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Cities of the Future How Green Infrastructure Shapes Urban Living

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Abstract. *The continuous dispute among green solutions that create a green future and solutions that have negative environmental repercussions will shape modern society's future. Urban agglomerations contain a large portion of Europe's population. Over 70% of the world's emissions come from cities, primarily from transportation, building development, and maintenance. Rapid urbanization is expected to add almost 1.2 billion people to cities in Asia by 2050, as well as other continents in more developed regions like Europe and Africa, according to the World Economic Forum. Particularly in places where infrastructure and people have not established a sustainable framework, the effects of climate change are becoming more noticeable. In this article, we will show the greatest models for smart cities and urban sustainability. These solutions, which function well in specific areas, can serve as a model for the construction of new smart cities for smart cities and urban sustainability through comparative analysis. These solutions, which function well in specific areas, can serve as a model for the construction of new smart cities. The comparison analysis reveals significant distinctions in structures, urban regulations, and cooperation for carrying out sustainable projects. Some solutions may serve as models for other regions, disregarding the continent.*

Keywords: environmental, climate change, sustainability, infrastructure green, urban, smart city.

Introduction

In the face of climate change and the political and social changes that have become standard practice in today's world, the smart city concept has emerged as a response. At the European level, the term known as smart city is growing that perfectly captures the idea of a sustainable future. Future cities must be directed by the smart city concept, which defines it as a location where traditional networks and services are changed into digitized and rapid solutions to satisfy new demands. An efficient city's major aims are smart urban transportation, improved water supply, decreased emissions, a sustainable waste stream and overall energy efficiency. However, the European model was simply the pioneer of this notion. There are additional good examples of smart towns in Asia and North America.

The global population transition from rural to urban areas coincided with the rise of smart cities in the previous century. Public policies that prioritize a prosperous economy have been a

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major factor in the rapid growth of the urbanization phenomenon. Seventy years later, fifty-seven percent of the world's population is concentrated in small or major cities, compared to thirty percent in 1950. North America (the United States and Canada) and Europe (Norway, Great Britain, France, Germany, etc.) are the continents with the highest levels of urbanization. Mega-cities, which may be examined in terms of population and urban agglomeration, are a new term that has emerged on a global scale since 1970. Tokyo and New York were the first two cities of this type. Los Angeles, Mexico City, Lima, London, Paris, Cairo, New Delhi, Mumbai, Calcutta, Lahore, Beijing, Shanghai, Shenzhen, Seoul, Jakarta, Manilla, Osaka, Bangalore, and so on are among the 38 mega-cities that arose by the year 2021 against the backdrop of cultural evolution. (OSINT, 2021)

The city of Singapore is a guideline of best practice in the area of green transition, having even developed a program to follow called Singapore Smart Nation. This curriculum focuses on the strong relationship between public policy and technological transformation. Over the last twenty years, Singapore has implemented innovative technologies in the urban environment, including artificial intelligence and communications based on mass data analytics. Smart city governance is a critical component of development that prioritizes in progress digitization and social-economic reliability. Singapore's Smart Nation Core Strategy integrates a design-build approach with practical solutions to achieve environmental and infrastructure policy objectives. This plan promotes the notion of Digital Society, which stands for increasing and strengthening access to the digitization area with the objective of inclusion, fostering digital literacy, and raising digital awareness (Sha, Taeihagh, 2024).

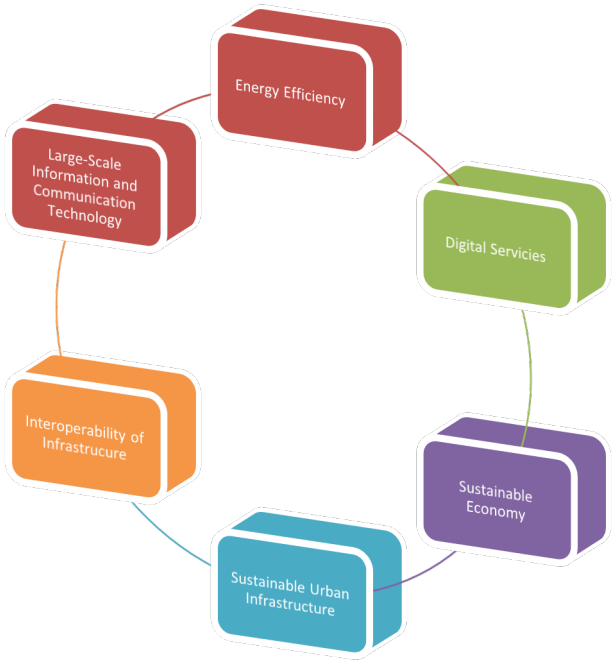

Figure 1. Development Pillars of a Smart City

Source: adapted after OSINT, 2021 (SRI, https://www.sri.ro/assets/files/publicatii/12_Smart_City.pdf).

According to the European Economic and Social Committee, a city can become a smart city by following the fundamental pillars shown in Figure 1. Large-scale information and communication technology, or mass digitization for a deeper connection with national and international networks, is the first pillar. Another important factor is energy efficiency, particularly in light of climate change. Strict guidelines based on the DNSH Principle are now required for every new construction, particularly in Europe. One environmental requirement in the recovery and resilience mechanism enforced at the EU level starting in 2020 is the adoption of the do no significant harm principle. In a digital age that depends heavily on digital services of all types, digital services play a significant role in a city's development process. Since it encapsulates the necessity of a precise circuit of the elements that occur in the urban environment, the sustainable economy is a fundamental component of any city or settlement's future. These models must encourage investment at the economic level. Connected transportation networks are the foundation of sustainable urban infrastructure. The concept of sustainability serves as the foundation for several ideas that are related to economic growth and sustainability. Since infrastructure is a key component in the development of a smart city, a city's industry is primarily linked to it. The idea and infrastructure interoperability are closely related since a 21st-century city's standard is safety based on the interaction of services in the most efficient framework (www.sri.ro, 2021).

Sustainability, a phrase that is mostly employed in the post-transition to nature era, is the foundation of the shift to a green metropolis. In 1713, the German forestry specialist Hans Carl von Carlowitz wrote a paper that introduced the term sustainability as a distinct idea. Even though the term "sustainable forest resources" was first used, it has since gained a lot of controversy, particularly when discussing the exploitation of natural resources for the purpose of boosting economic growth and quality of life. Sustainable development is a concept that touches on three important aspects: ecology, economy, and society. It wasn't until 1987 that the Brundtland Report issued a definition that was nearly identical to the term's present meaning. There are applications for the concept of sustainability in all significant reference areas. When a city's networks are interconnected and its core is strong, it can become sustainable (Prateeppornnarong, 2025).

In smart cities that are moving toward a complete green transformation, technology is the engine of sustainability. IoT and AI play a major role in the process of simplifying important components using smart sensors, which are mostly used to monitor waste, energy use, and the quality of the air and water. In big cities, the green transition is achieved by increasing the amount of green space in the form of horizontal green spaces, urban parks, green roofs, or green facades with the goal of lessening the terminal island effect. For underdeveloped nations, finding green transportation solutions has proven particularly difficult. These include electric vehicle charging facilities and the promotion of environmentally friendly urban mobility via electric bicycles and scooters.

The sustainable use of the resources required for the cogent development of cities is under tremendous strain due to the alarming increase in the urban population and the depletion of natural resources. Local governments face tremendous challenges in this context as they attempt to prevent malfunctions and ensure sustainable urban development for a clean future while simultaneously maintaining a high level of performance in the ongoing provision of public services, such as drinking water supply, electricity supply, urban transportation, and waste management of all kinds. A city's technological future can benefit from this well-established ecosystem, which is built on interdependent linksbetween the administration and service areas (Samasti, Cakmak, Ozpinar, 2025).

In conclusion, the robust growth of smart cities is centered on building energy efficiency, sustainability in the circular economy, and digitization in key areas, all of which are intended to enhance the quality of urban life. While green transportation and sustainable infrastructure, particularly in crowded regions, are crucial to the shift to an environmentally friendly climate, the deployment of IoT and AI technologies brings about the proper increase in resource monitoring and optimization. To maintain a balanced environment between economic development, environmental protection, and the social well-being of citizens, local and national governments face significant challenges due to urban population growth, the migration from village to city, and the depletion of natural resources, which has turned into an international security issue. Thus, cooperation among individuals, businesses, and the government is becoming crucial to creating a sustainable urban future. To be able to present all the desired elements we used a comparative analysis that can be used as a model for the construction of new smart cities for smart cities and urban sustainability.

Literature review

Europe's smart cities

When it comes to smart cities and sustainable development laws, Europe is the world leader. With the ultimate goal of making their cities the greenest possible for their residents, the great majority of large cities have embraced cutting-edge technologies and creative activities centered on enhancing urban living. Even the tiniest things, such daily living, infrastructure, and lifestyle, might reveal a sustainable oral. This significant development for European cities is mostly due to IoT solutions. The high-speed internet, which provides a framework for digitization and widespread accessibility, is another crucial component of this evolutionary process.

Forty European cities that follow the smart city pattern are depicted in Figure 2. Although the fundamentals of sustainability-based policies are strong, they vary from city to city. The nations highlighted in red can be categorized as medium-sized European cities with a high standard of living and a tendency toward intelligent development. The red-colored cities on the map below can be viewed as global metropolises with sophisticated technological and development strategies founded on an appropriate balance between industry and the environment. Cities are categorized as metropolises that have achieved performance in terms of emerging intelligence in the final classification, which is the green one. A society built on a proper sustainability circuit serves as the backdrop for the significant progress we see in Central and Northern Europe. Because of less rapid development brought about by various leadership-level policies, we see a modest presence of development in the Eastern European region. The fact that some nations, like Romania, Bulgaria, or Croatia, do not even have a single smart city illustrates the necessity this article supports, which states that models are required for the development of new smart cities (Cantuarias-Villessuzanne, Weigel, Blain, 2020).

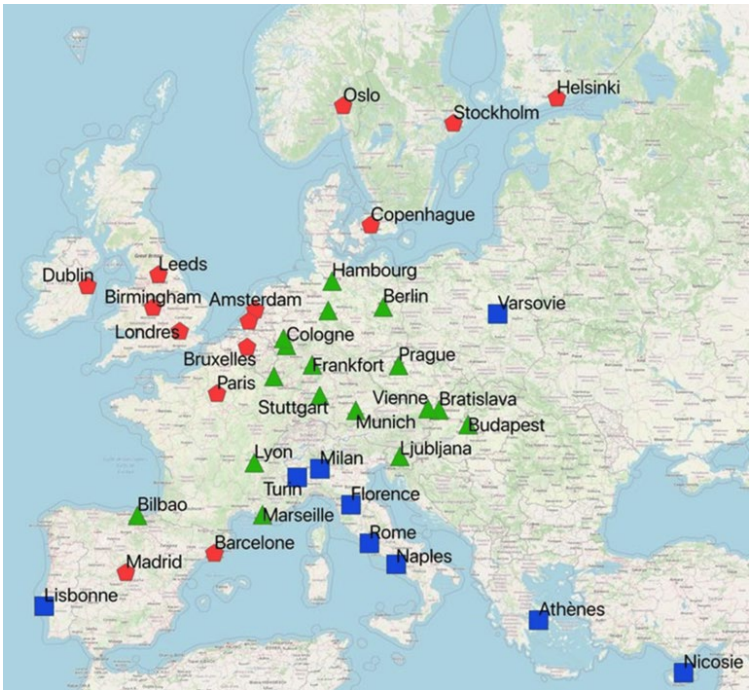

Figure 2. Smart cities

Source: Cantuarias-Villessuzanne, Weigel, Blain, 2020.

The key elements of a smart city that all emerging cities should focus on are illustrated in Figure 3. IoT sensors, connection, and data are the three main technology pillars upon which smart city concepts are built. Data is the act of storing, evaluating, and displaying current and past information. Sensors are networked appliances that collect and supply networked information. Connectivity is offered through fixed or wireless networks. Cities gain a strong platform that facilitates the creation of creative solutions to raise the typical cost of living in urban areas by combining all of these elements.

A further important field is smart building automation, where devices make sure lights are turned off in empty rooms and automatically adjust heating and ventilation based on occupancy, all of which help save energy. To help law enforcement and emergency response teams respond to occurrences and situations quickly and effectively, smart public safety systems additionally incorporate the use of sensors and connected cameras. Intelligent cities are becoming safer, more effective, and more ecologically friendly because to these new developments, which significantly raises the standard of living to feed their citizens (Andrea Sorri, 2024).

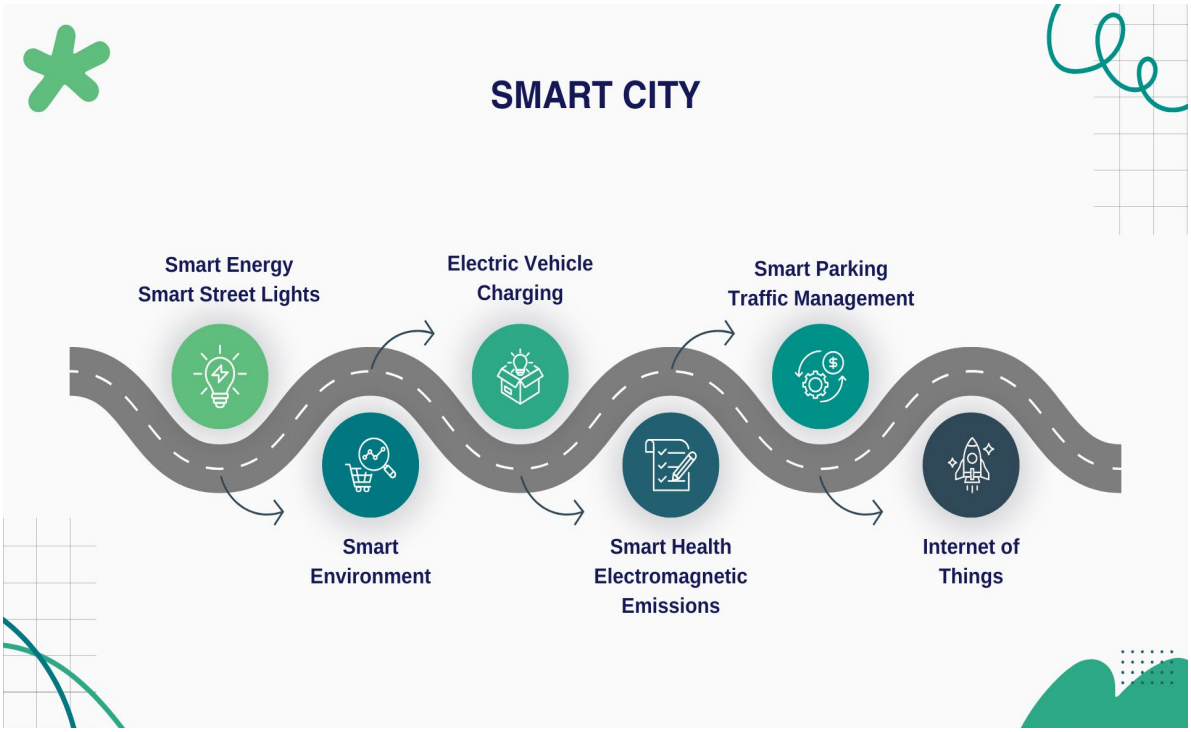

Figure 3. Smart city components

Source: On creation in Canva (https://www.canva.com/).

Because of its continuous dedication to sustainability and green technology innovation, Copenhagen, the capital of Denmark, has been recognized as one of Europe's finest cities by people all over the world. In order to reach near-zero CO_2 emissions by 20250, the city is implementing an aggressive plan to cut CO_2 emissions. Copenhagen is putting several creative projects into action in order to realize its short and medium-term objectives and continue to be a global phenomenon. Project Air View, one of the initiatives created in partnership with Google and the AI field, determines air pollution at the local level and offers information to fight pollution of all types.

The Signature Ai Project maximizes energy use in buildings for the public, cutting CO_2 emissions considerably. The Rapid project is working on digitization-based solutions for regulating public places during health or social emergencies, such as the COVID-19 pandemic, and has created a 3D model of Copenhagen Central Station. The Street Lab is where the city tests alternatives to cut CO2 emissions, operational costs, and improve ground-level maintenance services. The Danish Outdoor Lighting Lab (DOLL) is additionally concentrating on sophisticated green street lighting systems and sensors to reduce energy consumption based on traffic and promote citizen safety, particularly in issue or inadequate geographical areas (Emilie Bramly, 2024).

Asia's smart cities

Asia is a surprising region for a variety of reasons, including the world's largest metropolitan agglomerations and the world's two most populous countries, China and India. This area has experienced significant political and social upheavals, but it has recently emerged as a role model on a number of monetary fronts. Various geographies face challenges in the twenty-first century,

but Asia has managed to cope. Positive examples include Japan, Singapore, and South Korea, which started to evolve from industrial to smart cities in the 2000s. While we face several special problems in this field, such as major urban congestion, sanitation in India and Indonesia in particular, pollution, catastrophe resilience, and, of naturally, climate change. We are seeing exceptional performance, particularly in East Asia, where high-speed infrastructure and resilience to catastrophic earthquakes are emerging for the first time. The 2011 Fukushima nuclear tragedy presented Japan with an unprecedented disaster resilience challenge. Following this catastrophe, Japan implemented Society 5.0, a policy aimed at halting nuclear energy development to the greatest extent possible. The administration, led by the revered Prime Minister Abe, has defined a robust research agenda for the creation of smart cities (Sanada, Zappa, 2025).

Methodology

To be as scientifically based as possible, the findings presented in this article were obtained through a comparative examination of smart cities in Europe and Asia. Data and texts from academic and online sources were checked for correctness. The academic field, combined with specialist websites, provided a critical framework to comprehending and constructing the most precise terms. Specialists in the sector created the foundation for this intriguing social-economic-political story for nations in transition.

If academic sources were the primary sources, the second category would be represented by international and regional organizations with an agenda in the smart city field. In terms of comparisons, a special search was carried out in more than 200 papers published by journalists and scientists. We conducted a complex search utilizing terms such as sustainability, smart city, environment, Asia, and Europe on specialized platforms such as Google Scholar, ScienceDirect, and Web of Science. In this approach, selected information from multiple sources was given in depth in the Literature review, Results and Discussions, and Conclusion.

The credibility of the obtained information is based on a very accurate methodology for information selection. The selected data were evaluated and reported in accordance with the guidelines of this article, the desired purpose and the relevance to the topic. The conclusions reported in the following sections are the culmination of this rigorous research, providing a clear view on the crucial nature of smart city concepts for the world's future sustainability. The similarity between Europe and Asia can serve as a model for every city seeking to make this shift, regardless of its specifics.

To increase the article's credibility, we used data and information from the European Commission website, the Romanian Information Service website, the Romanian Government website on Sustainable Development, and articles in which authors focused on the subjects of smart cities.

Results and discussions

To accomplish the purpose of this article, we examined the variations between smart cities in Europe and Asia. We began with three criteria for gaining a clearer perspective: policy area, expenditure on infrastructure, and any type of collaboration.

Consequently, regardless of the country, public policies in Europe prioritize sticking to defined regulations. The capacity to organize varies according to the dynamo of the country being referred to. Muchen, Barcelona, and Milan are three realistic examples of investments in road infrastructure, as well as public-private collaborations. The decisions for moving to an intelligent

city have been made together with citizens and non-governmental organizations. Before the initiation of sustainable initiatives, we may see a specific subtlety in the feedback Europe area. Political continuity at the local level is crucial to emphasize; for example, administrations are unstable, and politics might be left, center, or right. With environmental sustainability as a common backdrop, urban governance in the European region is focused on a direct respect for human capital and aims to improve the productivity of urban operations, enhance the standards of life for citizens, and boost the local economy (Gasco-Hernandez, Nasi, Cucciniello, Hiedemann, 2022).

There is a distinct trend regarding smart mobility in Central and Northern Europe, particularly in conglomerated cities, thanks to CCTV, sensors, and connected devices such as those to intelligent transportation systems (STS), other smart automobiles, and road infrastructure. Intelligent transportation systems (STS) are the primary interface that smart autos in intelligent towns interact with. These systems track vehicle movements in real time using communications and information technology. A key component of intelligent cities is storage, particularly given the ongoing challenges they face. The race to become the smartest city is led by Zurich, Switzerland, as of 2023. Oslo, Norway, Canberra, Australia, Copenhagen, Denmark, and Lausanne, Switzerland are next in line. Is evident that Asia is concentrating on additional facets of intelligent cities (Kidmose, 2025).

One intriguing aspect of the concept of transparency at the level of legislation is that, with regard to each smart city initiative, we can see a strategy that is based on ongoing feedback prior to publication. Tel Aviv's approach is unavailable from Europe, while Beijing's strategy cannot be translated into English. One of the characteristics that was looked at in order to find any reoccurring trends or define key terms among the titles included the strategy's title. This allows us to observe how the policy affects urban mobility at the highest degree (Lnenicka, Hervert, Horak, 2024).

The distinctions across the European and Asian perspectives on the creation of smart cities are shown in Table 1. European cities prioritize decentralized and participative solutions, emphasizing democracy and public-private partnerships. Massive building projects can be implemented quickly in China under authoritarian administrations, which can spur innovation but also reduce participation from the public.

Green infrastructure is frequently incorporated into already-constructed cities through the use of strategies like vertical vegetable gardens, green corridors, and sustainable transportation, as evidenced by the movement towards historic heritage preservation (e.g., Barcelona). With smart power systems, cutting-edge electric transportation, and entirely new cities, the focus on high-tech infrastructure and government megaprojects (like Shanghai) suggests a more industrialized approach to green infrastructure. With an emphasis on resource efficiency and lowering carbon emissions, europe is creating shared transportation possibilities (such as bikes and car-sharing). Despite the high infrastructure costs, Asia is investing in high-speed rail networks, which provide quick and efficient in terms of energy lengthy transit options.

Table 1. Parallel between smart cities in Europe and Asia

Europe	Asia
Democratic governments	Totalitarian or more control-oriented governments
Historic preservation (Barcelona, Paris)	High-tech infrastructure (Shanghai, Tokyo)
Shared mobility solutions	High-speed rail networks (train)
Public-private partnerships	Government-led mega-projects

As nations look to cut greenhouse gas emissions, maximize resource use, and implement sustainable solutions, maximizing energy efficiency has emerged as a major global goal. Europe and Asia have adopted distinct approaches to increase energy efficiency. With stringent energy efficiency regulations enforced by the European Union and global green groups, Europe shines forth. As a continent with both industrialized and growing economies, Asia approaches energy efficiency differently. Asia's economy is expanding quickly, which means it needs a lot of energy. Despite the emphasis on energy efficiency, several nations, including Indonesia and India, still rely on coal to meet their energy needs. The report emphasizes the need of incorporating future technologies like IoT and AI to monitor and optimize resources. This study adds value by linking sustainability plans to present urban infrastructure demands, as well as emphasizing transit-related issues and opportunities. IoT sensors, connectivity, and data management are all essential components of a smart city. These aspects make it easier to design creative solutions for lowering living costs, optimizing energy use, and improving urban public safety through surveillance and prompt response.

In conclusion, the comparison of smart cities in Europe and Asia reveals significant distinctions in structures, urban regulations, and cooperation in carrying out sustainable projects. Europe has a participatory and decentralized strategy, focusing on environmental compliance, public-private partnerships, and citizen ownership. Asia, on the other hand, prefers ambitious initiatives supported by powerful governments, with significant expenditures made on cutting-edge transportation and high-tech systems.

Conclusion

Researchers have found significant discrepancies in structures, rules, and teamwork in executing sustainable projects by comparing smart cities in Europe and Asia. Europe advocates a decentralized model based on public-private partnerships and citizen participation, whereas Asia supports ambitious projects supported by powerful governments and investments in high-tech infrastructure. These diverse models can guide communities looking to transition to a smarter, more sustainable urban future.

Depending on the economic, political, and artistic assets available to them, different regions and regions execute the smart city concept differently. By incorporating stringent environmental and smart urbanism regulations based on EU regulations, initiatives in Europe primarily concentrate on sustainable development, digitization, and lowering the carbon footprint. Several nations, including Germany, Spain, Norway, the Netherlands, and Denmark, established successful and best practice models based on electric public transport, modern, green infrastructure, and the effective use of data to enhance urban services for people.

Asia, on the other hand, is notable for its rapid rate of technological invention and adaption. In order to make municipalities safer and more productive, nations like Singapore, South Korea, and Japan have made significant investments in automated traffic management systems, artificial intelligence, and the Internet of Things (IoT). Asia is placing a bet on the quick advancement of technology and its incorporation into daily life, whereas Europe places a higher priority on conservation and regulations. The active participation of individuals, the government, and the commercial sector is just as important to the success of a smart city as technology. In order for citizens to fully benefit from a connected and smart city, a sustainable urban environment need ongoing investment in contemporary infrastructure, efficient governmental policies, and digital literacy.

In conclusion, the acceptance of creative and workable solutions that blend technological efficiency with a deep regard for the natural environment and the social requirements of the world's population is frequently critical to the future of sustainable urbanization. The objective is always the same, whether we are discussing Europe, Africa, America, or Asia: to build safer, more environmentally conscious, and more effective cities that will be able to offer a better standard of living to coming generations. This study identifies optimal models in Europe/ Asia for smart cities and sustainable cities, giving a best practice framework for governments looking to make the transition to a digital and ecologically friendly urban environment.

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