives*, 2(3):81-105.
- Silva, B.N., Khan, M., Han, K., (2018). Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society*, Vol. 38, pp. 697-713.
- Silva N.S., Castro R., Ferrao P., (2025). Smart Grids in the Context of Smart Cities: A Literature Review and Gap Analysis, *Energies*, 18(5), 1186

- Simonofski A., Serral Asensio E., De Smedt J., Snoeck M., (2017). Citizen Participation in Smart Cities: Evaluation Framework Proposal. In: 2017 IEEE 19th CBI, 24-27 July 2017, Thessaloniki, Greece, Vol. 1, pp. 227-236
- Smart City Expo World Congress, (2025). World Smart City Awards: 2025 Finalists. Retrieved from: <https://www.smartcityexpo.com/world-smart-city-awards-finalists/>, Accessed on 11 October 2025.
- Ullah Z., Al-Turjman F., Mostarda L., Gagliardi R., (2020). Applications of Artificial Intelligence and Machine learning in smart cities, Computer Communications, Vol. 154, pp. 313-323
- UN-DESA, (2019). World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420), New York: United Nations.
- van der Laag C. & Östh J., (2025). Commentary - Asking artificial intelligence about regenerative economy, Journal of Regenerative Economics, 2(1): 33-39
- Vanolo A., (2016). Is there anybody out there? The place and role of citizens in tomorrow's smart cities. Futures, Vol. 82, pp. 26-36
- Vinod Kumar T.M., (2020). Smart Living for Smart Cities. In: Vinod Kumar T.M (eds), Smart Living for Smart Cities: Community Study, Ways and Means. Advances in 21st Century Human Settlements (pp. 3-70), Springer, Singapore.
- WWF, (2024). Living Planet Report 2024 - A System in Peril. WWF, Gland, Switzerland
- Yigitcanlar, T., Kamruzzaman, M., Foth, M., Sabatini J., da Costa, E., Ioppolo, G., (2019). Can cities become smart without being sustainable? A systematic review of the literature. Sustainable Cities and Society, Vol. 45, pp. 348-365
- Yigitcanlar T. & Cugurullo F., (2020). The Sustainability of Artificial Intelligence: An Urbanistic Viewpoint from the Lens of Smart and Sustainable Cities, Sustainability, Vol. 12, 8548

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, komplementarni i sinergijski, pre nego rivalski i isključivi, to se kao cilj rada nameće povezivanje konceptata 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*