AI AND THE DYNAMICS OF CREATIVE DESTRUCTION IN THE GREEN TRANSITION. AS A CASE STUDY THE MUNICIPALITY OF NEA FILADELFIA-NEA CHALKIDONA, ATTICA, GREECE.

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LinearUrbanSystem

AI-driventoCreativeDestruction
CaseStudy:MunicipalityofNeaFiladelfeia–Nea Chalkidona(Greece)

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Abstract

Joseph Schumpeter's concept of creative destruction offers a theoretical lens for analyzing processes of structural change through which outdated economic and governance systems are replaced by more innovative and efficient ones. While traditionally associated with industrial innovation, creative destruction has become increasingly relevant in the context of sustainable development and digital transformation. The transition from linear to circular economic models requires not only technological innovation but also the reconfiguration of local governance practices, policy instruments, and citizen participation mechanisms.

Within this framework, artificial intelligence (AI) emerges as a key enabler of circular economy transitions, supporting the optimization of resource flows, predictive management of urban services, and data-driven decision-making. AI-driven systems can enhance transparency, efficiency, and accountability in local governance, while facilitating more inclusive and participatory sustainability initiatives. This article examines how municipalities can leverage AI to implement circular economy principles and promote sustainable green growth, in alignment with the objectives of the European Green Deal.

Using the Municipality of Nea Filadelfeia–Nea Chalkidona as a case study, the article explores AI-supported applications in waste management, bio-waste collection, and citizen engagement. Empirical evidence from existing studies suggests that AI-based waste management systems can increase recycling rates by approximately 20–30% and reduce operational costs by 10–15%, while real-time analytics improve route optimization and service efficiency. At the same time, digital platforms can strengthen citizen participation and social inclusion, contributing to broader environmental and governance goals.

The findings indicate that the convergence of AI technologies, circular economy practices, and participatory local governance can operationalize creative destruction as a catalyst for smart and green urban transitions. While significant opportunities exist, the study also highlights challenges related to institutional capacity, data governance, and equitable implementation. Overall, the article provides insights for policymakers,

practitioners, and researchers seeking to align technological innovation with sustainable development objectives under the European Green Deal.

Keywords: *AI, Creative Destruction, Circular Economy, Sustainable Green Development, Smart Green Transition, Governance, European Green Deal.*

1. INTRODUCTION

Creative destruction provides a conceptual framework for understanding the transformation of outdated socio-technical systems into more innovative and efficient structures. In the context of green transitions, artificial intelligence is increasingly framed as a catalyst capable of accelerating the shift toward circular economic models by optimizing resource flows, supporting evidence-based policy decisions, and facilitating new forms of citizen engagement. However, such transformations are neither linear nor guaranteed, as they unfold within complex urban systems characterized by institutional fragmentation, competing land-use priorities, and uneven governance capacities (Schumpeter, 1942; Frantzeskaki et al., 2017).

Within this context, the concept of the Green City emerges as a complementary yet contested framework, particularly within European smart city and sustainability agendas. While municipalities are encouraged to leverage digital technologies such as AI to promote circular resource use, environmental sustainability, and improved quality of urban life, critical scholarship highlights a persistent gap between technological potential and effective local implementation (Kitchin, 2014; Bulkeley et al., 2019). This gap is especially pronounced in dense urban areas, where natural assets are limited, spatial pressures are high, and governance arrangements often struggle to integrate environmental objectives into everyday urban planning.

The municipality of Nea Filadelfeia–Nea Chalkidona exemplifies these challenges and opportunities. The presence of the Alsos (urban park) and the Podoniftis river constitutes a significant natural asset that could serve as a core element of a Green City vision, supporting biodiversity, climate adaptation, and citizen well-being. At the same time, these ecosystems are embedded within a highly urbanized environment and are subject to pressures related to pollution, fragmented management responsibilities, and limited data-driven monitoring. This raises critical questions regarding how digital tools and AI-driven governance can be mobilized not merely to enhance efficiency, but to enable integrated, participatory, and ecologically sensitive urban management. Addressing these challenges is central to determining whether Green City strategies can function as instruments of transformative sustainability or remain confined to symbolic and fragmented interventions.

2. Theoretical Framework

2.1.Creative Destruction and Economic Transformation

Joseph Schumpeter (1942) conceptualized **creative destruction** as the dynamic process through which innovation disrupts and replaces obsolete technologies and business models, fostering economic growth and structural transformation. This process operates through several interrelated mechanisms, such as:

- **Technological innovation** drives efficiency and productivity by enabling new technologies to outperform existing systems.
- **Market reconfiguration** emerges as innovative firms reshape production networks and consumer behavior, leading to the decline of outdated enterprises (Schumpeter, 1942; Aghion & Howitt, 1992).

- **Structural transformation** accompanies these changes, requiring adjustments in labor markets, skills, and institutional frameworks (Freeman & Louçã, 2001).
- Finally, **socio-institutional adaptation** ensures that governance structures, policies, and regulations evolve to support emerging technologies and mitigate transitional disruptions (Berkhout et al., 2004).

Collectively, these mechanisms highlight how creative destruction acts as a driver of technological progress, economic renewal, and socio-institutional change.

2.2.Creative Destruction in Sustainable Transitions

Sustainable transitions involve the gradual dismantling of fossil-based and linear production systems while promoting low-carbon, resource-efficient, and socially inclusive models (Geels, 2002; Loorbach, 2010). **Artificial Intelligence (AI)** can accelerate this transformation by optimizing resource use and waste collection, enabling predictive environmental management, supporting evidence-based and transparent policymaking, and reducing operational costs and emissions (Bughin et al., 2018; Dwivedi et al., 2021). Through these mechanisms, AI not only enhances technological innovation but also facilitates the structural and institutional adjustments essential for achieving a sustainable green transition (Schumpeter, 1942; Aghion & Howitt, 1992). By linking the theoretical principles of creative destruction with practical AI applications, municipalities can actively guide sustainable transformations while balancing innovation with environmental stewardship and social responsibility (Berkhout et al., 2004; Geels et al., 2017).

3. AI-Driven Circular Economy in the Municipality of Nea Filadelfeia–Nea Chalkidona

The Municipality of Nea Filadelfeia–Nea Chalkidona exemplifies how Artificial Intelligence (AI) can advance a local circular economy by integrating technology, governance, and citizen participation (Geissdoerfer et al., 2017; Kirchherr et al., 2018).

- **Smart waste management** systems, such as AI-enabled bins that continuously monitor fill levels, weight, and contamination, have been shown to improve recycling rates by 20–30% while reducing unnecessary collection routes (Bertolini et al., 2021; Song et al., 2020). AI-optimized collection routes, leveraging GPS and real-time analytics, contribute to lower CO_2 emissions and enhanced operational efficiency (Li et al., 2021).
- **Bio-waste management** also benefits from AI innovations. Real-time monitoring of moisture, contamination, and decomposition improves compost quality and reduces processing costs (Zhang et al., 2022). Community composting units integrated with AI systems can automatically regulate temperature and oxygen levels, enhancing compost production for urban gardens and supporting local circular loops (Bourlakis & Weightman, 2019).
- **Citizen participation** is strengthened through AI-powered mobile applications, which guide residents in proper waste sorting, enable reporting of overflowing bins or illegal dumping, and implement incentive systems such as “Green Points” to boost engagement (Hossain et al., 2020; Ghezzi et al., 2018).
- **Data-driven governance** is facilitated through AI dashboards that visualize waste generation trends, participation metrics, and cost–benefit analyses. Predictive modeling forecasts waste production based on population growth, commercial activity, events, and weather, enabling proactive resource allocation. AI-supported material recovery facilities automate sorting processes, increasing the recovery of plastics, paper, aluminum, and organic

materials, transforming waste into marketable resources and reinforcing the local circular economy (Korhonen et al., 2018; Lieder & Rashid, 2016).

By integrating AI across waste management, bio-waste treatment, citizen engagement, and policy planning, the Municipality of Nea Filadelfeia–Nea Chalkidona can implement a smart and sustainable circular economy, generating measurable environmental, economic, and social benefits (Geels et al., 2017; Bocken et al., 2016).

4. Current Limitations and Future Needs

The Municipality of Nea Filadelfeia–Nea Chalkidona currently lacks essential AI- enabled infrastructure necessary for a fully operational circular economy. Specifically, smart waste bins, predictive collection routing systems, bio-waste monitoring, automated composting, and AI-supported material recovery facilities have not yet been implemented. Furthermore, no publicly available data exist to demonstrate measurable improvements in recycling rates, operational efficiency, or cost reductions from prior digital initiatives (Bertolini et al., 2021; Hossain et al., 2020).

To achieve a fully AI-driven circular economy, the municipality must invest in several key areas. Firstly, the deployment of IoT-enabled waste infrastructure would allow real- time monitoring of fill levels, contamination, and bio-waste conditions, thereby enabling more efficient collection and resource allocation (Song et al., 2020; Li et al., 2021). Secondly, digital platforms for citizen engagement are critical to guide proper waste sorting, facilitate reporting of overflowing bins or illegal dumping, and promote participation through incentive mechanisms such as gamification and “Green Points” systems (Ghezzi et al., 2018; Zhang et al., 2022). Thirdly, AI dashboards for evidence- based decision-making would allow municipal authorities to visualize waste trends, participation metrics, and cost–benefit analyses, supporting proactive policy planning (Geissdoerfer et al., 2017). Finally, pilot projects are necessary to demonstrate measurable environmental, economic, and social benefits, providing empirical evidence for scaling AI-assisted circular economy initiatives (Bocken et al., 2016; Korhonen et al., 2018).

Despite these limitations, the municipality possesses significant advantages that can facilitate the gradual integration of AI technologies. The presence of the **Alsos park** offers a valuable green infrastructure that can be leveraged for bio-waste recycling, urban gardens, and community engagement initiatives, aligning with the Green City concept of integrating environmental performance, urban livability, and technological innovation (Geels et al., 2017; Kirchherr et al., 2018). Additionally, the municipal Innovation Hub provides a strategic platform for collaboration with universities, technology partners, and funding agencies, which can accelerate capacity building, knowledge transfer, and sustainable urban development (Bourlakis & Weightman, 2019).

By combining these natural and institutional assets with targeted investments in AI infrastructure and citizen-centered digital platforms, Nea Filadelfeia–Nea Chalkidona can transform its ambitious sustainability plans into tangible outcomes, enhancing both environmental performance and social inclusivity in line with circular economy principles (Korhonen et al., 2018; Lieder & Rashid, 2016).

5. CONCLUTIONS

The integration of Artificial Intelligence (AI) into local governance illustrates that creative destruction can function as a deliberate and managed process within sustainable urban transitions (Schumpeter, 1942; Geels et al., 2017). By aligning AI- driven innovation with

circular economy principles, municipalities can enhance administrative capacity, operational efficiency, and strategic decision-making, enabling more resilient and adaptive governance structures (Korhonen et al., 2018; Lieder & Rashid, 2016).

In the Municipality of Nea Filadelfeia–Nea Chalkidona, AI-based tools have the potential to significantly improve environmental performance and municipal management by facilitating more effective allocation of resources, real-time monitoring of waste flows, and proactive policy interventions (Bertolini et al., 2021; Li et al., 2021). However, the municipality currently faces **limitations in managing sustainability initiatives**, including the absence of AI-enabled infrastructure such as smart bins, predictive routing, bio-waste monitoring, and automated composting, as well as a lack of experience in data-driven decision-making. These gaps hinder the municipality's ability to fully implement circular economy practices and to achieve the objectives of a Green City (Geissdoerfer et al., 2017; Hossain et al., 2020).

Despite these challenges, there are **significant opportunities**. With targeted investments, pilot projects, and collaboration with academic and technological partners, AI can enhance municipal governance, foster citizen participation, and deliver measurable environmental, economic, and social benefits (Bocken et al., 2016; Kirchherr et al., 2018). The municipality also possesses valuable assets, including the **Alsos urban park**, which provides natural infrastructure for bio-waste recycling, urban gardening, and community engagement initiatives. Leveraging such resources through AI-driven management systems can transform sustainability plans into **practical Green City strategies**, integrating environmental performance, participatory governance, and citizen engagement into a coherent urban development model (Geels et al., 2017; Bourlakis & Weightman, 2019).

Ultimately, while current limitations highlight the municipality's challenges in managing sustainability initiatives, AI-driven circular economy initiatives, combined with natural assets and strategic planning, can enable Nea Filadelfeia–Nea Chalkidona to emerge as a **smart, sustainable, and socially inclusive Green City**. This demonstrates that creative destruction, when guided by public policy and supported by AI, can position municipalities as central actors in the green transition, aligning technological innovation with ecological stewardship and community well-being (Korhonen et al., 2018; Lieder & Rashid, 2016).

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