A REVIEW OF SMART CITIES' TECHNOLOGIES IN THE GOVERNANCE AND THE EVERYDAY LIFE OF CITIZENS IN GREEK CITIES

DOI: 10.26341/issn.2241-4010-2025-12a-9-K02079

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1. Introduction

Increasing urbanization, which is considered a hallmark of the 21st century, as research show that the human population is expected to grow by an additional two billion by 2050, thus reaching 10 billion people, with more than 70% of the world's population choosing to live in predominantly urban environments(Papa, Galdesi, & Angiello, 2022). As a result, these excessive concentrations in the world's major cities undoubtedly and significantly raise new issues that need to be addressed immediately, with the parallel penetration of ever-evolving technological development into the daily lives of citizens worldwide now constituting a fundamental method of resolution.

Specifically, with the ultimate goal of improving citizens' living conditions, sustainable economic development, and the proper and effective functioning of urban center's infrastructure and services, the 'construction' of smart cities, with the significant, if not absolute, contribution of technology, plays the most important role in achieving the above (European Commission, 2023; Ministry of Digital Governance, 2022).

Indeed, the 21st century could be described as the century of 'Smart Cities', with the global community taking action, utilizing mechanisms such as the Internet of Things for the optimal implementation and achievement of e-Government practices, Artificial Intelligence,

and big-data analytics techniques, with the aim of generally improving infrastructure, government functions, public consultation, and active citizen participation (Syed, Sosa, Kumar, & Elmaghraby, 2021). Greece is one of the few countries that faces and is expected to face, to an acute degree, the issue of urbanization, particularly in larger urban centers such as Athens and Thessaloniki. Consequently, the country has moved to integrate smart technologies in order to address the complex issues caused by the mass concentration of population in urban centers, such as traffic congestion, environmental degradation, and the management of already extremely scarce resources (Myers, 2019; Ministry of Digital Governance, 2022).

The issue of 'creating' smart cities is not only a matter of expediency, but a necessity that must be implemented at the national level for the effective functioning of countries in general, through the achievement of decentralized interoperability. Thus, in this study, the concept of smart cities and their characteristics will be analyzed and interpreted , the implementation of these technological measures will be mentioned and explained through examples of cities in Greece, and last but not least, the trammels that the country and each municipality faces in implementing them will be mentioned and explained (Venkatachalam, 2020; European Commission, 2022).

2. Definition of Smart Cities

Although there is no internationally accepted definition of the term 'smart cities', numerous researchers and academics have proposed different terminologies. Specifically, according to Nelson, a smart city is an area with high potential for innovation based on the creativity of its residents, their capacity for cognitive development, and the digital infrastructure for communication and knowledge management (Nelson, Toth, Linders, Nguyen, & Rhee, 2019). Kulkarni also interprets a smart city as a local entity (a city, a region) where a holistic approach is needed for the use of information technologies, with real-time analysis, for the dynamic development of a sustainable economic model (Papa, Galderisi, & Angiello, 2022). On the other hand, according to Hammons, a smart city is an urban center that uses and exploits both technological and non-technological means and services that improve the individual's life on a moral, economic, and social level. These smart tools also offer quality, efficiency, and interoperability of public services to reduce costs, manage resources effectively, and improve public consultation (Hammons & Myers, 2019; Ministry of Digital Governance, 2022).

Furthermore, the European Commission states that in smart cities, the digitalization of traditional networks and service methods is a fundamental way of meeting the needs of residents and businesses, while also promoting the use of smart tools and technology as a means of optimizing resource management and reducing emissions (European Commission, 2023). Furthermore, according to the Commission, the integration of these smart functions fills the gaps in public services to strengthen city administration, security, and the prosperity of citizens (European Commission, 2022).

Finally, as can be understood, there are many interpretations of the term, each with a different 'center of gravity', as each interpretation focuses on one parameter more (city, technology, citizens, community), intending to establish the corresponding terminology. Of course, if a common denominator could be extracted from numerous interpretations, it could be the efficient use of available smart tools with the ultimate goal of addressing and eliminating the complex issues created by urbanization and the ever-growing population to establish a sustainable, well-living environment for the residents (Venkatachalam, 2020; Ministry of Digital Governance, 2022).

3. Features of Smart Cities

As highlighted in the theoretical background of the interception of the term "Smart City", the latter consists of a series of specific characteristics that enable its implementation. Specifically, sustainability, accessibility, quality of life, and intelligence are the four fundamental parameters for building a smart city (Papa, Galderisi, & Angiello, 2022; European Commission, 2023).

It is indisputable that today's cities must fully comply with the criteria of sustainability, as the latter is inextricably linked to energy, climate change, ecosystems, and infrastructure. The transition to a smart city is therefore based on energy efficiency, energy supply through renewable energy sources, and protection of the natural environment (European Commission, 2022; Ministry of Digital Governance, 2022). In addition, the parameters of economic affordability and quality of life for citizens are two further fundamental parameters for the 'construction' of smart cities, as the use and exploitation of technological tools for optimal administrative operation, transportation, education, and health optimizes the efficiency of municipal operations, thus bringing significant economic benefits to residents while also improving their quality of life (Venkatachalam, 2020; Hammons & Myers, 2019).

Consequently, the application of smart economy techniques is directly related to the competitiveness of a city's economy, i.e., its importance in both national and international markets, to innovation in general, and to the support of entrepreneurs for the integration of technological tools (Nelson, Toth, Linders, Nguyen, & Rhee, 2019). Furthermore, in the case of transport, smart applications specifically concern the use of tools and devices such as web applications, sensors, and data collection mechanisms, with the ultimate goal not of improving private and individual transportation, but of the public transportation system, building an accessible, environmentally friendly, and sustainable system (Xiong, Sheng, Rong & Cooper, 2012; Syed, Sosa, Kumar, & Elmaghraby, 2021; Ministry of Digital Governance, 2022).

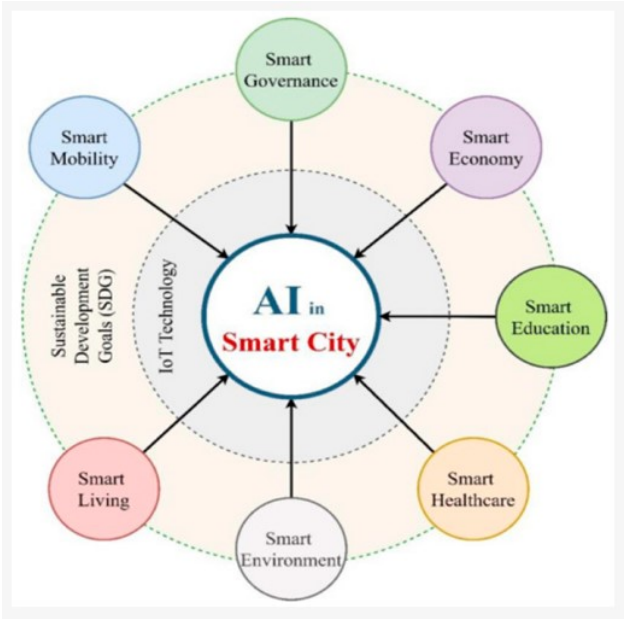

Figure 1 Applications and features of Smart Cities, here

Furthermore, in the areas of health and education, applications such as the digitization of already collected citizen data, in conjunction with the use of tools for analyzing and processing this data, as well as the creation of information and notification platforms for residents, specialists, and staff alike, offer enormous benefits, from faster and more efficient operation of hospital/educational administrations to the prediction of epidemics or the provision of educational material and training for all interested citizens (Hammons & Myers, 2019; European Commission,2023; Ministry of Digital Governance, 2022).

4. The integration of smart technologies

As explained in the previous chapter, in order to create smart cities, it is necessary to combine a number of characteristics. The implementation of these characteristics naturally requires the

integration of appropriate media technologies and smart tools. One of the most important of these in the Internet of Things, which enables municipal authorities to collect and store data, execute commands, transmit messages, and store them. The Internet of Things is essentially a set of networks, an ecosystem of smart sensors, tracking devices, and artificial intelligence components (Syed, Sosa, Kumar, & Elmaghraby, 2021; Joshi, 2022). More specifically, this ecosystem ensures the effective operation of all responsibilities, people and devices by identifying them.

It also integrates methods of cooperation between different systems and technologies, controlling the execution of their functions and the recording of the physical data they receive. Finally, it controls the effective operation and connection of all technologies that have been integrated into it. Consequently, the Internet of Things, through tools such as sensors and recording mechanisms, provides real-time data, so that public authorities, local businesses, enabling them to prepare accordingly and anticipate any challenges (Libelium, n.d.; Ministry of Digital Governance, 2022; COSMOTE 2023).

Another extremely important addition to the smart city sector is the creation and use of e-government online platforms. These platforms enable citizens to have direct access to public services, without the hassle of administrative procedures, thereby reducing the extremely large bureaucratic backlog, particularly in the case of Greece (City of Athens e-Services Platform, n.d.; Ministry of Digital Governance, 2022). Through these platforms, citizens can apply for services, submit documents, and make any payments digitally.

In addition, other platforms have been designed for different purposes and reasons, such as the direct participation of citizens in the leadership and administration of the municipality. More specifically, new applications enable citizens to record and report any delays, violations, deficiencies, or physical damage to infrastructure, thus gaining the ability to participate directly in consultations (Venkatachalam, 2020; European Commission, 2023; Ministry of Digital Governance, 2022).

5. Smart Cities in Greece

The adoption and implementation of measures for the design of smart cities in Greece is not carried out at a universal level by the state, but is left to the discretion and desire of the respective municipal authority. Some municipal authorities, therefore, both on their own initiative and through a European Commission evaluation process, to select 100 cities that will seek to become climate-neutral and smart by 2030, are taking steps to implement methods to become smart cities (European Commission, 2022; Ministry of Digital Governance, 2022). This study will analyze six major cities in Greece that have implemented a significant portion of the measures and practices for creating a smart environment. These are Trikala, Athens, Chania, Ioannina, Astypalaia, and Heraklion.

The case of Trikala

Trikala is a city that has made significant progress in implementing smart technologies in public administration and services, and is the first smart city in Greece (The Guardian, 2018; Ministry of Digital Governance, 2022). Specifically, the city has implemented a smart system to improve traffic and parking, as well as an autonomous bus service, thereby enhancing sustainable mobility and accessibility (PE4Trans, 2021; URBACT, 2022). It has also developed an online platform that offers remote medical services. Finally, the development of new strategies, such as Restart mAI City, is the next step in the evolution of municipalities in terms of digital transition (Trikala – Intelligent Cities Challenge, n.d.; Ministry of Digital Governance, 2022).

The case of Athens

As the country's capital, Athens has so far accepted the largest part of the Greek population, which has concentrated within its borders. As a result, the excessive concentration in this large urban center has led to a series of complex and labyrinthine issues, which are quite difficult to address. Traffic is one of the most important issues in the expanded urban environment of the metropolis. A traffic management program using artificial intelligence has been developed, providing real-time data and contributing to the optimization of urban mobility (AI Tech Daily, 2024). However, it is worth noting that Athens ranks among the lowest in the list of European smart cities, which demonstrates the need for further action (European Commission,2023).

The case of Ioannina

The Municipality of Ioannina, having been selected by the European Commission to participate in the European Mission for 100 climate-neutral cities by 2030, has proceeded to adopt and implement some fairly significant initiatives for the transition to a smart city, such as waste management, using Internet of Things sensors (SmartCity.gr, 2022, Joshi,2022).

It also participates in the European POCITYF program, which aims to fully integrate renewable energy sources and electric vehicle infrastructure (European Commission 2022). Moreover, the municipality has developed a Smart Urban Mobility Platform to optimize transportation and ameliorate citizens' accessibility (Municipality of Ioannina Smart Mobility Platform, 2023).

The case of Chania

The city of Chania has adopted and implemented a series of highly innovative and intelligent functions, even managing to take first place in Greece's list of smartest cities in 2022 (Parakritika, 2022; Ministry of Digital Governance,2022). Specifically, the Municipality has adopted and implemented smart policies and platforms that fully address the daily needs of citizens. The use of sensors and counting mechanisms, with the help of artificial intelligence, has reshaped the traffic system, optimizing the daily commute of citizens as well as the sustainability of the traffic system and its environmental footprint (Syed, Sosa, Kumar, & Elmaghraby, 2021; COSMOTE, 2023).

Furthermore, by integrating the Internet of Things, the city has created a network ecosystem that generously provides real-time data, supporting and optimizing services such as smart parking, traffic recording, smart lighting functions, waste bin recording, and proper energy source management (Smart City Applications-Municipality of Chania, 2023; Papa, Galderisi,& Angiello, 2022).

The case of Astypalaia

A highly effective programme, Astypalaia-Smart and Sustainable Island, has been implemented in Astypalaia, as evidenced by its impact over the last two years (Ministry of Digital Governance, 2022). Specifically, the program utilizes a range of technological tools that have proven effective in promoting ecological mobility and the proper management of energy resources. By creating an ecosystem of smart and environmentally friendly transport policies through services such as 'ASTYBUS'.

Through the implementation of pioneering and technologically advanced practices, such as ASTYBUS, residents were allowed to use electric public transport, expressing almost complete satisfaction when using the astiMOVE app (Ta Nea, 2023). This policy resulted in a reduction of 44.8 tons of carbon dioxide, demonstrating the optimal implementation of the program in terms of its environmental footprint (AI Tech Daily, 2024).

The case of Heraklion

Heraklion has implemented a series of new technological practices, digitizing a large part of its bureaucratic procedures. By designing and providing citizens with user-friendly websites and applications, it has become possible to submit requests, documents, and fulfill payments to the municipality entirely remotely, thus significantly reducing the administrative burden (City of Athens e-Services Platform, n.d.; Ministry of Digital Governance, 2022). Furthermore, through these online portals, citizens can get informed about consultations with the authorities, new decisions, and even job openings. Finally, the municipality has also implemented digital tools in the cultural and tourism sectors, as it receives a large number of visitors every year. More specifically, it has designed applications to inform tourists about cultural and other activities, as well as electronic information points for citizens about monuments and archaeological sites (Municipality of Heraklion – Smart City Vision, 2023; Ethnos, 2023).

6. Discussions – The trammels

Although the initiatives of the municipalities and their applications are extremely important, providing a truly improved, technologically advanced and environmentally friendly transition model, there are many challenges and obstacles that significantly delay their operation and implementation.

Specifically, one of the most important issues is extremely limited funding availability. Even though the Digital Change programme offers funding ranging from 210.000 to 2.770.000, these amounts, as practice has shown so far, are not sufficient for the holistic implementation of smart city practices (Balis, 2024).

In addition, there is a significant gap in the training and expertise of both municipal employees and citizens, which creates significant impediments to the effective management and interoperability of these smart tools. This obstacle highlights an even more important issue, that of socio-economic inequalities. Indeed, there are many citizens who do not have access to technological means. This creates a serious social issue, that of digital inequality (Bairaktaris, 2023).

In addition, another obstacle is the absence of up-to-date and modern strategies for data protection and artificial intelligence management, which leads to a series of legal hassles and inefficiencies, as well as objections and protests from users (European Parliament, 2014). The fear of misuse of personal data or excessive surveillance undoubtedly undermines the confidence of residents and users in general in the policies of a smart city (Lymperopoulos, 2024).

Addressing all of the above obstacles and issues requires the adoption and implementation of a comprehensive and multi-level response plan, without any variations. An example of a response plan is a combination of targeted investments, administrative reviews focused on transparency and rights, as well as the strengthening of public-private partnerships.

7. Conclusion

Smart cities are gradually evolving from local initiatives to a national strategic priority, with the ultimate goal of improving citizens' quality of life and sustainable urban development.

Despite significant progress in municipalities such as Trikala, Chania, and Heraklion, overall implementation faces obstacles, mainly financial and administrative. Limited human resources and a lack of expertise in digital training continue to be decisive factors hindering a complete and holistic transition.

Furthermore, social inequalities, particularly the digital divide between citizens and advanced technological tools, highlight the need to adopt and implement inclusive policies and develop citizen education initiatives.

At the same time, data protection and transparency are fundamental and critical issues of trust, as technological progress cannot proceed without social acceptance and, therefore, legitimization. Strengthening public-private partnerships and collaboration, as well as making good use of European programs, are also key solutions for a comprehensive implementation of the technological tools that make up a smart city.

Consequently, the future course of action should be a combination and convergence of technological innovation and social sustainability, with the ultimate goal of effectively transforming Greek urban centers into smart, technologically advanced, and environmentally friendly urban organizations.

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