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ARTIFICIAL INTELLIGENCE AS A TOOL FOR SUSTAINABLE URBAN TRANSFORMATION IN THE EUROPEAN UNION: SELECTED SMART CITY CASES

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TAAHHÜTNAME

Bu tezin Manisa Celal Bayar Üniversitesi Lisansüstü Eğitim Enstitüsü Siyaset Bilimi ve Uluslararası İlişkiler Ana Bilim Dalında akademik ve etik kurallara uygun olarak yazıldığını ve kullanılan tüm literatür bilgilerinin referans gösterilerek tezde yer aldığını, tamamen kendi çalışmam olduğunu, her alıntıya kaynak gösterdiğimi, tezin yazımında akademik ve etik kurallara aykırı herhangi bir yapay zeka ve program kullanmadığımı beyan ederim.

İmza

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ÖZET

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21. yüzyılın iki temel dinamiği olan iklim krizi ve dijital devrim, şehirleri küresel sorunların çözümünde öncü aktörler haline getirmiştir. Bu tez, Avrupa Birliği (AB) bağlamında yapay zekânın (YZ) sürdürülebilir kentsel dönüşümü nasıl şekillendirdiğini ve bu süreçte şehirlerin nasıl ulus-altı aktörler olarak öne çıktığını incelemektedir. Araştırma, AB'nin normatif çerçevesi ve politika araçlarıyla etkileşim içinde, Amsterdam, Stockholm ve Viyana'nın farklı tarihsel ve kurumsal bağlamlarda geliştirdiği yönetişim düzeneklerini çoklu vaka analizi yöntemiyle karşılaştırmalı biçimde analiz etmektedir.

Bulgular, YZ destekli sürdürülebilirlik için tek bir model olmadığını; aksine Amsterdam'ın iş birliği ve ekosistem odaklı, Stockholm'ün sürdürülebilirlik entegrasyonuna dayalı hibrit ve Viyana'nın insan merkezli ve kamu öncülüğündeki yaklaşımları temsil eden üç ayrı yönetişim arketipinin ortaya çıktığını göstermektedir. Bu modeller, AB'nin norm yayılımı ve finansal destek mekanizmaları ile şehirler arası politika öğrenme süreçlerinin kesişiminde şekillenmektedir.

Sonuç olarak bu çalışma, Uluslararası İlişkiler literatüründe hâkim olan güvenlik ve rekabet eksenli YZ tartışmalarına alternatif bir bakış sunarak, şehirlerin yalnızca politika uygulayıcıları değil, aynı zamanda norm girişimcileri ve işbirliği üreticileri olarak küresel dijital dönüşümde rol alabildiğini göstermektedir. Araştırma, aynı zamanda AB ve politika yapıcılar için kapsayıcı ve bağlama duyarlı yönetişim modellerinin önemine işaret etmektedir.

Anahtar Kelimeler: Akıllı Şehirler, Yapay Zekâ, Sürdürülebilirlik, Avrupa Birliği, Çok-Düzeyli Yönetişim, Politika Öğrenmesi.

2025, 73 sayfa

ABSTRACT

Master of Arts Thesis

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The climate crisis and the digital revolution — the two defining dynamics of the 21st century — have positioned cities as key actors in addressing global challenges. This thesis examines how artificial intelligence (AI) shapes sustainable urban transformation within the European Union (EU) and how cities emerge as subnational actors in this process. Employing a comparative multi-case study design, it analyzes how Amsterdam, Stockholm, and Vienna — each interacting with the EU's normative frameworks and policy instruments — have developed governance arrangements rooted in their distinct historical and institutional contexts.

The findings indicate that there is no single model for AI-enabled sustainability; rather, three distinct governance archetypes emerge: Amsterdam's collaboration- and ecosystem-oriented model, Stockholm's sustainability-integration hybrid, and Vienna's human-centric and publicly led approach. These models are shaped at the intersection of EU-driven norm diffusion, financial support mechanisms, and intercity policy learning processes.

Ultimately, this study provides an alternative perspective to the security- and competition-oriented debates dominating the International Relations literature on AI, demonstrating that cities are not merely policy implementers but also norm entrepreneurs and cooperation producers within the global digital transformation. It further underscores the importance of inclusive and context-sensitive governance models for the EU and policymakers.

Keywords: Smart Cities, Artificial Intelligence, Sustainability, European Union, Multi-Level Governance, Policy Learning.

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ABBREVIATIONS

AI	Artificial Intelligence
AIoT	Artificial Intelligence of Things
ASC	Amsterdam Smart City
EU	European Union
GDPR	General Data Protection Regulation
ICT	Information and Communication Technologies
IoT	Internet of Things
IR	International Relations
KTH	KTH Royal Institute of Technology
MIT	Massachusetts Institute of Technology
ML	Machine Learning
MLG	Multi-Level Governance
SDG	Sustainable Development Goals

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INTRODUCTION

The 21st century has confronted humanity with two deeply interconnected challenges: the climate crisis and the digital revolution. On one hand, the environmental and social pressures caused by climate change have demonstrated that traditional models of economic and urban development are unsustainable; on the other, transformative technologies such as artificial intelligence (AI) offer unprecedented opportunities to address these issues. The intersection of these two powerful forces increasingly manifests itself in cities. According to United Nations projections, cities, where more than two-thirds of the world's population will live by 2050, are both the main centers of global emissions and resource consumption and laboratories where technological innovation and new governance models are tested. (United Nations, 2019).

Traditional nation-state-centered analyses are becoming increasingly inadequate for understanding today's global problems. This situation points to a transformation in which local actors assume a greater role on the global stage—a process popularized by thinkers such as Barber (2013) through the thesis of the "rise of cities." The academic equivalent and empirical basis of this popular vision are provided by researchers such as Acuto (2013). Through the concept of "city diplomacy," Acuto (2013) demonstrates how cities have become an integral part of global governance through international networks and direct diplomatic activities. The research problem of this thesis emerges precisely at the intersection of this new governance sphere identified by Acuto (2013) and the European Union's (EU) green and digital transformation goals. The specific focus on artificial intelligence in this study stems from AI's distinctive and transformative role within the smart city ecosystem. Although technologies such as the Internet of Things (IoT), which forms the nervous system of the smart city, and Machine Learning (ML), which constitutes its learning mechanism, have existed for years, it is the recent breakthroughs in AI that have elevated their potential to revolutionary levels and made them truly "smart." AI is no longer merely a component of this technological brain; it has become its most strategic and inseparable part—one that transforms data into action, makes autonomous decisions, and continuously learns. Because of this strategic nature, AI has been examined within the discipline of International Relations (IR) as a phenomenon reshaping the dynamics of global competition and cooperation. Within this framework, the thesis asks the following questions: How does the EU employ such a powerful technology as a tool to combat climate change? Is the “smart city” model, which serves as the primary domain of this process, merely a technological efficiency project, or is it also an arena for new forms of governance, international cooperation, and policy learning?

Accordingly, the main objective of this thesis is to analyze the role of AI in achieving the European Union’s sustainability objectives through a study of selected leading smart cities—Amsterdam, Stockholm, and Vienna. The study aims to go beyond treating this process merely as a technical improvement in efficiency and instead examine it from an IR perspective. Within this framework, the research seeks (1) to identify how the EU shapes its supranational norms and strategies in this field; (2) to demonstrate, through a multi-case study, how pioneering cities adapt this framework to their specific local contexts and implement differentiated governance models—collaboration-based, sustainability-oriented hybrid, and human-centered; and (3) to examine existing critiques concerning the structural paradoxes of the EU’s financial instruments as well as the governance challenges and social dilemmas encountered in the implementation processes of these leading cities.

Achieving these objectives holds significant implications for both academic literature and policymaking. Theoretically, this thesis offers an alternative perspective to the prevailing security- and power-oriented literature on AI within the discipline of IR (Bode, 2024), by focusing instead on the dimensions of cooperation and governance. In practical and political terms, the different approaches adopted by the three leading European cities analyzed are expected to provide valuable reference points and a foundation for policy learning for other regions and countries developing their own smart city and sustainability strategies.

Within this purpose and significance, the research has been structured around the following central questions:

Main Research Question:

How does artificial intelligence contribute, through cities, to achieving the European Union’s sustainable urbanization goals?

Sub-questions:

What policy instruments and normative frameworks does the EU employ to steer AI-supported sustainable urban transformation?

How do Amsterdam, Stockholm, and Vienna implement AI within their local contexts, and what governance models do they develop?

What is the significance of the interaction between the EU (supranational level) and cities (subnational level) for key IR concepts such as multi-level governance, policy learning, and norm diffusion, and how do these dynamics affect the cities' international appeal (soft power)?

To address these questions, the thesis employs the multi-case study method. This methodology is based on the comparison of cases that share a common foundation but exhibit different processes. In this context, Amsterdam, Stockholm, and Vienna were selected as cases because they represent successful and pioneering cities within the EU that utilize AI for sustainability. However, despite this common foundation, they exhibit significant diversity in their governance models: Amsterdam's *collaborative and ecosystem* model, Vienna's *human-centered* social welfare approach, and Stockholm's *sustainability-oriented hybrid* model each represent distinct strategic paths. This diversity provides a rich methodological ground for analyzing different governance approaches to AI-driven sustainable urban transformation in depth.

The scope of this study is deliberately limited to the policy and governance dimensions of AI, with a thematic focus on sustainable energy and environment. Direct inter-city networks and peer-to-peer learning fall outside the scope of this research; instead, the focus is on how cities interact with the EU framework. The data collection process was conducted as a desk-based study, relying on the analysis of secondary sources such as official EU and city strategy documents, academic publications, and reports from reputable institutions.

Finally, the findings and arguments developed through this methodology are presented in the following structure: Chapter One outlines the conceptual framework of the thesis; Chapter Two presents the empirical analysis, including the EU policy framework and the three city case studies; Chapter Three relates the findings from the case studies to the conceptual framework and answers the research questions; and the Conclusion provides a general summary of the thesis and its final implications.

CHAPTER ONE

CONCEPTUAL FRAMEWORK

This chapter establishes the conceptual framework of the study, providing the basis for understanding how artificial intelligence (AI) contributes to sustainable urban transformation within the European Union. It outlines the key ideas and analytical approaches that guide the research, particularly the concepts of Multi-Level Governance, Policy Learning, and Soft Power. All of these perspectives, when considered together, offer a comprehensive lens for examining how cities interact with the European Union, a supranational actor, adapt to global norms of sustainability and digitalization, and shape their own governance models. Furthermore, the chapter elaborates on the concept and components of smart cities and introduces the technological tools—AI, ML, and IoT—that operationalize this transformation. By combining these conceptual and analytical elements, it lays the intellectual foundation for the empirical examination of Amsterdam, Stockholm, and Vienna in the following chapter.

1.1. THE GLOBAL SUSTAINABILITY CRISIS AND THE RISING ROLE OF CITIES

The inherently social nature of human beings compels them to live together. The difficulties that individuals cannot overcome alone are resolved through social interaction networks established within communities. This togetherness, which initially emerged out of basic needs such as security and collective labor before the advent of settled life, later evolved into social dynamics such as production relations and professional organizations. As a result, cities emerged as settlements that reflect this very nature of humanity.

This process of urbanization, which has continued throughout history, has reached an unprecedented pace in the contemporary era. The rapid increase in urbanization worldwide has significantly raised the proportion of urban populations within national totals. According to the United Nations' World Urbanization Prospects report, while only 30 percent of the global population lived in cities in 1950, this figure rose to 55 percent by 2018 and is projected to reach 68 percent by 2050. The particularly rapid rise of urbanization in low- and middle-income countries has led to both physical and social expansion and complexity within cities (United Nations, 2019).

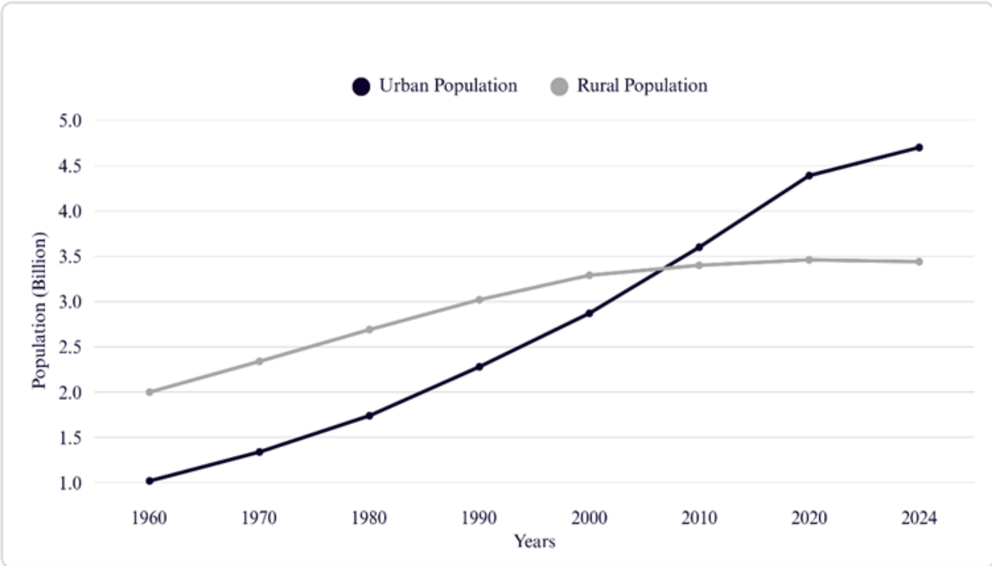

Figure 1. Global Urban and Rural Population by Year (World Bank, 2024)

Assessments based on World Bank (see **Figure 1**) data reveal that the global urban population has steadily increased from approximately one billion in 1960 to 4.7 billion in 2024. These figures demonstrate the continuous acceleration of global urbanization and the dramatic rise in the number of people living in cities. Meanwhile, the rural population has also experienced an absolute increase—from about two billion in 1960 to 3.44 billion in 2024. However, this growth remains far behind the pace of urbanization, clearly indicating that the global population center of gravity is shifting toward cities (World Bank, 2024).

This demographic transformation constitutes one of the most fundamental challenges of 21st-century global governance, transcending mere statistical significance. Achieving global objectives such as the Paris Agreement and the Sustainable Development Goals (SDGs) are now directly linked to the performance of cities. In particular, SDG 11 aims to make cities inclusive, safe, resilient, and sustainable for all, setting concrete targets such as access to affordable housing, sustainable transport systems, and participatory urban planning (UNDP, n.d.).

Consequently, urbanization has evolved from a domestic matter into an international phenomenon that influences states' capacity to fulfill their global commitments.

However, this rapid population growth and spatial expansion have brought about numerous large-scale challenges. Issues such as traffic congestion, inadequate infrastructure, environmental pollution, and inefficient use of natural resources are pushing the limits of traditional approaches to urban governance. The search for innovative and effective responses to these complex problems has driven urban policymakers toward technology-driven and data-based approaches, encapsulated in the concept of the smart city.

The concept of a smart city is defined as the use of information and communications technology (ICT) to address social, economic, and environmental sustainability challenges in urban areas (Mora & Bolici, 2016, p. 252). Within this perspective, smart cities aim to achieve sustainable development goals and enhance quality of life by integrating technology and innovation. This process requires the integration of physical, social, and digital systems and the transcendence of conventional governance models. Smart cities seek to anticipate current and future problems, harmonize digital innovations with physical planning, and foster effective collaboration among diverse stakeholders (Akıllı Şehirler Portalı, n.d.). In this respect, smart cities serve not only as tools for improving local living standards but also as crucial governance instruments for states in fulfilling their international climate and sustainability commitments.

Smart cities, which are developed through the integration of advanced technologies, are realized by means of the Internet of Things (IoT), Artificial Intelligence (AI), Cloud Computing, and Geographic Information Systems (GIS). These technological infrastructures are utilized to improve quality of life, support environmental sustainability, and generate innovative solutions. Thus, ICT fundamentally transforms urban structures while supporting their development (Akıllı Şehirler Portalı, n.d.).

Furthermore, smart cities not only ensure the efficient management of essential services such as infrastructure and transportation but also strengthen data-driven decision-making mechanisms. Digital platforms enhance citizen participation in urban governance, thereby enabling more transparent and flexible administrative processes.

This approach fosters the creation of more livable and competitive cities guided by the principles of sustainability, efficiency, and innovation.

In addition, the smart city concept facilitates digital interaction among diverse urban stakeholders, including public institutions, the private sector, financial organizations, and individuals. The technological solutions developed within this framework enable more coordinated, rapid, and effective delivery of urban services. As a result, cities respond to increasing complexity and demand through technology-supported solutions, laying the groundwork for a sustainable future. Since the sustainability challenges faced by cities are universal in nature, an innovative solution developed in one city naturally serves as a model or reference point for others. This creates a dynamic of learning and interaction between cities.

This spontaneously emerging network of interactions and learning indicates a deeper transformation in the role of cities in the twenty-first century. The new global agency of cities can be understood through Barber's (2013) vision of practical cooperation that transcends the nation-state-centered order and Acuto's (2013) approach to city diplomacy. Therefore, the concept of the smart city examined in this thesis is not merely a project of technological modernization but also one of the most tangible arenas in which this new form of global agency and city diplomacy is exercised.

1.2. ANALYTICAL FRAMEWORK: GOVERNANCE, LEARNING, AND INFLUENCE

The analytical framework of this thesis is designed to understand the internal dynamics and external effects shaping the development of smart cities. The foundation of the framework lies in Multi-Level Governance (MLG) and Policy Learning/Norm Diffusion, which explain the internal mechanisms of the process, while the concept of Soft Power provides a complementary lens to analyze its international implications and influence.

1.2.1. Multi-Level Governance (MLG)

Modern governance has evolved into a structure in which decision-making processes have moved away from centralized states and dispersed across multiple levels. To comprehend this transformation—particularly within the context of the European Union (EU)—the main analytical lens of this thesis is the theory of multi-level governance. The concept of multi-level governance was first defined by Marks (1993, p. 392) as "a system of continuous negotiation" among nested governments at different territorial tiers: supranational, national, regional, and local. Similarly, according to John (2000, p. 882), multi-level governance constitutes a layered system encompassing regional, national, and European levels, thereby creating a new form of politics.

Hooghe and Marks (2003, p. 233) explain the core design dilemma underlying this governance model through the debate between "consolidationist" and "fragmentationist" approaches. The consolidationist view advocates for fewer, unified authorities to ensure more efficient service delivery, whereas the fragmentationist perspective argues that multiple, overlapping jurisdictions provide citizens with greater flexibility and choice. This dichotomy is also reflected in the EU context through the discussions between "federalist" (integrated structure) and "variable geometry" (fragmented structure) models (Hooghe & Marks, 2003, p. 233).

One of the central debates within this theory concerns the changing role of the nation-state. While multi-level governance offers an alternative to the state-centric perspective, it nonetheless acknowledges that nation-states remain "the most important part of the European Union puzzle" (Marks, Hooghe, & Blank, 1996, p. 346). However, the role of the state has transformed: it has lost its monopoly as the sole bridge between domestic and foreign policy and now shares decision-making authority with supranational institutions and subnational actors such as cities (Marks, Hooghe, & Blank, 1996, pp. 342–343).

In conclusion, the theory of multi-level governance provides an excellent analytical lens for examining the phenomenon of smart cities discussed in this thesis. As this theory predicts, smart city strategies are shaped not only by national governments but also through the interaction of norms and funding mechanisms determined by the EU (supranational level), local visions of cities (subnational level), and the active participation of private actors such as technology companies (horizontal level).

1.2.2. Policy Learning and Norm Diffusion

The Norm Diffusion Theory is a theoretical approach that explains how norms emerge, spread, and become internalized at both societal and international levels. Norms are not merely patterns of behavior but shared understandings of what constitutes "appropriate" and "expected" conduct. The theory examines how these norms circulate through individuals, states, international organizations, and civil society actors, becoming embedded in the structures of social order (Sustainability Directory, 2025). This process typically consists of stages of emergence, diffusion, and internalization. However, due to power asymmetries, cultural differences, and conflicting economic interests, the process does not always progress linearly.

Policy learning, on the other hand, is useful for understanding how these norms are adopted at the local level and translated into practical applications. According to Dunlop and Radaelli (2020, pp. 2–5), policy learning is the process through which policy actors update their knowledge and beliefs through social interaction, organizational experience, or new evidence. Although learning does not always lead directly to policy change, it transforms the actors' knowledge base and normative perspectives, thereby laying the groundwork for future strategies.

In this thesis, these two concepts are employed as complementary analytical tools: Norm Diffusion provides a framework for understanding how a supranational actor such as the EU disseminates norms of sustainability and digitalization, while Policy Learning explains how these norms are localized and transformed into concrete projects and strategies by cities such as Amsterdam, Stockholm, and Vienna.

1.2.3. Soft Power and the International Agency of Cities

Traditionally, the concept of power in IR has been defined through hard power, which is based on military and economic capacity. Hard power is exercised through direct threats ("sticks") or rewards ("carrots") to alter the behavior of other actors (Nye, 2004, p. 5).

In contrast, soft power refers to the capacity of an actor to influence others to act in a certain way without coercion, relying instead on their voluntary consent (Nye, 2004, pp. 5–6). Soft power derives from intangible sources such as an actor's culture, political values, and the legitimacy of its policies. In other words, soft power represents the ability to shape the preferences and behaviors of others through attraction rather than direct coercion or inducement (Nye, 2004, p. 6). Historically, states—such as the United States through its cultural influence or the Soviet Union through its ideological appeal—have provided the most prominent examples of this form of power.

In this thesis, while Multi-Level Governance and Policy Learning are used to explain the internal dynamics and operational mechanisms of smart city development, the concept of Soft Power serves as a complementary lens to evaluate the international significance and impact of these processes. In other words, Soft Power is not employed as a primary analytical tool in the case studies, but rather as a higher-level interpretive framework for understanding the place and importance of the findings within global politics.

1.3. SMART CITIES: CONCEPTUAL DEPTH AND COMPONENTS

1.3.1. The Concept of the Smart City

The concept of the smart city stands at the center of contemporary debates on urbanism and technology, yet it remains a multidimensional term without a universally agreed definition (Kaygısız & Aydın, 2017, p. 56). This ambiguity stems from the fact that the concept has been approached from multiple disciplinary perspectives and has evolved over time.

The origins of the concept can be traced back to the 1960s and the early theoretical discussions on integrating technology into urban planning processes, particularly the idea of "cybernetically planned cities." In the 1980s, the notion of "networked cities" emerged, envisioning more integrated and collaborative urban systems through digital networks and communication technologies (Yimsek & Yakar, 2023, p. 51). During the 1990s, the "smart growth movement," which sought to manage urban expansion within a more strategic and sustainable framework, came to the forefront (Çetin & Çiftçi, 2019, p. 135). Vanolo (2014, p. 888) argues that the contemporary discourse on "smart cities" represents a synthesis of this "smart growth" movement and technology-oriented approaches.

The historical evolution of the smart city concept—arising at the intersection of technology, sustainability, and urban planning—has generated a rich variety of related terms with nuanced distinctions. This conceptual diversity has, over time, created a need for clarification in the literature. Responding to this need, Cocchia's (2014) systematic literature review presents a typology that illuminates this complex conceptual landscape through key approaches, summarized in the following table (Table 1).

Table 1. Different Meanings of Smart Cities (Adapted from Cocchia, 2014, pp. 19-20)

Concept	Definition	Original Reference
Wired City	Emphasizes that merely having cable infrastructure and connectivity does not make a city "smart"; what matters is how that infrastructure is used.	Hollands, 2008
Virtual City	Focuses on the digital representations and virtual presences of cities.	Schuler, 2002
Ubiquitous City	Represents the next step beyond the digital city concept, referring to cities or regions where information technologies are omnipresent and continuously accessible.	Anthopoulos et al., 2010
Intelligent City	Refers to territories with high capacities for learning and innovation, supported by digital infrastructures that enhance creativity, knowledge production, and management.	Komninos, 2006

Table 1 (continued)

Concept	Definition	Original Reference
Information City	Digital environments that collect formal and informal information from local communities and make it accessible to the public through web portals.	Anthopoulos et al., 2010
Digital City	The comprehensive web-based representation or replication of various aspects or functions of a real city.	Couclelis, 2004
Smart Community	A geographical area where residents, institutions, and governing bodies use information technology to significantly transform their region.	California Institute, 2001
Knowledge City	Aims to foster knowledge-based development by encouraging the continual production, sharing, assessment, and renewal of knowledge.	Ergazakis, 2004
Learning City	It encompasses learning at both individual and institutional levels. It aims to enable individuals to acquire new skills and keep their existing knowledge current through lifelong learning.	OECD, 1999
Sustainable City	Aims to reduce CO_2 emissions, improve energy efficiency, and promote the use of renewable energy through technological means, with the ultimate goal of becoming a "green city."	Batagan, 2011
Green City	It follows the "Green Growth" paradigm, which supports economic development by reducing greenhouse gas emissions and pollution, minimizing waste generation and inefficient use of natural resources, and preserving biodiversity.	OECD, 2010

As illustrated in Table 1, various approaches such as the Sustainable City, Green City, and Learning City have gradually converged under the umbrella concept of the Smart City. This convergence demonstrates that the concept encompasses not only technological infrastructure but also goals of environmental sustainability and social learning. As a result of this comprehensive transformation, two major tendencies regarding the role of technology in the literature have become apparent.

The first tendency treats smart cities primarily as technological projects. This approach emphasizes the central role of ICT in integrating critical urban infrastructures and services. For instance, Washburn et al. (2010, p. 2) state that the use of ICT makes city management, education, health, public safety, transportation, and infrastructure services "more intelligent, interconnected, and efficient."

The second tendency, by contrast, positions technology not as an end in itself but as a means to achieve higher quality of life and sustainable development. This holistic perspective defines smart cities as visions shaped not only by technological infrastructures but also by multidimensional elements such as social capital, participatory governance, and environmental sustainability. The definition provided by Caragliu et al. (2009, p. 50) is one of the most well-known examples of this approach.

> *A city may be called 'Smart' when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.*

This definition reveals that smart cities are shaped not merely by technology but by social capital, sustainability, and participatory governance. Therefore, the smart city concept today represents a comprehensive vision for sustainable and participatory urban development that goes far beyond being a simple "wired city." Similarly, Yılmaz (2015, pp. 4–5) views smart cities as a modernization effort aimed at using urban resources more efficiently to provide better services to residents.

In addition to defining the concept of smart city with these two main trends, it is also necessary to note the emergence of a critical perspective that questions the concept itself and its underlying motivations. One branch of this critical current focuses on the commercial motivations behind the smart city discourse. For example, Hollands (2008) argues that the term "smart city" is often used as a tool for place marketing, allowing cities to brand themselves as "smart" through technology-oriented imagery that often fails to reflect genuine urban transformation. A more fundamental philosophical critique is offered by Greenfield (2013), who contends that the problem lies not merely in marketing but in the very philosophy of the smart city itself. According to him, this approach reduces cities—complex, contradictory, and political entities—into technocratically controlled systems to be optimized, thereby posing a serious threat to democratic processes. Sadowski (2020) deepens this philosophical critique through an economic perspective, defining smart cities as projects of "digital capitalism." He argues that technology companies use smart city initiatives to transform public services and spaces into profitable "data extraction" centers. In this process, citizens and cities become raw materials for data exploitation, creating a new form of "digital colonialism."

A concrete example of alternative approaches developed in response to these critiques can be seen in Barcelona's model of "technological sovereignty." This model emerged during the mayoralty of former housing activist Ada Colau and was embodied in Barcelona's Digital City project (Morozov & Bria, 2018, pp. 27–29). Rejecting the profit-driven and top-down vision of smart cities, this model focuses on the principle of technological sovereignty and positions technology as a political instrument for social transformation—addressing the housing crisis and re-municipalizing public services. It measures "efficiency" not by technical speed or cost reduction but by contributions to social justice, democratic legitimacy, and the creation of public value.

In academic discussions, the concept—maturing around the axis of sustainability—has also become a critical item on the agenda of policymakers. The European Parliament highlights the need for innovative methods to manage complex challenges arising from growing urbanization, such as overpopulation, energy consumption, and resource management. In this context, smart cities play a key role not only as strategies for managing future urban life but also in addressing fundamental issues such as poverty, inequality, unemployment, and energy management (European Parliament, 2014, p. 17).

In summary, the concept of the smart city has evolved beyond a purely technology-based modernization tool into a multidimensional framework encompassing sustainability, social capital, participatory governance, and quality of life. Nevertheless, the literature also reflects criticisms of the concept, including its use as a marketing strategy, its potential for technocratic control, and its links to digital capitalism. On the other hand, some cities have responded to these critiques by developing more participatory and socially just alternative models. The European Union's smart city policies are shaped within this understanding, emphasizing sustainability and citizen-centered governance while developing regulatory frameworks to mitigate the risks associated with technology-centric approaches.

1.3.2. Components of Smart Cities

Today, the concept of the smart city refers not only to technologically equipped urban spaces but also to a multidimensional understanding grounded in economic, environmental, administrative, and social sustainability. In its 2014 report, the European Parliament emphasized that cities must adopt innovative methods to cope with challenges such as increasing population density, energy consumption, environmental pollution, and inefficient use of resources. In this context, the integration of ICT with human- and socially centered policies plays a key role in achieving sustainable economic growth and improving quality of life. As shown in Figure 2, the report defines smart cities around six core dimensions: Smart Economy, Smart Mobility, Smart Governance, Smart Environment, Smart Living, and Smart People. Each of these dimensions is associated with multidimensional factors such as innovation, social participation, environmental sensitivity, and digital transformation (European Parliament, 2014, pp. 17–18).

Figure 2. Components of Smart Cities (European Parliament, 2014, p. 30)

The meanings of these six dimensions are explained as follows (European Parliament, 2014, p. 28):

– Smart Governance: Smart Governance functions as a mechanism of policy transfer and policy learning while connecting actors within and between cities (public sector, private sector, and civil society) through digitalization and open data usage. This structure facilitates transparency and data flow, allowing cities to observe and adopt each other's successful practices (policy transfer) (Dolowitz & Marsh, 2000). At the same time, through participatory decision-making and co-production of public services, it prevents blind imitation of these experiences, instead enabling each city to draw contextually appropriate lessons and adapt solutions to its own local conditions (policy learning) (Dunlop & Radaelli, 2020). It also exemplifies models of multi-level governance in which supranational actors such as the EU engage directly with local administrations (Hooghe & Marks, 2003).

– Smart Economy: Enhances efficiency through ICT-supported innovation and new business models while promoting integration into local and global networks.

– Smart Mobility: Comprises sustainable, connected, and integrated transport systems that include alternatives such as public transport, cycling, and pedestrian mobility. The ICT-supported management of these systems aims to improve traffic efficiency, save energy, and reduce emissions. These objectives serve as tangible indicators of how cities contribute to international climate commitments such as the Paris Agreement (United Nations, 2015). Moreover, such standardization efforts offer a significant example of how international regimes shape the behavior of sub-state actors.

– Smart Environment: Promotes environmental sustainability through initiatives such as renewable energy adoption, smart grids, resource efficiency, and urban infrastructure renewal (e.g., wastewater management, green space planning, and air quality monitoring). The transition of cities to renewable energy also carries a geopolitical dimension, as it affects national energy security and external dependency (Çıtak & Kılınç Pala, 2016).

– Smart People: Centers on cultivating individuals who possess digital skills, creativity, and innovativeness, while ensuring access to education and strengthening social participation. It also aims to empower citizens to actively participate in data-driven decision-making processes.

– Smart Living: Seeks to improve urban quality of life through ICT-supported lifestyles that foster health, safety, cultural diversity, and social cohesion. Smart Living is also closely linked to the enhancement of social capital. A high quality of life enables cities to occupy top positions in international rankings and indices, strengthening their global image and attractiveness. This, in turn, reinforces a city's "power of attraction," representing one of the most concrete manifestations of urban soft power (Nye, 2004).

1.4. TECHNOLOGICAL TOOLS OF SUSTAINABLE URBAN TRANSFORMATION: ARTIFICIAL INTELLIGENCE (AI), MACHINE LEARNING (ML), AND THE INTERNET OF THINGS (IoT)

Achieving the goal of sustainable urban transformation requires the use of a robust and integrated set of tools grounded in digital technologies. This toolkit provides the capacity to collect and analyze the data necessary to make intelligent, data-driven decisions that enhance the efficiency, environmental sensitivity, and livability of urban infrastructures. At the core of this technological framework lie three interdependent instruments that function within both hierarchical and functional relationships: Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT). The foundation of the smart city paradigm rests not on the individual capabilities of these tools but on the synergy they create as an integrated system.

1.4.1. Artificial Intelligence (AI)

In recent years, the concept of Artificial Intelligence has become a significant element in nearly all sectors of life. AI has led to profound transformations in sectors such as education, healthcare, agriculture, and banking. While its potential to make life easier has been welcomed by many, others have approached it cautiously due to the potential risks and uncertainties it may pose. Simply defined, Artificial Intelligence refers to systems capable of replicating many cognitive functions unique to the human brain. These systems can perform essential operations such as production, analysis, and prediction (Ndzendze & Marwala, 2023).

The term "Artificial Intelligence" was first introduced in 1955 by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon during the Dartmouth Summer Research Project on Artificial Intelligence (McCarthy et al., 1955/2006). This study assumed that certain features of learning or intelligence could be simulated by a machine. In a more contemporary perspective, Russell and Norvig (2021) define AI as a computational science that models decision-making and action processes using logical connections between information and objectives, generating effective solutions under conditions of uncertainty and complexity.

Beyond these technical and historical definitions, the significance of AI for the discipline of IR is far more strategic and multidimensional. IR does not examine AI merely as a technology but as a phenomenon with the potential to transform inter-state relations, power dynamics, and global governance structures. Summarizing current academic debates in this field, Bode (2024) identifies four main thematic orientations in IR's engagement with Artificial Intelligence.

The first and most dominant of these themes is the Balance of Power and Strategic Competition (Bode, 2024, p. 68). This approach explores how AI affects geopolitical rivalries—particularly among great powers—and examines the potential emergence of an "AI arms race." One of the most concrete and recent examples of this perspective can be found in the 2021 National Security Commission on Artificial Intelligence (NSCAI) report, which shaped the United States' national strategy.

In 2021, the U.S. established this commission, composed of fifteen experts representing diverse fields ranging from national security and technology to business and academia. The appointment of Google's former CEO Eric Schmidt as chair underscores the importance attributed to the issue. The report contains striking assessments regarding the United States' position in the age of Artificial Intelligence.

> *America is not prepared to defend or compete in the AI era. This is the tough reality we must face... Our final report presents a strategy to defend against AI threats, responsibly employ AI for national security, and win the broader technology competition for the sake of our prosperity, security, and welfare... And America needs to enlist its oldest allies and new partners to build a safer*

and freer world for the AI era." (National Security Commission on Artificial Intelligence, 2021: 1).

The language and content of the report clearly reveal that Artificial Intelligence is regarded as a pivotal factor capable of determining global leadership in the twenty-first century. It emphasizes that China possesses both the capability and determination to challenge U.S. leadership. The report is built upon the argument that the United States must emerge victorious from this competition to sustain its global leadership as the "defender of free societies" (NSCAI, 2021).

According to Bode (2024), other major themes in the literature include Governance, which examines how AI can be regulated through international norms and rules; Disinformation, which focuses on issues such as misinformation and cyberattacks; and Ethics, which addresses moral questions concerning the use of autonomous systems.

However, Artificial Intelligence plays an increasingly strategic role not only in the context of global power balances and security competition but also in shaping the tangible transformation of cities. To illustrate, the integration of open data and AI within the European Union has become a significant policy domain enhancing the efficiency and sustainability of urban services. The EU's Smart Cities Marketplace initiative supports cities in leveraging open data to strengthen their data-driven decision-making and participatory urban planning capacities. For instance, the AMIGOS project in Las Rozas, Madrid, uses AI-supported smart cameras and sensors to monitor urban spaces and provide real-time information to city planners. Similarly, France's ELABORATOR initiative improves transportation efficiency and safety through applications such as automated intersection management and the provision of secure lanes for cyclists. The digital twin projects developed in Dublin and Rotterdam further demonstrate how the integration of open data with AI contributes to transparent and sustainable urban governance (European Commission, 2025c).

Nevertheless, the AI literature does not focus solely on issues of international security and strategic competition; smart city applications at the urban scale have increasingly attracted critical attention due to privacy and data protection concerns (Mark & Anya, 2019). In this context, the conceptual frameworks proposed by Tonsager and Ponder (2023) highlight a set of key principles essential for safeguarding privacy: human-centered design, the cultural and ethical sensitivity of projects to local communities (as exemplified by the Toronto Quayside case), transparency and public awareness regarding data processing, the adoption of the privacy by design approach during the design phase, anonymization of personal data, data minimization focusing on the collection of only necessary information, as well as the implementation of trusted data-sharing mechanisms and strong cybersecurity measures. However, Tonsager and Ponder (2023) also emphasize that significant limitations and risks accompany the implementation of these principles; for instance, the potential for re-identification may undermine anonymization measures, public-private partnerships can complicate data sovereignty, and promises of transparency may not always be fully realized in practice.

As observed, while the global AI literature largely centers on security, power, and competition, Artificial Intelligence has become increasingly important at the city level. Particularly prominent are the debates surrounding open data-based smart city policies and their accompanying concerns regarding privacy, data protection, and ethics. This thesis seeks to synthesize these distinct orientations within an integrated framework, offering an original contribution by examining how AI functions not only as an instrument of geopolitical competition but also as a mechanism that facilitates supranational cooperation in pursuit of sustainable urban transformation, energy management, and environmental objectives.

1.4.2. Machine Learning (ML)

As one of the subfields of artificial intelligence, machine learning enables computers to improve their performance through experience without being explicitly programmed. Jordan and Mitchell (2015, p. 255) state that ML not only allows for an automatic learning process but also enhances systems' ability to adapt to environmental changes and to predict future conditions.

ML can be examined within the framework of three main paradigms: supervised learning, unsupervised learning, and reinforcement learning. In supervised learning, the model is trained using pre-labeled data pairs (input and correct output) (Jordan & Mitchell, 2015, p. 257). For example, in smart cities, to predict the fill levels of waste containers, the model is trained with container images and their associated fullness data; thus, the system can make predictions based on new images.

Unsupervised learning, on the other hand, focuses on discovering hidden patterns and structures in unlabeled data (Jordan & Mitchell, 2015, p. 258). Analyzing urban energy consumption data to identify groups of users with similar consumption profiles is an application of this approach. This allows energy management to become more targeted and efficient.

Reinforcement Learning enables an agent to learn through interaction with its environment based on the rewards and penalties it receives (Jordan & Mitchell, 2015, p. 258). The dynamic adjustment of traffic lights according to congestion levels is one of the significant applications of this method in urban management. The system learns the optimal light durations through trial and error, optimizing traffic flow. While this learning capacity provides cities with a strategic advantage in international competition, it simultaneously raises ethical and governance questions concerning who trains these algorithms and according to which values.

1.4.3. Internet of Things (IoT)

The Internet of Things (IoT) is a technological ecosystem that enables physical objects to connect to each other and to internet infrastructure, continuously collect and share data, and make intelligent decisions based on that data. IoT devices, equipped with sensors, actuators, and communication modules, perceive and process environmental information without human intervention. This allows for the development of more efficient and sustainable solutions in numerous areas, from urban infrastructure to healthcare, transportation, and energy management (Al-Fuqaha et al., 2015, p. 2347).

The IoT architecture is generally conceptualized as a layered structure. At the lowest layer are physical sensors and devices that collect data from the environment. The collected data are securely transmitted to upper layers for analysis and processing through data transmission layers. At this stage, data management, analysis, and service delivery take place. At the top layer, users, administrators, and applications benefit from these data by accessing smart services such as systems that optimize traffic flow or solutions that balance energy consumption. In addition, business processes and strategic decisions are supported at this layer (Al-Fuqaha et al., 2015, p. 2349).

In smart city applications, IoT is of critical importance for the effective management of urban resources. For instance, it enables the real-time collection of data from physical infrastructure and services across the city. IoT sensors remotely monitor critical infrastructure ranging from streetlights to water distribution systems, allowing malfunctions to be detected in advance. In transportation, connected vehicles and road sensors optimize traffic flow, while autonomous vehicles and delivery robots adjust their routes and timings based on real-time data. Environmental monitoring sensors track key indicators such as air quality and water resources, contributing to the development of sustainable policies. Furthermore, in emergencies, IoT devices facilitate coordination among first responders, support disaster management, and lay the groundwork for data-driven decision-making in urban governance (Hoang, 2024, pp. 66–67).

However, the security of sensor networks that constitute the nervous system of cities, as well as issues of data privacy and control, represent vital international policy concerns in terms of national security and digital sovereignty. These dynamics provide a rich analytical lens for understanding how supranational actors (such as the EU) and subnational actors (such as cities) cooperate or compete in matters of data management and digital sovereignty.

1.4.4. AIoT Synergy: From Data to Action

Artificial Intelligence of Things (AIoT), emerging from the integration of AI and the IoT, stands out as a paradigm promising significant transformations in areas such as real-time decision-making, automation, and efficiency. Through the integration of AI algorithms into IoT devices, AIoT enables these devices not only to collect data but also to analyze it locally and make intelligent decisions. This integration is applied across a wide range - from smart homes to agriculture, healthcare to industry, and energy management to autonomous vehicles - optimizing processes while making resource use more sustainable. However, it also brings important challenges related to data security, connectivity infrastructure, and ethical responsibilities. In the future, with technological advancements such as 5G, quantum computing, and edge computing, the effectiveness of AIoT will further increase; thus, smart systems will operate more autonomously and efficiently, becoming the foundational building blocks of sustainable urban life (IoT Business News, 2023).

At the core of this transformation lies the process of "from data to action," which reveals the true value of the vast amounts of raw data collected through sensors and users. AI algorithms and methods such as ML are employed to transform this data into meaningful insights; thereby, the diverse and high-volume data provided by IoT devices are processed through AI-based analyses to enhance cities' operational efficiency and improve quality of life. However, this integration process also necessitates advanced data management systems for the storage and processing of heterogeneous data formats. Moreover, the effective use of AI-powered algorithms facilitates the visualization of data, allowing human decision-makers to interpret the resulting information easily. On the other hand, the proliferation of IoT devices increases the number of connection points, which also heightens cybersecurity risks; therefore, dedicated security technologies have been developed and implemented for IoT-based systems (Bauer et al., 2021, pp. 18–20). Ultimately, the capacity to establish and sustain a secure, ethical, and efficient AIoT ecosystem constitutes both a competitive advantage for actors such as the EU and a strategic instrument to disseminate its own normative model across the world such as a human-centered and trustworthy AI.

1.5. SUMMARY AND TRANSITION TO EMPIRICAL ANALYSIS

This section has analyzed the phenomenon of artificial intelligence and smart cities within an interconnected, multilayered conceptual framework. First, it demonstrated how the global sustainability crisis and its international political dimension have triggered the rise of cities. Then, the definition, historical background, and key components of the smart city concept, such as Smart Governance, were examined in a manner that reflects the analytical framework of this thesis (Multi-Level Governance and Policy Learning). Finally, the core technologies that operationalize this vision, such as AI, ML, and IoT, were discussed not only in terms of their technical functions but also their strategic significance in international competition and governance. This comprehensive framework has laid the groundwork for the following chapter, which will analyze the cases of Amsterdam, Stockholm, and Vienna through this clearly defined analytical lens and within their international context.

CHAPTER TWO

EMPIRICAL ANALYSIS: THE EUROPEAN UNION FRAMEWORK AND SELECTED CITY CASES

This chapter connects the thesis's conceptual framework to concrete policies and practices. It first analyzes the European Union (EU) as a supranational actor within a system of multi-level governance, showing how norms, funding instruments, legal regulations, and cooperation platforms shape the smart-city agenda. It then examines how these EU-level dynamics are localized through three city cases—Amsterdam (collaboration- and ecosystem-oriented), Stockholm (sustainability-oriented hybrid), and Vienna (public-centered, human-centered)—to trace pathways of policy learning and norm diffusion.

2.1. INTRODUCTION: THE EUROPEAN UNION AS AN ARENA OF MULTI-LEVEL GOVERNANCE

According to a recent survey by Eurocities, European mayors state that their top priority for the coming years will be combating climate change (Eurocities, 2023). This sense of urgency drives both the European Union and European cities to use digitalization as a strategic instrument for achieving sustainability goals. In this chapter where the dynamics discussed in the conceptual framework meet concrete policies and practices the ways in which these orientations have taken shape will be examined. In particular, the analysis will first focus on the European Union (EU) level, where these policy dynamics are most prominently observed and institutionalized, and then on the city level, through cases such as Amsterdam, Stockholm, and Vienna.

The European Union offers one of the most advanced examples of multi-level governance in the world, where supranational (Commission, Parliament), national (member states), and subnational (cities, regions) actors are in constant negotiation and interaction. A complex issue such as smart cities, which bring together technology, environment, economy, and social policy, finds meaning and form precisely within such a governance structure. In this context, cities are no longer passive implementers of national policies but have become active actors that define their own strategies through funds, legal frameworks, and cooperation networks provided by the EU.

The EU, through its ambitious strategic objectives, functions as a mechanism of "norm diffusion," and by means of its financial incentives, regulatory frameworks, and cooperation platforms, has become a central actor steering this multi-level governance structure. Accordingly, the following section analyzes the main policy dynamics shaping the EU's smart city vision, followed by case studies exploring how this framework manifests in Amsterdam, Stockholm, and Vienna.

2.2. THE EUROPEAN UNION'S SMART CITY VISION AND POLICY FRAMEWORK

The European Union's approach to smart cities is too multilayered and dynamic to be reduced to a single policy document or directive. The EU does not treat this field as a standalone issue but rather as a central instrument for achieving broader strategic objectives such as urban competitiveness, economic prosperity, environmental sustainability, and technological sovereignty. The origins of this approach date back to the late 2000s, when the Union's interest in the issue began to grow significantly. The concept of smart cities gained widespread attention within the EU during the Seventh Framework Programme (2007–2013) and was further supported by the European Innovation Partnerships launched by the European Commission in 2010 (Uçar, Şemşit & Negiz, 2017, p. 1789). These early initiatives served as the initial steps that paved the way for today's more structured and integrated policies.

Currently, the EU's policy framework exhibits a holistic structure composed of an ambitious vision, financial instruments supporting this vision, legal regulations setting the rules of the game, and platforms that promote cooperation among actors. This framework serves as a tangible illustration of how the mechanisms of norm diffusion and multi-level governance discussed in the conceptual framework of this thesis operate in practice.

2.2.1. Strategic Vision: The Green and Digital Twin Transition

At the core of the EU's 21st-century vision lie two main pillars: the European Green Deal and Europe's Digital Decade. While the Green Deal aims to make the continent climate-neutral by 2050, the Digital Decade seeks to position the EU as a global leader in the technological sphere. At the intersection of these two strategic objectives lies a holistic approach referred to in the literature as the twin transition.

The twin transition argues that digitalization and sustainability should not be addressed separately but in a mutually reinforcing synergy. This approach recognizes that technology and data hold immense untapped potential to accelerate sustainability goals. However, this process is not unidirectional; while digital tools accelerate sustainability ("technology for green"), the carbon footprint of digital infrastructures and data centers must also be reduced which means that technology itself must be made "green" (Blüm, 2022).

Smart cities constitute the most concrete field of application for this dual purpose, serving as the embodiment of the twin transition vision. They not only employ digital technologies such as artificial intelligence and IoT to help the EU achieve its green objectives, which include climate neutrality and resource efficiency, but also have the potential to minimize the environmental footprint of digitalization itself through efficient technological use. This strategic framework transforms cities from mere local administrative units into strategic partners playing a key role in achieving the EU's international objectives. The EU's strong emphasis on this vision indicates that the twin transition has evolved from being merely a policy objective into a "norm" expected to be adopted by all member states and cities. This constitutes the first and most fundamental stage of norm diffusion: the introduction of a norm by a supranational actor.

2.2.2. Financial Instruments

To realize this ambitious vision, the EU has developed comprehensive financial incentive mechanisms. The most important of these is Horizon Europe which is the Union's main research and innovation program with a budget of approximately €93.5

billion. This program serves global objectives such as combating climate change and achieving the United Nations Sustainable Development Goals while providing massive funding for projects in areas such as smart city technologies, renewable energy, and the circular economy (European Commission, n.d.-a).

Within Horizon Europe, the EU has introduced Missions to ensure that this vast budget is used more effectively and in a more targeted manner. The Mission most directly related to this thesis is the Climate-Neutral and Smart Cities Mission, which manages an annual budget of approximately €120 million. It defines a two-stage objective: to make 100 pioneering cities climate-neutral and smart by 2030, and to lead the transformation of all European cities by 2050 based on the experiences of these frontrunners (European Commission: Directorate-General for Research and Innovation, 2025).

Complementing Horizon Europe's research and innovation-oriented approach, the Digital Europe Programme aims to ensure the practical deployment and scaling up of these innovations. With a budget of approximately €8.1 billion, this program was designed in response to the external technological dependencies revealed by the COVID-19 pandemic and the digital vulnerabilities exposed by geopolitical developments, with the goal of strengthening Europe's digital sovereignty. It focuses on capacity-building in strategic fields such as artificial intelligence, cybersecurity, and semiconductors and promotes the broad use of these technologies by SMEs and public administrations through the European Digital Innovation Hubs (EDIH) network (European Commission, 2025a).

The effectiveness of these two programs is complemented by a third one: the Connecting Europe Facility (CEF Digital) which aims to build the physical infrastructure underlying digital transformation. With a more focused budget of around €1.6 billion, CEF Digital plays a foundational role by constructing the "highways and data bridges" on which the innovations of the other programs can operate. It focuses on strengthening backbone infrastructures such as 5G networks, cross-border transport corridors, and submarine fiber-optic cables, thus ensuring the high-capacity and uninterrupted connectivity required by future smart city initiatives (Roth & Colakides, 2024).

Through these programs, the EU not only provides financial support but also brings together cities, universities, and companies from different countries in joint projects, creating a foundation for transnational cooperation and policy learning. These financial mechanisms constitute the most concrete and powerful engine of the multi-level governance model discussed in theory, serving as a bridge linking EU-level (supranational) objectives with local (subnational) needs, while involving national (state) governments in the process. Nevertheless, the literature also highlights that these mechanisms create practical challenges such as bureaucratic complexity and unequal access (Matthews, 2024; Veugelers et al., 2015). These dimensions will be examined in detail in Chapter 3 of this thesis.

2.2.3. Legal and Normative Framework

One of the EU's most significant roles is setting the legal and ethical boundaries of technological transformation and developing globally influential standards. In this regard, the EU Artificial Intelligence Act, recognized as the world's first comprehensive AI regulation, holds particular importance. The Act not only establishes technical rules but also adopts a risk-based approach that classifies AI applications into four main categories (European Commission, 2025b):

1. Unacceptable Risk: AI systems that clearly pose a threat to fundamental rights, such as social scoring, are completely prohibited.
2. High Risk: AI systems managing critical urban infrastructure (energy grids, transport systems) or used in accessing public services fall into this category and must comply with strict transparency, oversight, and safety standards.
3. Limited Risk: For systems such as chatbots that interact with citizens, transparency obligations are imposed to ensure users know they are communicating with AI.
4. Minimal Risk: Most other AI applications fall under this category and can be freely used.

This risk-based approach of the AI Act is complemented by the General Data Protection Regulation (GDPR), which governs data - the most critical resource of smart cities. The GDPR defines personal data protection not merely as a technical issue but as a fundamental right. According to Article 1, the EU aims both to safeguard individuals' fundamental rights and freedoms and to ensure the free flow of such data within the Union (GDPR, 2016). This dual objective provides a crucial framework for smart cities: while the development of innovative and data-driven urban services is encouraged, the protection of citizens' privacy rights is strictly mandated.

When these two legal instruments are considered together, it becomes clear that the EU aims to foster a smart city vision that is not only technologically innovative but also aligned with democratic and ethical values. Moreover, through the so-called Brussels Effect, these regulations extend beyond EU borders, becoming de facto global standards. Thus, the EU stands out as a norm-setter not only within its territory but also worldwide.

However, academic debates also highlight shortcomings in this regulatory framework. Scholars have raised concerns regarding the AI Act's potential negative impact on innovation (Nizza, 2025), its limited capacity to provide protection due to conceptual ambiguities in areas such as "high risk" and manipulation (Zhong, O'Neill & Hoffmann, 2024), and the inadequacy of existing legal tools (such as PLD, AILD) to address AI-induced harms (Wachter, 2024). These critical dimensions will be discussed in detail in Chapter 3.

2.2.4. Cooperation Platforms and Networks

The European Union actively supports intercity cooperation and policy learning to ensure that the smart city vision does not remain limited to isolated success stories but instead leads to a transformation spanning the entire continent. As emphasized by the Eurocities (2023) report, inefficiencies such as cities repeatedly spending resources to solve similar problems underscore the importance of such collaboration. In this context, the EU supports existing city networks such as Eurocities, facilitating policy transfer, and initiatives such as the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), which bring stakeholders together to spread good practices across Europe, thus functioning as mechanisms of norm diffusion.

Beyond promoting cooperation, the EU also develops concrete tools and legal frameworks to remove practical barriers. For example, steps have been taken to create a “Local Digital Twin Toolbox” designed to facilitate technology sharing and the dissemination of best practices (Eurocities, 2023).

As a more structural solution, the EU has established legal frameworks such as the European Digital Infrastructure Consortia (EDICs) to enable joint resource pooling and the implementation of shared infrastructure projects. These consortia allow cities and member states to share investments and produce large-scale, interoperable, and efficient digital solutions (Eurocities, 2023). All these platforms and mechanisms illustrate that processes such as policy learning and norm diffusion do not emerge spontaneously but can instead be consciously designed and institutionalized by a supranational actor like the EU.

The political framework outlined in this section defines the playing field within which cities such as Amsterdam, Stockholm and Vienna, which will be examined in the case studies that follow, operate. The success of these cities is not merely a product of their local dynamics but is closely related to how effectively they utilize, adapt to, and even shape this complex EU framework.

2.3. CASE STUDY 1: AMSTERDAM

Amsterdam, the capital and largest city of the Netherlands, is a pioneering metropolis that combines its rich historical heritage with an ongoing search for innovative solutions to the technological and environmental challenges of the twenty-first century. According to the Statistics Netherlands, by the end of 2024 the city’s population had reached approximately one million (CBS, 2025), and through its intensive economic activities it has become one of Europe’s key centers. However, in order to understand Amsterdam’s responses to these challenges and the distinctive “collaboration and ecosystem”-oriented smart city model it has developed, it is necessary to examine the centuries-old political and cultural heritage of both the city and the Netherlands more broadly.

At the core of this heritage lies the culture of consensus and cooperation known as the “Polder Model,” which emerged out of the historical necessity to fight against water and came to define the socio-political structure of the Netherlands (Hoppe et al., 2014, p.36). The necessity for actors with differing interests to come together and negotiate in order to solve a common problem has profoundly shaped Amsterdam's current understanding of governance. Rather than relying on hierarchical and top-down planning, this model promotes flexible, network-based, and pragmatic solutions involving multiple stakeholders from the public sector, private industry, and civil society.

Furthermore, Amsterdam's historical identity as a trading and port city has always rendered it outward-looking, open to innovation, and inclined toward international cooperation. This cosmopolitan structure enables the city to seek not only local but also global solutions to the problems it encounters and to easily form partnerships with international centers of knowledge such as MIT. Therefore, Amsterdam's "collaboration and ecosystem"-oriented smart city model represents a modern reflection of a society that learned to survive through collective intelligence on land reclaimed from rivers and of a commercial city positioned at the heart of global networks. The city's Living Lab approach constitutes one of the most tangible manifestations of this pragmatic and experimental culture.

2.3.1. Smart City Vision and Interaction with EU Policies

Amsterdam's smart city vision, rooted in the "Amsterdam Smart City (ASC)" program initiated in 2007, is built upon a multi-actor collaboration model, as detailed in the comprehensive study of Mora and Bolici (2017). From its inception, this process was shaped by the partnership among key public and private sector institutions such as the Municipality of Amsterdam, the energy network operator Liander, and the city's innovation engine, the Amsterdam Innovation Motor (AIM) (Mora & Bolici, 2017, pp. 254-255). This structure represents a local reflection of the multi-level governance model that forms the main framework of this thesis, since this horizontal collaboration between the public sector (the municipality), the private sector (Liander), and civil society (through AIM) demonstrates the city's capacity to define its own strategy.

The primary objective of this strategy was to address the city's urgent environmental problems particularly the reduction of CO_2 emissions by employing

Information and Communication Technologies (ICT) and to transform the city into a sustainable urban structure. To achieve this goal, a planning process integrated with the city's strategic framework was designed. Developed in parallel with the "New Amsterdam Climate Program," the strategy set a concrete and ambitious target of reducing greenhouse gas emissions by 40 percent compared to 1990 levels by the year 2025 (Mora & Bolici, 2017, p. 256). During this planning process, the Living Lab approach was adopted to ensure the active participation of citizens and stakeholders in real-life technology testing, and to coordinate these projects, the "Amsterdam Smart City" platform was established as an independent foundation through a public-private partnership (Mora & Bolici, 2017, p. 257).

From the very beginning, this model was designed not only for Amsterdam but also to serve as an example for other European cities. Indeed, within the scope of the strategy, the ASC platform presented its goals, results, and projects at more than 50 national and international conferences and disseminated them through reports and articles (Mora & Bolici, 2017, pp. 260-261). This development process is visually summarized in Figure 3. This proactive effort toward dissemination clearly illustrates Amsterdam's early ambition to act as a center of policy learning and norm diffusion.

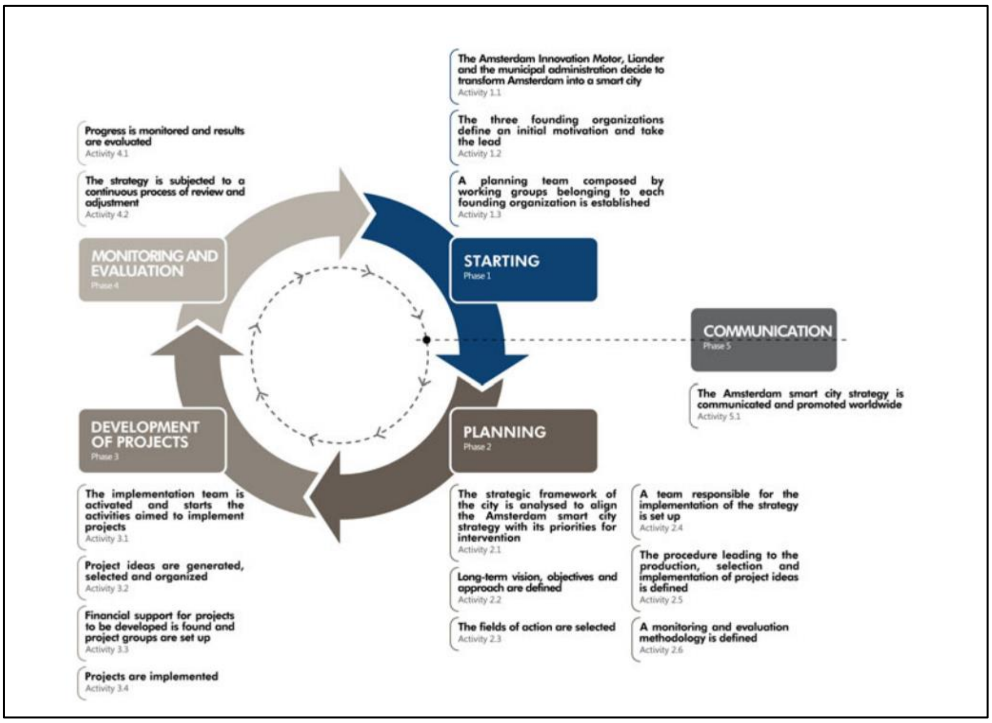

Figure 3. The Development Process of Amsterdam's Smart City Strategy (Mora & Bolici, 2017, p. 254)

This vision was further deepened with the launch of the "Digital City Agenda" in 2019. As the officials of the Chief Technology Office (CTO) emphasized, through this agenda the city acknowledged the reality that "technology is never neutral" and set the goal of becoming a free, inclusive, and creative city where everyone benefits from digitalization. This critical perspective also entails the municipality's responsibility to ask the right questions in order to prevent the acquisition of "black-box" technologies that may be biased or vulnerable to hacking (Dinca, 2019).

This philosophical orientation has now taken on a more tangible institutional form through the "Amsterdam AI" platform, which brings together nine of the city's leading institutions. The platform's core aim is to develop human-centered and responsible AI, and this vision directly intersects with the main theme of this thesis, as expressed by Rijk van Ark, Amsterdam Director of Economic Affairs and Culture:

> *we encourage companies and talent to use AI to make a positive impact on society, from ethical AI to applications for sustainability and the energy transition." (Amsterdam AI, 2024).*

At the same time, as the headquarters of the Netherlands AI Coalition (NLAIC), which plays a central role in the national strategy, this platform is viewed - as the Rector of the University of Amsterdam notes- as "a means to attract talent from all over the world and to remain a leading player" (Amsterdam AI, 2024). This demonstrates that the city's AI strategy is focused not only on local challenges but also on national objectives and international competition.

Amsterdam's long-standing, pioneering, and internationally oriented vision from the outset displays perfect alignment with the strategic priorities adopted by the European Union in recent years. The city's experience in using digital technologies as a lever for environmental goals practically mirrors the twin transition vision which is the combination of the European Green Deal and Digital Decade objectives. This alignment and pioneering role have been officially recognized by the European Commission. Indeed, Amsterdam was selected as one of the 100 pioneer cities within the "EU Cities Mission," which aims to achieve climate neutrality by 2030 (European Commission: Directorate-General for Research and Innovation, 2024).

Being included in this mission has further accelerated Amsterdam's existing strategy and made it part of the EU's most ambitious policy goals. Within this framework, the city is required to prepare a "Climate City Contract" that includes its decarbonization targets and investment plans for key sectors such as energy, transport, and buildings (European Commission: Directorate-General for Research and Innovation, 2024). Therefore, Amsterdam's smart city strategy is no longer merely a local initiative but a concrete example of multi-level governance in which the EU's global climate and technology policies are implemented at the local level, functioning as a center of policy learning and norm diffusion for other European cities. However, as practitioners in the field emphasize, the success of this governance model depends not only on "top-down" policies from the EU but also on "bottom-up" innovations developed by entrepreneurs and citizens (Dinca, 2019). Indeed, as Amsterdam Smart City officials acknowledge, ensuring data sharing among different public institutions remains one of the most significant challenges to realizing this holistic vision (Dinca, 2019).

Ultimately, Amsterdam's smart city journey, which has continued for over a decade, provides a rich example of the international political dynamics forming the main framework of this thesis ─ beyond the realm of technological innovation. The case clearly illustrates a complex structure of multi-level governance: the European Union's financing of projects through programs such as Horizon 2020 (supranational), the City of Amsterdam's leadership in shaping strategy (subnational), and the active participation of the private sector and civil society (horizontal) collectively demonstrate that solutions to global challenges no longer emerge from a single level of authority, but from the continuous interaction among actors operating at multiple levels.

2.3.2. Smart City Projects and the Role of Artificial Intelligence

Amsterdam's smart city vision goes beyond theoretical principles and governance frameworks, coming to life through tangible projects embedded in the city's fabric. The city's project portfolio demonstrates how multidimensional and comprehensive its vision of urban transformation truly is. Some of these projects are as follows (Amsterdam Smart City, n.d.):

– Urby: Provides recommendations for daily tasks and destinations within the city of Amsterdam.

– Amsterdam Tech City: Promotes collaborative participation in implementing inspiring new technology trends to improve the city.

– Amsterdamdecks: Facilitates citizen participation in water use and development.

– City Alerts: Ensures adequate information exchange between emergency services during emergencies.

– Fuel Cell Technology: Aims to reduce CO_2 emissions by 50% using 21st-century technology in a historical building.

– MX3D Bridge: A bridge built using 3D printing and robotics in collaboration with multinational partners such as the AMS Institute and Hacettepe University.

– Biogasboot: Converts organic waste into biogas and fertilizer.

– GridFriends: Coordinates energy supply and demand among households to achieve neighborhood-level energy neutrality.

– City Zen: Integrates solar energy and home battery systems through a virtual power plant.

– Smart Sports Parks: A project aimed at making sports parks more sustainable.

– Climate Street: Invests in CO_2 reduction and environmental efficiency along a specific street.

– Amsterdamse Zoncoalitie: A project to install one million solar panels across the city.

Amsterdam's extensive project portfolio serves as tangible evidence of the city's efforts to achieve its sustainability goals, which include reducing carbon emissions, improving energy efficiency, and promoting a circular economy. This approach allows electric vehicles to feed power back into the grid through Vehicle-to-Grid (V2G) technology and facilitates data-driven solutions to urban challenges via platforms such as the IoT Living Lab. Furthermore, the Circular Amsterdam Platform targets waste reduction, while EU-supported programs like City-Zen accelerate the integration of renewable energy sources into urban life. These projects demonstrate that Amsterdam translates its environmental goals into concrete actions (Bayramova & Uçar, 2026, pp. 395–396).

Within this vision, the city's artificial intelligence strategy manifests itself not merely through theoretical principles or governance frameworks but through concrete projects that permeate the urban fabric. These initiatives extend from the most fundamental identity elements of the city to its most complex infrastructures.

Perhaps the most visible applications of AI appear in Amsterdam's innovative solutions to mobility challenges. The city's historic canals are being transformed into a 21st-century intelligent mobility network through the Roboat project. Developed in partnership with the Massachusetts Institute of Technology (MIT) and the AMS Institute, this initiative introduces new solutions for urban services such as waste collection using autonomous watercraft (I Amsterdam, 2025b). The technological infrastructure enabling autonomous navigation is based on advanced AI algorithms (I Amsterdam, 2025b). As a primary data source for navigation and localization, the Light Detection and Ranging (LiDAR) system is used. The high accuracy and reliability of LiDAR data allow for the creation of an offline map, which is a prerequisite for autonomous operation, and the precise localization of the vessel within this map. Among its functional objectives is to provide an efficient alternative to existing waste collection and transport systems (AMS Institute, n.d.).

This innovative approach is not limited to waterways; on the roads, projects such as Smart Flow seek to address traffic congestion in Amsterdam's narrow and historic streets through IoT. This cloud-based platform monitors traffic flow and parking availability in real time via sensors deployed throughout the city. A pilot study reported that Smart Flow reduced the time spent searching for parking by 43%, thereby contributing to lower traffic congestion and environmental pollution (Smith, 2022). These individual projects gain strategic coherence through the city's broader Smart Mobility Program 2019–2025 (City of Amsterdam, 2019) and are further elevated to an international scale through European Union initiatives such as metaCCAZE (AMS Institute, 2024).

The city's sustainability goals not only focus on optimizing the movement of people and goods but also on the intelligent management of the energy that powers this mobility and the city as a whole. The most tangible example of these efforts is Schoonschip, Europe's most sustainable floating neighborhood. The microgrid that enables the neighborhood to generate its own energy and connect households to one another is managed using AI and ML algorithms within the GridFriends project (Amsterdam Smart City, 2016). The fact that this local and pioneering experience is funded by the EU's Horizon 2020 program under the ATELIER project (Dinca, 2019) serves as concrete evidence of how multi-level governance - one of the central arguments of this thesis - operates in practice. These micro-level successes are transforming into a macro-level vision as smart grids expand across the city. Amsterdam's pioneering position in this area is no coincidence; it builds upon early EU-supported initiatives such as City-Zen and major investments by the grid operator Alliander (I Amsterdam, 2023). Today, innovative companies like Dexter Energy are taking this vision even further by using AI to integrate renewable energy sources into the grid (I Amsterdam, 2025a).

However, Amsterdam's AI strategy reveals its most distinctive character not merely in critical infrastructures such as mobility and energy, but in its approach to the management of public spaces and citizens' rights. The most striking example of the city's critical and human-centered philosophy toward technology is Public Eye, an AI system developed in-house instead of relying on commercially available crowd management products. The system analyzes crowd density, size, and movement using existing city cameras and computer vision algorithms. Its goal is not to impose fines but to proactively prevent the formation of dangerous crowds and guide citizens toward safer routes through mobile applications (Wray, 2021).

The decision of the Amsterdam Technology Office to develop this project in-house was driven by strategic concerns: the lack of transparency and ethical standards in existing commercial solutions, and the *"black box"* nature of proprietary systems. With this move, the city aimed both to define its own privacy and ethical standards under the privacy by design principle and to encourage the market to develop better and more transparent products (Wray, 2021). The project's release as open source and its registration in the city's public AI Register further demonstrate Amsterdam's ambition to act as an international norm-setter in technology governance.

This approach provides a compelling example of how transparent, human-centered, and public-interest-oriented AI applications can respond to concerns about privacy, data security, and ethics frequently discussed in the literature.

The final project to be discussed is Shuttercam. Developed jointly by the City of Amsterdam and the Responsible Sensing Lab within the AMS Institute, this initiative aims to enhance transparency in surveillance processes by adding physical shutter mechanisms to city cameras, visually signaling to citizens when data is being collected. Shuttercams make camera activity easily recognizable while producing only anonymized numerical data (such as crowd density, direction, and mobility) instead of recording footage. This allows the system to provide public benefits like crowd management and safe route planning while preserving personal privacy (Responsible Sensing Lab, n.d.). The project's public reporting and adherence to ethical design principles contribute to Amsterdam's positioning not only as a city that develops technological capacity but also as an actor advancing responsible AI and data governance standards at the international level.

However, not all of the city's initiatives, particularly in sensitive areas such as social welfare, have achieved similar success. The algorithmic experiment known as Smart Check, designed to prevent welfare fraud, encountered challenges related to fairness and discrimination, ultimately leading to the project's termination (Guo, Geiger, & Braun, 2025). The dilemmas emerging from this experience will be analyzed in greater depth in the Discussion section of this thesis.

As evident from these examples ranging from autonomous boats on the canals to smart energy grids, from open-data-based mobility solutions to public space management grounded in privacy and ethical principles, Amsterdam's projects clearly demonstrate that AI is far more than a tool for achieving technical efficiency. These initiatives not only materialize the city's sustainability objectives but also showcase its pioneering role in strengthening transparency, data protection, and ethical design standards in technology governance. Thus, through its innovative EU-funded solutions and commitments under the Climate City Contract, Amsterdam assumes a norm-setting role at the international level in both sustainability and responsible AI.

2.4. CASE STUDY 2: STOCKHOLM

The foundations of Stockholm's current leading position as a smart city were laid two decades ago through a strategic initiative: the establishment of an open fiber network infrastructure owned by the city and leased to all stakeholders under equal conditions. This move has provided a solid basis for the city's digital transformation by ensuring high-speed internet access to all businesses (100%) and nearly all households (95%) today. This long-term infrastructural vision draws upon Sweden's and its capital Stockholm's deep-rooted innovation heritage and technological leadership, which gave rise to global giants such as Ericsson (Landahl, 2021, p. 296).

Home to approximately one million residents (Statistics Sweden, 2025), Stockholm is a metropolis that combines its strong technological identity with the unique natural beauty of its archipelago setting. However, this geographical structure also makes the city vulnerable to the impacts of climate change. It is precisely this dual character —technological leadership and ecological responsibility —that has driven Stockholm to assume a pioneering role in developing sustainability-oriented smart city solutions. This role makes it an ideal case for examining how local technological capacity interacts with supranational policy objectives.

2.4.1. Smart City Vision and Interaction with EU Policies

Stockholm's smart city vision goes beyond being a technology-driven strategy; it constitutes a strategic framework that integrates the city's long-standing commitment to sustainability, social equality, and quality of life with the instruments of the digital age. This approach treats technological innovation as a means to develop holistic and human-centered solutions to urban challenges. The city's strategic documents reveal that this vision did not emerge overnight but represents the digital evolution of a consistent urban planning philosophy spanning decades. This section examines the key strategic documents and philosophies that define Stockholm's approach and analyzes the symbiotic relationship between the vision's three pillars: climate neutrality, social equity, and economic growth.

Stockholm's smart city identity is built upon foundations laid long before the concept of the smart city became popular. The evolution of the city's urban planning philosophy demonstrates a consistent effort to create a human-centered and sustainable urban fabric even before the transition to technology. This process reveals how physical and social infrastructures were designed as prerequisites for later digital layers (Stockholms stad, 2018, p. 14). At the core of this plan lies the goal of creating a connected, well-maintained, and safe pedestrian network, ensuring that all key locations are within walking distance. Combined with the city's dense and mixed-use structure, this approach makes Stockholm internationally recognized as a pedestrian-friendly city and makes walking a natural choice for short-distance travel (Stockholms stad, 2018, p. 78).

The city's long-term and holistic efforts in this area were officially recognized by the European Commission in 2010, when Stockholm became the first European Green Capital. This award was the result of the city's achievements in areas such as integrated waste management, water conservation planning, and urban design that allows 95% of residents to live within 300 meters of green spaces. Stockholm reinforced this pioneering role by actively sharing its experiences with other cities through international conferences and professional study visit programs, demonstrating from the outset its intent to act as a hub for policy learning and norm diffusion (European Commission, n.d.-b).

On 3 April 2017, the City Council adopted the Smart and Connected City Strategy, which shapes Stockholm's current official vision by building upon its strong sustainability legacy and the solid foundation laid by the Walkable City plan. This strategy aims to coordinate and guide the city's numerous digitalization projects under a unified framework. Its philosophical core is based on the principle that all investments and technological solutions must ultimately serve "the needs of people living in, working in, or visiting the city." This human-centered approach constitutes the defining feature of the Stockholm model, integrating the city's sustainability legacy with the dimensions of social participation and quality of life (Landahl, 2021, p. 297).

The most critical element in realizing this digital vision is Stokab, a city-owned company established in 1994. The open, competitive, and 100%-coverage fiber-optic network developed by Stokab forms the essential infrastructure that makes the Connected City vision possible. This network not only provides high-speed internet access but also enhances Stockholm's competitive advantage by making it an attractive hub for international talent and businesses. The existence of Stokab illustrates Stockholm's early and forward-looking decision to manage its smart city infrastructure strategically as a public asset rather than leaving it to the discretion of the private sector. This marks an important distinction from many technology-centric smart city models, where infrastructure is viewed not as an end in itself but as a means to achieve broader urban goals (Urenio Research, 2015).

One of the most remarkable aspects of the strategy lies not only in its content but also in its development process. Instead of preparing the strategy behind closed doors, the Stockholm Municipality adopted an open, multi-stakeholder model involving broad segments of society. In this context, face-to-face dialogues were held with citizens at City Hall, and online discussions received feedback from over 3,350 participants via social media. This participatory approach has been institutionalized through permanent innovation platforms such as Digital Demo Stockholm and Urban ICT Arena. These platforms function as living labs where the municipality collaborates with Sweden's largest industrial giants (Ericsson, Volvo, Scania, etc.) and leading universities (Royal Institute of Technology – KTH) to test innovative, sustainability-oriented digital solutions (Landahl, 2021, pp. 297–298). This structure represents the institutionalized form of what Stockholm calls the Quadruple Helix model, a sophisticated form of multi-level governance that brings together the public sector, academia, industry, and citizens.

Stockholm's pioneering and learning-oriented role has become even more tangible in its most recent policy documents. With the adoption of the Environmental Program 2030 and the Climate Action Plan 2030 at the end of 2024, the city elevated its sustainability vision to a new level. These new strategies set out an ambitious goal of becoming completely fossil fuel-free and climate-positive by 2040. The plan includes 150 specific actions, such as reducing emissions from energy and transport by 80% and halving consumption-based emissions (European Commission: Directorate-General for Environment, 2025).

The city's ambitious local vision also engages in a strong and symbiotic interaction with the European Union's broader policy frameworks. The most recent indicator of this interaction is Stockholm's selection for the EU's prestigious 100 Climate-Neutral and Smart Cities Mission (European Commission: Directorate-

General for Research and Innovation, 2024). This Mission provides a supranational framework for the city to develop its own Climate City Contract. Another significant example of such cooperation is the award-winning GrowSmarter project (Landahl, 2021). Directly coordinated by the Stockholm Municipality and funded with €24.8 million from the EU's Horizon 2020 program, this project clearly demonstrates how Stockholm implements its local objectives through supranational funding mechanisms (European Commission, 2023). The project aimed to showcase integrated solutions such as smart grids and energy-efficient buildings in three lighthouse cities like Stockholm, and to facilitate the transfer of these successes to follower cities.

Stockholm's participation in EU projects functions not only as a means of obtaining funding but also as a mechanism that enables the city to actively contribute to the broader European knowledge ecosystem. This process has elevated Stockholm from the position of a learner to that of a teacher and mentor.

One of the core designs of the EU's SCC1[1] projects is the Lighthouse/Follower City model. In this framework, experienced lighthouse cities such as Stockholm, Barcelona, and Cologne are paired with Follower cities such as Suceava, Graz, and Porto. The goal of this structure is to ensure that the solutions developed and tested in lighthouse cities are not only successful but also transferable and replicable by other cities. This model formally positions Stockholm as a role model, assigning it the responsibility to systematically transfer its experience (GrowSmarter, Remourban, & Triangulum, 2019, p. 2).

This demonstrates that policy learning and norm diffusion are not merely spontaneous processes but can also be consciously designed and institutionalized by a supranational actor like the EU, which employs pioneering cities such as Stockholm as both a "teacher" and a "norm diffuser."

In conclusion, Stockholm's smart city vision represents not a single strategic document but a layered and continuously evolving structure built over decades. Rooted in the Walkable City plan and a strong sustainability culture recognized by the European Green Capital award, the city has integrated digitalization through assets like Stokab and platforms such as Digital Demo Stockholm. This mature local model

[1] These projects include large-scale initiatives such as GrowSmarter, REMOURBAN, Triangulum, and others funded under the 'Smart Cities and Communities – Lighthouse' (SCC1) call launched by the EU under the Horizon 2020 programme.

has aligned with supranational frameworks such as the EU's Cities Mission and Horizon 2020, becoming an institutionalized mechanism of policy learning and norm diffusion.

Thus, the following section examines the concrete reflections of this vision in practice, focusing on specific projects and the role of AI within them.

2.4.2. Smart City Projects and the Role of Artificial Intelligence

Stockholm's goal of becoming "the world's smartest city" under its "Vision 2040" framework is based on a deliberate and multi-stakeholder innovation strategy. At the core of this strategy lies the Quadruple Helix collaboration model, which brings together the public sector, academia, industry, and citizens (Stockholms stad, n.d.-a). Although this model aims to build urban policies upon collective knowledge and experience, the literature indicates that its implementation does not always function ideally. For instance, Gustavsson, Hallin and Dobers (2023), who examined the Stockholm Royal Seaport project, reveal that the community- the fourth helix -is sometimes positioned not at the center of decision-making processes but rather at the testing and feedback stages. This finding suggests that the participatory vision requires continuous improvement in practice.

Nevertheless, Stockholm's innovation ecosystem possesses a strong capacity to transform this multi-stakeholder approach into tangible and measurable outcomes. The most successful showcase of this strategy is the GrowSmarter project, which enabled the city to win the 2019 World Smart City Award. Funded by the European Union's Horizon 2020 program, this Lighthouse project went beyond a purely research-oriented initiative, serving as an instructive example of multi-level governance by demonstrating how the EU, cities, and industries operating at different levels can collaborate toward a common goal. In the project, conducted under Stockholm's leadership with Cologne and Barcelona, twelve innovative solutions in the fields of energy, infrastructure, and transportation were tested and successfully implemented under real urban conditions (Enarsson, Granström & Taintor, n.d., p. 6).

In this project, IoT technology played a central role. For example, the Building Energy Management System (BEMS) used data collected from indoor sensors and external weather conditions to adjust heating systems according to real-time needs, achieving up to 10% energy savings (Enarsson, Granström & Taintor, n.d., p. 12). The experience gained from these pilot applications formed the basis for developing a permanent city-wide IoT infrastructure, for which a large-scale procurement process was subsequently initiated (Enarsson, Granström & Taintor, n.d., p. 51).

Stockholm also stands out for its efforts to integrate fundamental scientific research with urban innovation policy. The KTH-MIT Senseable Stockholm Lab (SSL) partnership positions the city as a "living laboratory," focusing on solving complex urban problems through big data, AI, and IoT. The lab's decision to address "urban segregation" as one of its first projects illustrates its intention to employ technology not only for efficiency but also to pursue more complex goals such as social equality (MIT News Office, 2019).

In addition to these initiatives, AI is actively used to enhance the efficiency and sustainability of Stockholm's most essential and critical infrastructure services. The city's smart traffic management system utilizes real-time data and predictive AI analyses to optimize traffic flow and reduce congestion. This system has been further strengthened through AI-driven analysis of traffic patterns and forecasting of future density. These technological measures shorten travel times and improve transport efficiency, directly contributing to urban sustainability by reducing carbon emissions. Alongside technology, physical investments such as an efficient public transport network and a bicycle-friendly infrastructure encourage sustainable mobility. Stockholm's sustainability vision extends beyond transport, aiming to enhance the city's overall quality of life through environmentally friendly practices such as green roofs and sustainable waste management. All these efforts make Stockholm a model city demonstrating how innovation and technology can be harnessed to create a more livable environment (Inclusion Cloud, 2023).

An even more innovative example is the project aimed at preventing losses in the city's drinking water network. In this network, where approximately 17% of produced water is lost due to leaks, an AI model analyzes data such as pipe age and material to predict future leakage risks and prioritize repairs. Simultaneously, another AI system monitors real-time water flow to detect sudden leaks instantly. This dual AI approach safeguards one of the city's most valuable resources (Stockholms stad, n.d.-b).

In conclusion, Stockholm's use of AI is supported by a holistic strategy at both the policy and applied technology levels. The Quadruple Helix approach, EU-funded projects such as GrowSmarter, and collaborations like those with KTH and MIT have positioned the city as a strong actor in international innovation networks. However, the incomplete realization of the participatory dimension in practice and the limited role of citizens in some projects indicate areas for further improvement. Despite these challenges, Stockholm's achievements across diverse domains, from energy efficiency to social inclusion, demonstrate that the city positions AI as a powerful lever for fulfilling its commitments under the "Climate City Contract."

2.5. CASE STUDY 3: VIENNA

Vienna, the capital and largest city of Austria, is a pioneering metropolis that combines its rich imperial heritage and cultural depth with a quest to produce human-centered solutions to the social and environmental challenges of the twenty-first century. With a population of approximately two million (Statistics Austria, 2025) and as the host of numerous international organizations such as the United Nations, the city is a major political and cultural hub of Europe. Vienna regards the preservation of this global position and its internationally recognized high standard of living as its fundamental driving force for the future. This dual character – preserving historical grandeur while enhancing social welfare – has led Vienna to pursue a distinctive path that views technological innovation not as an end in itself but as a means to maintain this high quality of life. This human-centered pioneering role enables the city to offer an ideal and contrasting case study for examining how local dynamics can interact differently with the European Union's broader policy objectives.

2.5.1. Smart City Vision and Interaction with EU Policies

Vienna's smart city approach deliberately distances itself from technological determinism and places its unique philosophy at the center of its strategy: ensuring a high quality of life for all residents while conserving resources to the greatest extent possible through social and technical innovations (City of Vienna, 2022, p. 22). This vision is validated by the city's repeated recognition as "the world's most livable city" by international organizations such as The Economist Intelligence Unit. The essential feature distinguishing the Vienna model from other cases is that the roots of its smart city strategy extend far beyond the digital era, tracing back to its clean water supply network sourced from mountain springs since 1873 and the social housing legacy of the "Red Vienna" period of the 1920s (WienTourismus, n.d.).

Built upon this deep social and environmental heritage, the city's contemporary vision was institutionalized with the adoption of the "Smart City Vienna Framework Strategy" in 2014. However, this strategy is not a static document but a dynamic process that continually evolves in response to global developments and local priorities. Indeed, the first comprehensive revision of the strategy in 2019 emerged from Vienna's need to achieve full alignment with international commitments such as the Paris Climate Agreement, to which Austria is also a signatory (City of Vienna, 2022, p. 13). Furthermore, the Smart City Vienna Strategy demonstrates that the city builds its local policies directly upon global norms and objectives by adopting all seventeen Sustainable Development Goals (SDGs) of the United Nations as the foundation of its strategic framework (City of Vienna, 2022, p. 18). The most significant step in this evolution was taken in 2020, when the new municipal government adopted the goal of becoming carbon neutral (net zero) by 2040. As Mayor Michael Ludwig stated, with this goal the existing framework was revised and renamed the "Smart Climate City Strategy for Vienna" (City of Vienna, 2022, p. 6).

This updated strategy is built upon three interrelated pillars: quality of life, resource preservation, and innovation (see Figure 4). Within this framework, innovation is positioned as a "means" to achieve the other two objectives; the aim is not merely to adopt the newest technology but to find the most appropriate and inclusive solution to urban and social challenges. As emphasized in the strategy, Vienna's interpretation of a smart city is one that never loses sight of the "human dimension" and ensures that life is not improved at the expense of the environment or future generations (City of Vienna, 2022, p. 23).

The city's local and ambitious vision is strongly aligned with the general policy frameworks of the European Union. However, Vienna not only aligns with these frameworks but also assumes a more ambitious role by setting its own targets, such as the 2040 carbon-neutral goal, which is a decade ahead of the EU's 2050 target. This demonstrates that Vienna positions itself not merely as an implementer of EU policies but as a proactive actor of norm diffusion. Yet, the norm that Vienna seeks to disseminate is not a specific technology or project, but rather the very philosophy of the smart city itself - namely, the principle that technology must serve humanity and quality of life. Vienna's self-definition in its strategy document as "an active participant in shaping the international debate" (City of Vienna, 2022, p. 19) clearly reveals its intention to present this human-centered model as an alternative to more technology-determinist approaches.

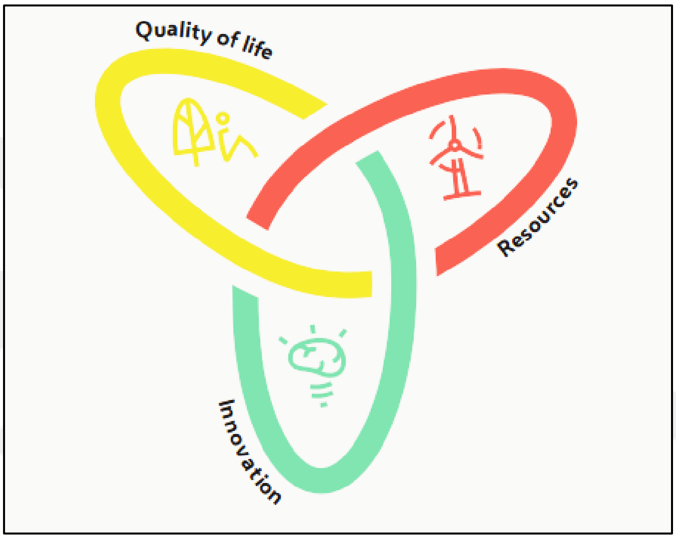

Figure 4. Three Pillars of the Vienna Smart Climate City Strategy (City of Vienna, 2022, p. 23)

2.5.2. Smart City Projects and the Role of Artificial Intelligence

Vienna's human-centered and sustainable smart city vision is implemented through concrete goals defined in its official strategic documents and thematic action areas established to achieve these goals. The city's "Smart Climate City Strategy Vienna" sets forth specific and measurable objectives ranging from making energy supply 100% fossil-free and halving transport-related emissions to strengthening the circular economy and ensuring that all citizens have easy access to green spaces (City of Vienna, 2022, pp. 41–45). Vienna's pursuit of these strategic goals is guided by a fundamental philosophy known as "Digital Humanism." According to this approach, digitalization and technology are never seen as ends in themselves; rather, they are positioned as tools serving the city's core objectives of high quality of life, social equality, and sustainability. This philosophy aims to ensure that all digital transformation efforts place human beings, their rights, and their needs at the very center (City of Vienna, 2022, p. 108).

One of the most significant steps in translating this philosophy into concrete policy has been Vienna's development of its own dedicated strategy for the use of AI in municipal services, making it a pioneer in Europe. This strategy clearly defines the ethical rules and transparency principles by which AI applications are to be developed and deployed, providing a framework for the responsible use of technology in the public domain (City of Vienna, 2022, p. 111). This initiative underscores how proactive and autonomous Vienna is as an actor in technology governance. Long before general regulations at the EU level reached maturity, the city established a local ethical framework rooted in its own priorities and in the philosophy of Digital Humanism, thus assuming a pioneering role. This serves as important evidence that, within a multi-level governance structure, a subnational actor can not only implement rules but also develop norms and standards according to its own values, influencing even supranational debates.

At the same time, Vienna's human-centered and sustainable smart city vision is realized through institutional innovation platforms such as the KICK Lab, established for this very purpose. Managed by the city's official smart city agency, Urban Innovation Vienna (UIV), this AI laboratory develops practical solutions for municipal departments using the methodology of human-centered design. This approach aims to ensure that technology is never an end in itself, but merely a tool serving the city's fundamental goals of quality of life and social equality. In this section, pioneering projects that stem from this strategic center or reflect this philosophy will be examined (Urban Innovation Vienna, n.d.). This institutional structure highlights the distinctive nature of Vienna's multi-level governance model. Unlike Amsterdam's multi-actor, market-driven "ecosystem" approach or Stockholm's "Quadruple Helix" partnerships led by major private-sector actors, innovation in Vienna is shaped predominantly through a public-led and more centralized structure.

These projects reveal that Vienna's approach to technology prioritizes different aspects compared to the other case studies. While the initiatives in Amsterdam and Stockholm tend to focus on system-level issues such as infrastructure efficiency (for instance, smart grids and traffic management), Vienna stands out with socially innovative projects that directly impact citizens' daily lives. However, this does not mean that the city works exclusively on human-centered projects; for example, the Aspern Smart City Research (ASCR) initiative serves as a large-scale pilot area testing smart grids, smart meters, and data-driven energy management solutions that optimize energy production and consumption under real urban conditions (ASCR, n.d.). At the same time, Vienna also develops innovative applications that integrate technical infrastructure with social participation. For instance, the Culture Token project incentivizes individuals to walk, cycle, or use public transportation instead of private vehicles by rewarding them with digital tokens that grant free access to cultural events such as museums and theatres (City of Vienna, 2022). Similarly, the Sag's Wien platform allows residents to directly report everyday problems to the municipality and monitor the resolution process (City of Vienna, 2022, p. 113). This diversity underscores Vienna's emphasis on the notion of "human-centered technology," while the official strategies of Amsterdam and Stockholm place greater emphasis on infrastructure efficiency and system integration.

Vienna's philosophy of human-centered technology manifests itself not only in citizen-oriented services but also in the transformation of the municipality's internal operations. The most recent example is the artificial intelligence-based virtual assistant "WienKI" (ViennaAI), developed for the city's 70,000 employees. Designed in response to challenges such as increasing service demand and an aging workforce, WienKI uses Large Language Models (LLMs) to provide employees with instant and accurate access to the municipality's vast knowledge base, including laws, decisions, and procedures. The project's most distinctive feature is that Vienna chose not to adopt this technology as an external "black box," but instead developed it internally to maintain full control over its own data. Full compliance with the EU AI Act and the consistent application of the "human in the loop" principle in all final decisions demonstrate the project's alignment with the philosophy of Digital Humanism (Red Hat, n.d.). This defining characteristic of the project serves as tangible evidence of Vienna's pursuit of strategic autonomy in technology and its public-led governance model. By building its own capacity rather than becoming dependent on global technology giants, the city demonstrates its determination, as a subnational actor, to maintain full control over its data and processes. This approach also illustrates how the EU's norm of "trustworthy and human-centered AI" can be internalized not merely as an externally imposed rule but as a locally generated and implemented principle.

Vienna's vision also materializes in projects aimed at enhancing the quality of life and safety of one of the city's most vulnerable groups: the elderly. A good example of this is fearless, an AI-based, contactless fall detection and prevention system developed by the Vienna-based company Cogvis. Using 3D sensors, the system analyzes movements within a room, proactively detecting not only actual falls but also situations that present a risk of falling, and alerts caregivers accordingly. The development process of this project serves as an instructive example of how Vienna's multi-layered innovation ecosystem functions. Initially launched as a research initiative funded by national grants, it evolved into an international project with EU funding and was piloted in Vienna under the leadership of the Smart City Vienna Agency (Smart City Wien, n.d.). This process clearly demonstrates how the multi-level governance model that forms the analytical framework of this thesis operates in Vienna. A project that began as a response to a local social need - the safety of the elderly - expanded through national funding, gained a supranational dimension through EU support, and was ultimately implemented by local agencies at the subnational level, illustrating how these three layers of governance can complement each other and translate into tangible social benefit.

CHAPTER THREE

FINDINGS AND DISCUSSION

This chapter presents and discusses the findings derived from the comparative analysis of Amsterdam, Stockholm, and Vienna, situating them within the conceptual framework established in Chapter Two. The case studies demonstrate that the European Union's (EU) digital and green transformation goals are implemented by cities not through a single standardized approach but rather adapted to distinct historical, social, and institutional contexts. All three cities employ AI as a tool for sustainability and interact with the EU's policy frameworks; however, they display marked diversity in terms of their governance logics, interpretations of technology, and implementation priorities.

This diversity primarily stems from the distinct ways in which multi-level governance mechanisms are established in each city.

- In Amsterdam, a horizontal, network-based ecosystem model stands out, characterized by collaboration among public, private, and civil society actors.
- Vienna adopts a more public-led and centrally coordinated approach.
- Stockholm presents a more balanced cooperation model situated between these two poles within the Quadruple Helix framework that integrates the public sector, industry, academia, and citizens.

Table 2 provides a comparative summary of how these distinct governance philosophies translate into different approaches to technology, success metrics, and inherent limitations.

Table 2. The Comparative Summary of Governance and Technology Approaches in Amsterdam, Stockholm, and Vienna

Dimension	Amsterdam	Stockholm	Vienna
Governance approach	Horizontal, network-based "ecosystem"	Hybrid, Quadruple Helix (public–industry–academia–citizens)	Public-led, centralized coordination

Table 2 (continued)

Dimension	Amsterdam	Stockholm	Vienna
Approach to technology	Experimental and adaptive; strong start-up ecosystem	Long-term planning and strategic infrastructure investment (e.g., Stokab)	Technology viewed as a tool; ethics and public control prioritized
Indicators of success	Innovative practices and international visibility	Systemic sustainability achievements	Quality of life and inclusive services
Key limitations	Risks of inequality and discrimination in social domains (Smart Check)	Limited depth of citizen participation (citizen roles sometimes remain superficial)	Challenges in digital inclusivity (e.g., accessibility issues with Culture Token)
Relationship with the EU	Aligned and learning-oriented; contributes to norm diffusion by sharing some applications (e.g., Public Eye)	Strong integration through EU funds and Lighthouse/Follower mechanisms	Aligned with EU goals but more ambitious in some areas (e.g., 2040 net-zero, "Digital Humanism")

Nevertheless, these models are not entirely distinct from one another. In all three cities, both network-based and public-led elements coexist to varying degrees; the differences primarily emerge in the relative emphasis of governance structures and the strategic orientation of priorities. Despite these variations, sustainability serves as the shared normative foundation across all three cases. In Amsterdam, sustainability is pursued through innovation and experimentation; in Stockholm, through long-term planning and systemic integration; and in Vienna, through ethical governance and inclusivity. Thus, even though their institutional structures differ, their shared goal of creating an urban transformation that is both socially and environmentally sustainable aligns these various models with the European Union's broader green and digital transition agenda.

These findings reveal that, even within a shared EU policy framework, cities follow different pathways in terms of governance structures and strategic priorities. Amsterdam's more open and experimental model generates rapid innovation but can produce challenging social outcomes. Stockholm's more structured model focuses on long-term sustainability gains, although citizen participation remains limited in practice. Vienna, while centering on quality of life, still faces areas for improvement such as digital inclusivity.

In conclusion, cities operating under a common EU framework develop context-specific strategies that reflect their historical and institutional settings, leading to different outcomes in terms of both achievements and challenges. This diversity provides a crucial analytical basis for addressing the research questions in the following section (3.1).

3.1. ANSWERS TO THE RESEARCH QUESTIONS

In this section, the research questions introduced in the first chapter are addressed in light of the findings derived from the case analyses of Amsterdam, Stockholm, and Vienna. The aim is to present a comprehensive understanding of the European Union's (EU) role in AI-driven sustainable urban transformation and the positioning of cities within this process.

– First sub-question — The EU's guiding role:

Findings indicate that the European Union employs three main policy instruments to steer AI-driven sustainable urban transformation. First, it acts as a norm diffusion actor by defining strategic visions such as the European Green Deal. Second, through financial instruments like Horizon Europe, it actively manages the multi-level governance structure by linking supranational objectives with local projects. Third, through regulatory frameworks such as the AI Act, it transforms ethical and democratic technology norms into legally binding standards.

– Second sub-question — Cities' governance models:

The case analyses of Amsterdam, Stockholm, and Vienna demonstrate that there is no single "correct" model; each city has developed its own multi-level governance arrangement shaped by its historical and institutional context. Amsterdam adopts a horizontal, network-type collaboration and ecosystem model; Stockholm displays a more structured Quadruple Helix framework based on cooperation between the public sector, industry, and academia; Vienna distinguishes itself with a public-led and centralized "human-centered" model.

– Third sub-question — The perspective of International Relations:

This process illustrates the materialization of the concepts of multi-level governance and policy learning found in the International Relations literature. The EU delineates a supranational framework, while cities interpret this framework according to their local dynamics and, in some cases (as in Vienna), even surpass it with more ambitious targets, becoming proactive norm entrepreneurs. The “Lighthouse/Follower City” mechanism of the GrowSmarter project and Amsterdam’s decision to make its Public Eye application open-source are concrete examples of institutionalized policy learning and city-led norm diffusion. Moreover, all three cities utilize their international brand identities (“most livable,” “greenest,” “most innovative”) as elements of soft power.

In summary, the main research question can be answered as follows: AI serves as a strategic instrument utilized by cities to achieve the European Union’s sustainability objectives, adapted to their unique historical, institutional, and social contexts. While the EU sets the overall direction through normative frameworks, financial support, and regulatory standards, cities reinterpret this framework according to their own priorities, develop local solutions, and, at times, influence the EU’s policy space upward by generating new ethical and governance norms. Consequently, smart cities are not merely sites of technical infrastructure implementation but active actors within a multilayered and dynamic international governance process.

3.2. LINKING THE FINDINGS TO THE CONCEPTUAL FRAMEWORK

The cases of Amsterdam, Stockholm, and Vienna analyzed in this study provide rich empirical ground for the International Relations theories presented in the conceptual framework. The findings support the validity of the theoretical tools employed, while also illustrating how these concepts evolve in the context of accelerated digitalization and urbanization in the 21st century.

First, the multi-level governance approach developed by Hooghe and Marks (2001, 2003) aligns with the findings of this research. The examined cities are influenced by the EU’s strategic visions, funding mechanisms, and legal regulations, yet they do not implement them uniformly. Amsterdam’s horizontal and network-type ecosystem model, Stockholm's Quadruple Helix structure bringing together public, industrial, academic, and civic actors, and Vienna's more centralized, public-led human-centered approach represent three distinct institutional forms of multi-level governance shaped by contextual factors.

Similarly, the concepts of policy learning and norm diffusion are visible within the empirical findings. The EU's "Lighthouse/Follower City" model and projects such as GrowSmarter provide institutionalized mechanisms for transferring successful practices among cities. However, cities are not merely passive recipients in this process. Amsterdam's decision to make the "Public Eye" project open-source exemplifies a bottom-up diffusion of norms related to ethical technology use. Likewise, Vienna's "Digital Humanism" approach and its more ambitious 2040 carbon-neutral target compared to the EU (Finnemore & Sikkink, 1998) illustrate the capacity of cities to project their values into international debates.

The findings also resonate with the critical literature. The concerns raised by Greenfield (2013) and Sadowski (2020) regarding data exploitation and digital inequality find a concrete counterpart in Amsterdam's Smart Check case. Similarly, Stockholm's limited citizen participation and Vienna's challenges in digital accessibility indicate that responsible AI principles alone may not suffice in practice.

Finally, the international agency of cities aligns with existing theoretical discussions. Nye's (2004) conceptualization of soft power is reflected in how Amsterdam, Stockholm, and Vienna deploy their innovative, green, and livable identities globally. This tendency also intersects with debates on urban diplomacy (Acuto, 2013). Thus, cities emerge not only as implementers of EU policies but also as actors capable of elevating their values and experiences to the global stage.

Overall, these findings support the validity of the theoretical framework employed in this study, while highlighting that the concepts of multi-level governance and norm diffusion operate as flexible and bidirectional dynamics within the EU–city relationship.

3.3. THEORETICAL IMPLICATIONS

This study presents several noteworthy theoretical implications for the discipline of IR and its related subfields. Firstly, the findings offer an alternative perspective to the dominant security-, competition-, and geopolitics-oriented approaches to AI in IR (e.g., Bode, 2024). The examined cases of Amsterdam, Stockholm, and Vienna demonstrate that AI can serve not only as a tool of strategic rivalry or threat production but also as an instrument for fostering multi-layered cooperation and norm creation in response to global challenges such as the climate crisis and sustainability. Thus, technology can be conceptualized not merely as an element of power struggle, but also as a component supporting common goals.

Secondly, the study contributes originally to the literature on multi-level governance. The framework developed by Hooghe and Marks (2001, 2003) has long emphasized the European Union's role in shaping local policies; however, the case analyses reveal that this process is not uniform and that three distinct governance archetypes emerge in different contexts. Amsterdam's horizontal and network-based ecosystem approach, Stockholm's structured yet multi-stakeholder Quadruple Helix model, and Vienna's state-led centralized structure all support the argument that multi-level governance should be conceived as a flexible and context-sensitive concept.

Thirdly, the study strengthens the literature concerning the international agency capacity of cities. Finnemore and Sikkink's (1998) conceptualization of norm entrepreneurship illustrates that cities are not merely passive implementers of EU regulations but can also elevate their own local values and priorities to higher governance levels. Amsterdam's open-source solutions regarding ethical technology use and Vienna's "Digital Humanism" approach are concrete examples of this process. Likewise, Nye's (2004) soft power framework provides a meaningful tool for understanding how cities employ their most livable, green, or innovative identities as sources of international attraction and diplomatic capital.

Lastly, the study introduces a critical dimension to the smart city literature. The risks of digital inequality and surveillance highlighted by authors such as Greenfield (2013) and Sadowski (2020) are not entirely eliminated, as illustrated by Amsterdam's Smart Check case. This finding indicates that while responsible AI frameworks are theoretically valuable, they retain practical limitations, and ethical capacity within multi-level governance must be continuously reproduced.

Overall, this study offers a twofold contribution to the literature on IR and urban studies: on the one hand, it highlights the growing role of cities in global governance within the context of AI and sustainability; on the other, it encourages a reconceptualization of the EU–city interaction as a multi-layered and flexible domain of norm production.

3.4. PRACTICAL AND POLICY IMPLICATIONS

The findings of this thesis present several practical lessons for policymakers aiming to achieve sustainable urban transformation. The three examined cases demonstrate that success depends not on a "one-size-fits-all" model but on the development of strategies tailored to each city's historical, social, and economic context. Within this framework, four key implications emerge:

1. Lay Strong Foundations: Strategic Infrastructure Investment.

Stockholm's public fiber network (Stokab), initiated in the 1990s, has become the backbone of the city's digital capacity and innovative solutions. Long-term, publicly guided infrastructure investments are a critical prerequisite for the success of subsequent smart city initiatives.

2. Work Together: Capacity of Collaborative Ecosystems.

Amsterdam's network-based ecosystem approach and Stockholm's Quadruple Helix model highlight the value of multi-stakeholder partnerships in tackling complex urban issues. However, as seen in the Smart Check and Royal Seaport examples, such collaborations must be supported by ethical and transparency frameworks and by robust public oversight mechanisms.

3. Ask "Why": The Primacy of a Human-Centered Philosophy.

Vienna's "Digital Humanism" approach underscores the importance of positioning technology not as an end in itself but as a means to enhance quality of life and inclusiveness. Cities that ask from the outset for whom and for what value they are investing in technology tend to produce more sustainable outcomes in terms of social acceptance and long-term impact.

4. Make Funding Processes More Accessible.

While EU programs such as Horizon Europe offer significant opportunities, their complex application procedures and access barriers can pose difficulties for smaller actors. This limitation may restrict cities' innovative capacity and generate structural risks such as "projectification," which will be discussed in greater detail in the next section (3.5). The key policy lesson here is that making funding processes more accessible and inclusive is critical to the widespread diffusion of sustainable urban transformation.

In conclusion, the effective use of AI for sustainability depends not only on selecting the right technology but also on building solid governance models, collaboration mechanisms, and philosophical foundations that bring those technologies to life.

3.5. A CRITICAL ASSESSMENT

The examined cases of Amsterdam, Stockholm, and Vienna present remarkable examples of the European Union's vision for AI-supported sustainability in practice. However, these successes coexist with structural tensions and unintended side effects. The critique can be structured around three key pillars:

– EU Funding and Governance Paradoxes

In theory, EU funds aim to balance "excellence" and "regional cohesion," yet in practice, they exhibit various constraints. For instance, Horizon Europe's application procedures remain complex and time-consuming; the time span between the closing of a call and the signing of a grant agreement has increased compared to Horizon 2020, reaching an average of 273 days, revealing the bureaucratic burden (Matthews, 2024). This complexity has fostered the growth of a self-sustaining "consultancy industry," with approximately 15% of Horizon funds channelled to intermediary companies managing application processes rather than producing innovative outputs (Fuest, Gros, Mengel, Presidente & Rujan, 2025). This not only generates administrative overload but also creates a distinct “project world” within the EU funding ecosystem. As conceptualized by Büttner and Leopold (2016), this “project world” develops its own jargon, specialized professions, and technical standards, which make access difficult for actors lacking the necessary knowledge, networks, or financial resources - thus producing exclusionary effects, particularly for small and independent innovators.

This dynamic can be explained through Merton’s (1968) “Matthew Effect”: once actors receive funding, their access to future funds becomes easier, and advantages accumulate cumulatively. A study of a large-scale grant program in the Netherlands, published in the Proceedings of the National Academy of Sciences (PNAS), showed that while project quality was nearly identical, those who won a grant subsequently attracted more than twice the funding of “near-winners” (Bol, de Vaan & van de Rijt, 2018). This pattern arises less from scientific superiority than from the status signal conferred by winning itself. Consequently, this “snowball effect” leads to the concentration of funds within specific institutions and regions, deepening regional inequalities. Indeed, the concentration of Horizon 2020 funds in Western and Northern Europe - regions with stronger R&D infrastructure - creates a structural paradox that undermines the EU’s Cohesion Policy objective of regional balance (Veugelers et al., 2015).

Moreover, most funds are distributed through short-term “project” mechanisms, and this trend, known in the literature as projectification, can constrain long-term strategic capacity (Büttner & Leopold, 2016). This pattern poses particular challenges for small and medium-sized cities with limited access to resources, creating barriers and exclusionary effects within the funding ecosystem.

- Ethical and Societal Risks

Although technology-oriented projects aim to be inclusive, in practice they may exclude certain groups. Amsterdam’s Smart Check initiative, despite being grounded in “responsible AI” principles, struggled to ensure fairness in social welfare decisions and was ultimately suspended (Guo, Geiger & Braun, 2025). This case demonstrates that even well-designed ethical frameworks may fail to provide sufficient safeguards in highly sensitive social domains. Similarly, Vienna’s innovative Culture Token application may exclude individuals without digital literacy or smartphones, while Stockholm's widely praised Quadruple Helix model has been criticized for positioning citizens primarily as "test users" (Gustavsson, Hallin & Dobers, 2023).

At a broader level, European cities remain heavily dependent on global technology providers, which partially contradicts the EU's strategic goal of achieving "digital sovereignty" and generates long-term vulnerabilities.

– Limitations of the Regulatory Framework

The EU's AI regulatory framework also struggles to comprehensively manage these risks. Although Article 5 of the AI Act aims to prohibit "unacceptable-risk" applications, the definition of "subliminal" or "manipulative" techniques remains ambiguous (Zhong, O'Neill & Hoffmann, 2024). Similarly, the EU's AI liability directives (PLD and AILD) focus on material damages, making them inadequate for addressing harms such as discrimination or privacy violations (Wachter, 2024). These gaps impose high compliance costs and potential innovation constraints, particularly for small developers (Nizza, 2025).

In conclusion, this critical framework does not invalidate the successes of Amsterdam, Stockholm, and Vienna; rather, it reveals that these successes have evolved amid complex interactions between EU funding structures, ethical and inclusivity challenges, and tensions surrounding digital sovereignty. Therefore, future strategies for both the EU and cities must focus not only on enhancing technological capacity but also on reducing governance, equity, and ethical risks.

3.6. LIMITATIONS OF THE RESEARCH

As with any scientific study, this thesis has certain limitations. These boundaries were deliberately set to ensure a focused and in-depth analysis and should be considered when interpreting the findings.

Firstly, this study is an International Relations thesis and was not conducted from an engineering or computer science perspective. Therefore, the technical infrastructure, algorithmic efficiency, or performance metrics of the examined AI applications were excluded from the scope; the focus remained on the policy and governance dimensions rather than the technical functioning of technologies.

Secondly, the research adopts a qualitative design and employs a multiple case study method focusing on three cities: Amsterdam, Stockholm, and Vienna. While this approach allows for deep contextual understanding, the findings are not intended to be statistically generalizable to all European cities or other geographies. The presented models and conclusions should be interpreted within the specific conditions of these three pioneering cases.

Thirdly, the thematic scope of the study was intentionally limited to the role of AI in the field of "sustainable energy and environment." Other domains of smart cities, such as mobility, health, and security, were referenced only partially and not analyzed in depth.

Lastly, although this study examines EU–city relations and multi-level governance mechanisms in detail, it does not cover inter-city networks and reciprocal policy learning processes. Yet mechanisms such as the EU's "Lighthouse/Follower cities" approach play a crucial role in the diffusion of innovation and norms. In this context, exploring how inter-city networks and mutual policy learning mechanisms (e.g., Eurocities or the "Lighthouse/Follower" models) contribute to the dissemination of innovation and norms could serve as a valuable extension of the analytical framework developed here. Investigating how these networks intersect with the EU's normative power and are translated into local strategies would enrich the smart city governance literature.

These limitations also open new horizons for future research. For instance, assessing the applicability of the governance models presented in this thesis to different geographical and political contexts (such as smart cities in Asia or North America) or examining the international policy dynamics of AI in other sectors such as healthcare could generate fruitful research questions. Likewise, exploring how structural tensions identified in Europe, such as funding inequalities and "projectification", manifest in more centralized or more liberal market-oriented systems could broaden the thesis's critical insights and provide a solid foundation for global comparative analyses.

CONCLUSION

This thesis has examined how the European Union's vision of AI-driven sustainable urban transformation materializes at the city level and how cities have become active agents in this process. As demonstrated through the empirical analyses of Amsterdam, Stockholm, and Vienna, the role of AI in sustainability is not defined by a single, uniform model; rather, each city has developed its own distinctive multi-level governance mechanisms according to its historical and institutional context. Nevertheless, all three cities engage with the EU's normative framework, funding mechanisms, and regulatory instruments to utilize AI as a strategic tool serving sustainability goals.

The study contributes to the international relations literature by introducing the urban scale into debates on AI and sustainability, which are often interpreted through a state-centric lens. It demonstrates that cities are not merely passive implementers of EU policies but are instead capable of producing norms, developing ethical frameworks, and shaping global discussions. In doing so, the concepts of multi-level governance and norm diffusion become tangible and comparable within the context of AI and sustainable cities.

The findings reveal that a "one-size-fits-all" approach is insufficient for policymakers; successful transformation requires governance designs that are sensitive to local contexts and supported by robust ethical frameworks. At the EU level, the research underscores the importance of investing not only in technological capacity but also in inclusivity, equity, and digital sovereignty.

However, the research also shows that the EU-led approach is not without challenges. As discussed in the analysis, both the structural paradoxes within EU funding mechanisms and the field-level tests of social inclusion and fairness represent areas that must be carefully managed to ensure the long-term success of this transformation. These observations do not invalidate the examined approaches; rather, they provide valuable insights for building a more balanced and inclusive digital future.

In conclusion, this thesis develops a holistic academic and practical understanding of the relationship between AI and sustainable urban transformation in

Europe and confirms that cities are emerging on the global governance stage not merely as implementers but as influential actors shaping the direction of change.

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