

Smart Cities, IoT, and e-Government: Applications in Greek Municipalities [†]

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Abstract: The smart city era has already begun and its societal and environmental implications in urban development are expected to be huge. In this context, Internet of Things (IoT) technologies have become the major path towards novel e-Government practices, to improve citizens' quality of life, increase the efficiency of infrastructure and services, promote sustainable economic growth, and integrate multiple city sectors, creating an interconnected and smart urban environment. This work offers an up-to-date survey of smart city definitions, their development framework, their characteristics, and their areas of application. Furthermore, it provides the current state of smart city applications in Greek municipalities and a proposed comparison among them, in terms of well-accepted key performance indicators, while it comments on their suitability in the context of e-Government and the challenges that must be faced regarding their efficient implementation.

Keywords: smart cities; Internet of Things; data-driven solutions



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1. Introduction

Nowadays, smart cities are gaining popularity worldwide to improve urban and economic development and environmental protection [1]. As technology's involvement in citizens' lives is increasing at a huge rate, the concept of smart cities is becoming more and more important and there is great interest in what makes a city smart. Recently, all over the world, governments and the private sector are investing a lot of funds in smart city projects to address intense urbanization and smart city development [2]; that is the reason why there is a great need for systematic research on this field. This research paper is a literature review that is structured into two main stages. The first stage examines how smart cities can be developed while the second stage examines the current state of smart cities in Greece. The study is structured into three main sections: Section 1 aims to describe the definition of smart cities, the development framework, the characteristics of its model and its application areas, and the ICT technologies that contribute catalytically to the transformation of a city into a "smart city", plus the role of the Internet of Things in smart cities' e-Government. The Section 2 explores the smart city solutions that have been proposed in the Greek territory. Section 5 discusses the performance indicators that are used to compare smart city applications, the challenges of smart city implementation, and it presents some suggested solutions for the successful implementation of smart city actions. Finally, we come to the conclusions that are discussed.

2. The Concept of a "Smart City": Definitions, Characteristics, Development Framework, and Applications

Smart cities are a rapidly emerging research area, as the human population is expected to grow from today's approximately 8 billion to almost 10 billion by 2050 and it is estimated

that about 70% of the world's inhabitants will live in an urban environment. Living based on measurable data, community participation that enhances and supports human existence, and new, smart technological systems are critical parameters of a smart city that seeks to bring together government, commerce, society, and technology, enabling modern processes that play a key role in protecting the vitality and sustainability of our world.

2.1. Defining Smart Cities

Although smart cities have been considered a very interesting and important concept for citizens, authorities, and investors in recent years, there is no universally accepted definition of a smart city [3–6] and different approaches have been proposed by different researchers, since there is no single model for the construction of a smart city [7]. A set of conceptual variations can usually be achieved by replacing the term “smart” with other terms such as “intelligent” or “digital”. Kulkarni et al. [8] state that smart city refers to a local entity, i.e., a city, a region, or a small location that takes a holistic approach to using information technologies with real-time analysis that encourages sustainable economic development. Hammons et al. [9] defines a smart city as an urban area that uses technological or non-technological services or products that enhance the social and moral well-being of its citizens, providing quality, efficiency, and interoperability of urban services to reduce costs and resource consumption and increase contact between citizens and government. Nelson et al. [10] define a smart city as “a region with a high capacity for learning innovations based on the creativity of its inhabitants, their knowledge development and their digital infrastructure for communication and knowledge management”. Xiong et al. [11] mention that ICT applications with their impact on human capital/education, social and relational capital, and environmental issues are often pointed out by smart city residents. Siri (IEEE) [12] mentions that a smart city involves the interactions of three heterogeneous dimensions: the technologies that can improve the efficiency of a city; the social dimension that addresses the social impact and effects of these technologies on the residents, visitors, and travelers of the city; and the institutional dimension that includes the behavior of organized units such as managers, who regulate these technologies through policies. Finally, the European Commission [13] states that in smart cities, the digitalization of traditional networks and services raises the degree of their efficiency for the benefit of residents and businesses and goes beyond the use of digital technologies to make better use of resources and less emissions, while it represents a more responsive city administration, safety, and citizens' prosperity. Other researchers approach the smart city concept in other related terms (digital cities, ubiquitous cities, etc.), demonstrating that smart cities do not have a universal definition. The differences between the variants are technology, people, and communities depending on priority given to sustainability, efficiency, and quality-of-life issues [14] or geographical and socio-economic contexts [15,16]. Nevertheless, according to most researchers, smart cities are cities where ICTs are widely used in vital infrastructure and services, so ‘technology’ is a key tool used to carry out smart city projects and, in addition, great importance is attached to improving the quality of life of residents [17]. Still, the lack of clear definitions usually creates challenges for policy makers, city planners, and stakeholders who try to design and implement smart city strategies and applications [18]. Therefore, in an effort to bring together as fully as possible the views of researchers, with particular emphasis on the definitions of the IEEE [12], European Commission [13] and ISO [19], a suggested definition could be “Smart cities are cities in which digital information and communication technologies, measurable data-based solutions and data analytics are used to induce an efficient and effective service environment, and in which the city is designed and built to meet the needs of its citizens.”

2.2. Features of the Smart City Model

As can be seen from the above definitions, the pillar of a smart city includes four key characteristics: sustainability, comfort, quality of life, and intelligence [1,15,20,21]. It is imperative that future cities are sustainable, environmentally sound, affordable, and

provide citizens with a high quality of life. Sustainability is a major factor in the expansion of a city and is related to pollution, energy, climate change, and ecosystems. Modern cities must grow naturally. Therefore, it is important to solve energy problems and to identify the lack of non-renewable energy sources. Consequently, the protection of natural and energy resources seems to be a sustainability prerequisite for a smart city [22–24]. The quality-of-life characteristics of citizens are aimed at advancing their well-being. At the beginning of smart cities development, the aim was to improve the luxury of residents, and this was attempted by using technological applications that reduce the constraints and limits of social learning and enhance social participation. With this objective, the model of metropolitan administration was improved, improving at the same time the comfort and the economic status of users' daily life and training them in the relevant technologies [4,25]. Finally, intelligence features include the transformation of technology, infrastructure, and management into an "intelligent" and "efficient" urban environment. "Intelligence" is explained in terms of the desire to improve the community, environmental, and economic standards of cities and their people through digital transformation, measurable indicators, and data analysis that discover solutions based on real data that were previously not easily discernible [26,27].

2.3. *The Novel e-Government Framework for the Development of Smart Cities*

The framework for the development of smart cities initially consists of four components: (a) the definition of community, (b) the study of community, (c) the development of smart city policies, and d) citizen participation and interaction [28]. The definition of community includes geography, and the connections between urban and rural areas and the people between these areas [27]. The study of community refers to the need to analyze the characteristics of the community and identify its assets before initiating its development into a smart city. More specifically, communities need to be studied to understand the business needs and unique characteristics of their citizens, for example, the age, education level, hobbies, and habits of the members [29]. Policy development involves defining roles, responsibilities, goals, and objectives and developing planning and strategies to achieve these goals [30]. Finally, citizen participation must be active and can be activated through e-Government initiatives, open data, social and sporting events, etc. [31].

But the key success triptych for the development and governance of a smart city are People, Procedures, and Technology (PPT). The first two parameters were explained earlier: cities need to research citizens and communities, understand processes, and develop policies and goals to meet their needs. The third parameter, technology, is the one that can be applied to meet citizens' needs, improve their quality of life, and create real economic opportunities [32] through a global and tailored approach that considers local urban cultures, long-term urban planning, and local regulations. Augmented reality support, cloud computing, eHealth, the Internet of Things (IoT), smart grids, and other innovative capabilities are fundamental technology standards used for smart city applications, while open technology standards are crucial for continuous innovation and technological development and have a long-term positive impact on the sustainable cities of tomorrow. Standards create a cross-functional foundation on which next-generation technologies and capabilities can be seamlessly positioned in the coming decades and further developed for ever-improving services available to citizens. The global, open development of technology standards provide a balanced environment for multiple stakeholders to collaborate to create solutions and drive innovation in the smart cities of the future [33].

2.4. *Classification of Smart City Applications/Actions*

Given the complexity of the smart city ecosystem, the IEEE through the IEEE Smart Cities Initiative [34] has cooperated with municipalities around the world to understand the key issues and work with them to develop solutions. It has come up with the following classification of smart city application development: smart economy—governance—transport—

environment—healthcare, smart infrastructure, smart security—living. In Figure 1, a classification of applications/actions for smart cities is presented.

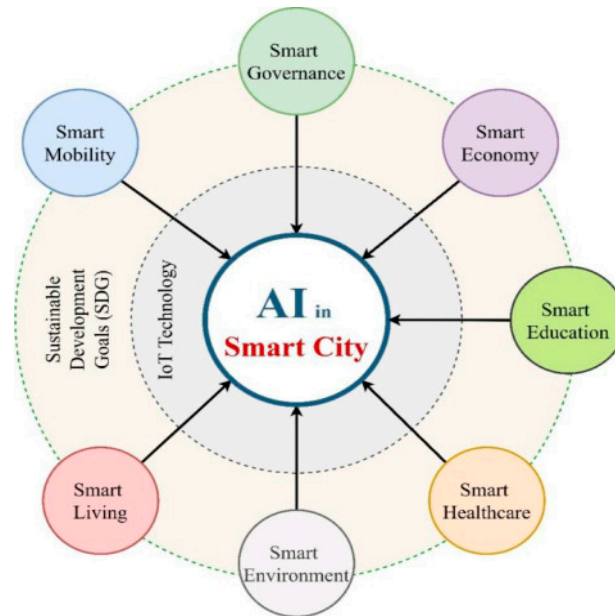


Figure 1. Classification of applications/actions for smart cities. Source: Herath et al., 2022 [35].

Smart economic applications include areas related to the competitiveness of a city's economy, such as the economic importance of the city in national and international markets, entrepreneurship, flexibility in work and production, and innovation [36]. It is also related to investing in the development of citizens' qualifications and their level of education and social cooperation. E-learning programs, such as online courses offered by cities and distance education, have had beneficial effects on the development of citizens [37]. Smart government applications are made to enhance the services provided to citizens in response to administration procedures or data openness, and participation in local communities or urbanization [38], providing greater transparency, accountability, and better cooperation between citizens and authorities.

Smart transport applications include the use of devices, sensors, the Internet of Things (IoT), the collection and analysis of huge amounts of data for regional and international transport accessibility, and modern and sustainable transport systems that focus on optimizing the use of urban infrastructure and resources rather than individual transport. Additionally, smart city technology can help traffic management by using sensors and monitoring tools to help with car signaling, velocity control, reduced traffic, or improved road safety in real time [39]. Other examples include autonomous vehicles using artificial intelligence for navigation purposes or ridesharing [40].

The applications of the smart environment in cities are mainly related to the management of environmental pollution, the protection of natural resources, and the organization of product storage. Urban areas are committed to minimizing ecosystem footprints and increasing the use of clean energy (solar, wind, etc.) and resource management [41], while precision agriculture applications, improved forecasting, or resource and energy management services [37,39–42] can really help farmers and local authorities to reduce pollution or minimize the risk of wasting valuable goods or energy [43,44].

Smart apps in healthcare have shown huge potential to improve patient health, reduce the cost of care, enable distance patient monitoring and care, employ health prediction and analytics tools by analyzing large data volumes, and identify patterns that can predict disease outbreaks and improve public health policies [2,45,46].

Smart infrastructure applications include smart building systems to monitor and manage energy consumption, air quality, humidity, and temperature indoors, thereby

reducing costs and improving the citizen experience, or for fire protection and earthquake prevention. In addition, infrastructure applications involve systems for monitoring the condition of public buildings, roads, or bridges, allowing authorities to immediately check the infrastructures and intervene or correct problems if necessary [14,47,48].

Finally, despite any challenges and concerns about privacy, security, and ethical issues, smart living applications cover all aspects of improving quality of life, initially those covered above such as health and safety, but also culture, education, tourism, housing, hospitality services, etc., and represent a very broad field of development as long as basic urban needs are met and improved [45–47]. Smart applications in the field of citizen protection and security include smart control or security systems to monitor public spaces and detect suspicious behavior, reduce crime, and increase security. In addition, early warning and emergency response systems are in place to detect emergencies and alert government structures and citizens [14,47–49].

2.5. Internet of Things in Smart Cities' e-Government

There are many information and communication technologies that can be considered as stakeholders in the implementation of smart city applications, but there are four key technologies that are considered as pillars in the smart city deployment architecture: Internet of Things (IoT), Big Data, cloud computing, artificial intelligence, and Blockchain, with the Internet of Things being the “backbone” as researchers typically refer to it [21]. According to the International Telecommunication Union, the term Internet of Things is “a broad term that can be used to describe any object connected to the Internet” [50]. There is no single definition for the IoT, and different organizations and individuals may suggest differences from one definition to another. However, the majority of IoT definitions converge that the IoT is a “set of technologies for accessing data collected from various devices over wireless and wired Internet networks” [50].

IoT objects can (a) recognize, collect, and store information, (b) understand commands, (c) transmit and receive messages, and (d) cause actions (activation). The ecosystem of smart sensors, monitoring devices, AI programs, and actuators can assess, monitor, and control certain aspects of city life with the Internet of Things describing how objects are uniquely identified, have a recognized location and state, and become part of the Internet in a network-accessible way [51]. Three key elements can define the IoT environment: identity, integration, and interoperability [50]. Identity includes security and the ability to identify the rights and privileges of devices accessing a network, as well as the recognition that the people or machines behind the keys or actions are exactly what they are supposed to be. Integration is about the collaboration and ability to integrate technologies with a variety of partners and industries and is significantly related to CPS (Cyber–Physical System) technologies that are responsible for controlling, programming, and integrating physical elements within the data framework [52]. Interoperability refers to the requirement of connectivity and compatibility with the entire set of technologies embedded in the IoT.

From the IoT definition and the description of its main features, it can be easily derived that IoT adoption in smart city government provides extended analytics services to support fast and informed decision-making and can monitor, manage activities, and cause smart actions to help citizens and officials in their decisions. In today's ever-evolving landscape, cities and municipalities are rapidly altered and new, efficient, scalable, and reliable applications for smart city governance are proposed based on the IoT infrastructure. With the help of IoT, the key for governing smart cities is real-time data; numerous sensors generate huge volumes of data, intelligent technologies store and analyze data, public authorities, local companies, and citizens are informed and gain knowledge, and then can easily keep pace with any upcoming challenges or efficiently innovate new solutions.

3. Current Situation of Smart City Actions in Municipalities in Greece

Over the last fifteen years in Greece, efforts have been made in the development of smart city applications and actions, mainly sporadically, either by municipal authorities

that spend time, effort, and resources to take the lead in this field and have won significant distinctions at a global level (Trikala, Heraklion), or, in recent years, by more coordinated government actions that promote financial tools for the adoption of innovative technological solutions that aim to facilitate and improve the quality of life in urban areas. According to the 16 June 2022 press release of the Ministry of Digital Governance [53,54], cities can participate in the “Smart Cities program” and to align with the central administration in the field of digital transformation, sustainable mobility, energy saving, improving citizen and business services, and quality of life or enhancing local democracy, consultation, and transparency. The action for 315 Greek municipalities is funded with around EUR 230 million from the European Regional Recovery Fund and the strategy plans that will be developed should reflect a time horizon of at least 5 years and should be future-oriented. This program is already running for 16 municipalities of 100,000 inhabitants, plus the city of Trikala, supposed as the most well-known smart city in Greece.

Before this project call, six Greek cities (Athens, Ioannina, Kalamata, Kozani, Thessaloniki, and Trikala) were selected by the European Commission to participate in the EU Mission for 100 climate neutral and smart cities by 2030. Through EU financial instruments, they will implement investments that accelerate their transition to climate neutrality and digital transformation and should present holistic models for better energy management in urban centers. Furthermore, the Ministry of Environment and Energy’s goal is to support and activate as many Greek municipalities as possible to participate in the EU Mission. Thus, on 27 January 2022, the first Memorandum of Cooperation was signed among 21 other municipalities in the country [55].

Indicative Smart City Applications in Municipalities in Greece

According to Heraklion officials, the vision of a smart city includes smart governance, smart citizens, smart living, smart mobility, smart economy, and smart environment [56]. Since 2008, the city has developed an extensive fiber optic network connecting city services and schools with citizens, a wireless network covering most parts of the city, and a proprietary datacenter to serve its services. The digital services provided to the citizens are either exclusively digital (35 fourth-level services) or the citizens are digitally informed about the progress of their cases (130 second-level services). Through the public web portal or by mobile phone application, they can make electronic payments to municipal services, and they have a digital citizen’s box. In addition, the city provides open government e-services, such as live broadcasting of municipal meetings, online decision index, online consultations, job advertisements, procurement tenders, etc. As Heraklion is a renowned tourist destination, the municipality can demonstrate remarkable digital actions in the field of tourism and culture. Such actions include interactive electronic information points for the most important cultural monuments in the city, while tourists can use mobile devices and applications for virtual tours of places of historical and cultural interest in the city or for information on cultural activities, newspapers, magazines, etc. Finally, the city has implemented IoT applications for collecting, storing, and visualizing data from the urban environment enriched with demographic, economic, and urban planning data, which attribute to any interested party for creating applications that contribute to local entrepreneurship [56,57].

The main smart city project in Ioannina concerns the improvement in urban mobility through the development and operation of an intelligent parking management system, using underground sensors for 100 spaces in the city of Ioannina, which alleviates the issue of short-term parking for citizens and visitors, while also covering parking spaces for people with disabilities. The result is a single information platform for available parking spaces in the city through multiple information channels (municipal electronic signs, mobile applications, websites) [58].

In Monemvasia, the first water metering project in Greece that is implemented by using the NB-IoT network has been built. The project is an application of smart water management, and it uses smart meters in the municipal water supply network to monitor

and manage the water supply and consumption in real time and remotely. The practical advantages of this smart city solution are water resource savings, stabilization of water pressure, control of water quality, detection of any leaks, and dramatic reduction in costs and energy consumption [59].

In the context of smart urban mobility, the pioneering program “Astypalaia—Smart and Sustainable Island” is in its third year of implementation and the results of the period Jan–Sep 2023 justify the choice of developing actions in the field of smart cities that aim to improve the lives of the island’s residents and tourists, in terms of ecological mobility and energy saving. The action is based on the operation of the vehicle sharing service “astyGO”, in combination with the shuttle service “ASTYBUS” for an ecosystem of smart and ecological mobility. The electric vehicles for this period covered 168,300 km across 25,503 routes, while the action was positively accepted by the local community; 25% of the permanent residents of Astypalaia were transported through the “ASTYBUS” service and they reported a 90% satisfaction rate when using the astyMOVE application. Similarly, about 900 routes were implemented through the “astyGO” service, increased by 84% in 2022, with 1.4 users per day and per vehicle “sharing” the route and adopting the vehicle sharing service in Astypalaia. Since the beginning of the project in June 2022, more than 373,000 km have been driven with electric cars, which means that approximately 44.8 tons of CO₂ have not been released into the environment, enhancing the environmental footprint of the project [60].

Finally, successful examples of smart city actions can be found in the city of Chania, Crete. In 2022, the Municipality of Chania took first place as the best and smartest city in Greece. The city gained the highest score among nominations from all over Greece and received four gold awards in the categories of bicycle path projects (new bicycle path network), public and municipal buildings (energy upgrading of school buildings), sustainable public sector (fully digital services in municipal services), and social responsibility (social laundry). The essential element for its emergence as a successful example of a “smart” municipality is that it has developed actions in multiple areas of citizens’ lives [61]. Additionally, the city has carried out very important work in the framework of the Urban Mobility project to regulate traffic on the most important roads in Chania and put into productive operation an Integrated Information and Light Signaling System, which improves traffic management, reduces vehicle queues and journey duration, while it reduces environmental pollution from vehicle traffic in the area of its installation [59,62]. The information system receives data from multiple types of sensors for urban services regardless of their interconnection technology and informs citizens about traffic on the roads in real time, about the estimated travel time between sections of the road network under surveillance, and about current traffic incidents, thus avoiding traffic congestion. The results of this action are used as guidelines for assessing the impact of traffic on urban pollution in the future development of Sustainable Urban Mobility Plans and the installed systems are fully scalable for additional functionalities and geographical expansion. Furthermore, the “Smart City” platform of Chania is an open-source, cloud-based platform that allows the interconnection and communication of individual smart city solutions and applications and leverages the advantages of Internet of Things technologies to connect all the dynamic factors of the municipal ecosystem (citizens, processes, data, and objects). This platform supports services such as (a) smart parking, (b) smart traffic monitoring, (c) smart street lighting, (d) remote management of the municipal wireless network and analysis of its usage data, (e) collection, management, and monitoring of environmental data, (f) smart monitoring of energy resources, (g) location and tracking of bins and refuse collection vehicles, (h) smart monitoring of bin occupancy, and (i) monitoring of electric car chargers and overall smart management of information systems [62].

4. Discussion

As is mentioned in the previous chapter, the smart city development efforts in Greece, apart from very few cases, are either sporadic or the strategy plans that have been developed

reflect a time horizon of at least 5 years from 2022 and they have not yet concluded to derive safe results at the national level. Still, from the international literature and the actions that have been developed in the abovementioned cases, well-accepted key performance indicators in order to compare the smart city applications or to comment on their suitability in the framework of e-Government are the following: the existing infrastructure of the cities and the technological services available to the inhabitants, in respect of health and safety, mobility, activities, opportunities, and governance [63–67].

The IMD Smart City Index [68] assesses the perceptions of residents on issues related to structures and technology applications available to them in their city and it is based on the Structures pillar (city infrastructure) and the Technology pillar (technological parameters). Since 2019, the IMD has produced this index in respect of the economic, technological, and social aspects of smart cities. According to the 2023 index, Zurich is taking the lead in the global smart cities market and was named the world’s smartest city for 2023. In fact, Zurich managed to displace Oslo, which held the scepter in 2021. Europe manages to distinguish itself globally from the smart services that cities provide to their residents, as eight of the ten smartest cities on the planet are in the European area. For example, Copenhagen (4th in the 2023 ranking), Lausanne (5th), and London (6th) are high performers, while Helsinki (8th), Geneva (9th), and Stockholm (10th) complete the “top 10” of the world’s smartest cities for 2023. The Greek capital (only this Greek city is included in the index) is low on the list of the world’s elite metropolises that are championing smart cities. For 2023, Athens is ranked 113th (Figure 2) out of the 141 smartest cities in the world. In fact, Athens, according to the assessment, loses five places in this year’s rating, as in 2021 (when the last measurement was made), it was ranked 108th worldwide. Athens’ subdued performance this year puts it lower in the ranking, under cities such as Bucharest (104th), Cairo (108th), and Sofia (111th).

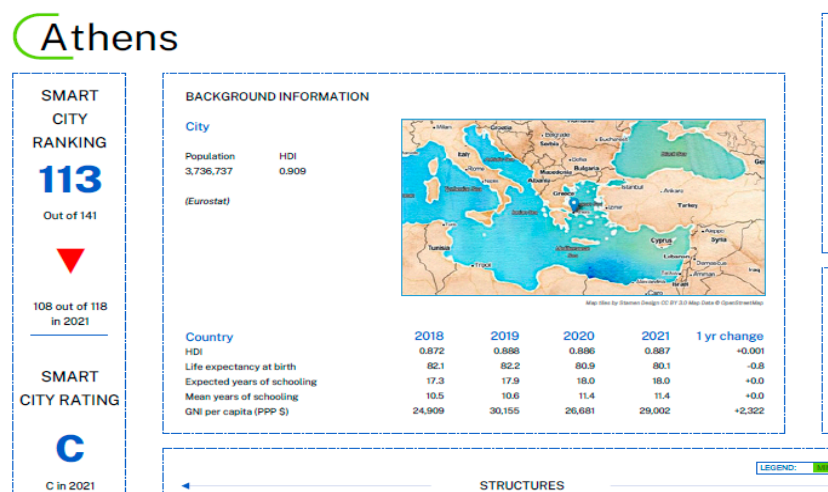


Figure 2. IMD Smart City Index 2023 for the city of Athens, Greece: city ranking & smart city priority indicators [68], pages 42–43.

Yet, another quality-of-life online tool, NUMBEO [69], allows citizens to see, share, and compare information about the quality of life in their city, based on the following parameters: cost of living, affordability of housing, environmental pollution, crime rates, health system quality, and traffic. The data for each country are based on all entries from all cities in that country, while for each measured feature in a city, the tool reports the minimum and the maximum number of contributors. Although it is not designed as a sophisticated smart city and e-Government metric tool, it includes critical features such as cost of living, pollution, health, and traffic that are considered as basic indicators in a smart city metric system. As shown in Figure 3 [70,71], taking the last update of February 2024, when comparing the quality-of-life index in Greece to Switzerland (which owns Zurich, the top smart city in the world’s ranking according to the previous index), it is easily derived

that in all key parameters, Greek cities must perform a lot of work in order to improve the aspects of citizens' life.

Quality of Life in Greece

Select city in Greece:

Do you live in Greece? [Add data for Greece](#)

Index
Quality of Life Index: 128.41



Purchasing Power Index	44.94	Low
Safety Index	53.21	Moderate
Health Care Index	57.33	Moderate
Climate Index	93.83	Very High
Cost of Living Index	54.12	Low
Property Price to Income Ratio	13.52	High
Traffic Commute Time Index	33.60	Low
Pollution Index	51.97	Moderate

f Quality of Life Index: 128.41 **Moderate**
 Minimum contributors for an underlying section: 472
 Maximum contributors for an underlying section: 1909
 Last update: February 2024
 Our data for each country are based on all entries from all cities in that country.

Quality of Life in Switzerland

Select city in Switzerland:

Do you live in Switzerland? [Add data for Switzerland](#)

Index
Quality of Life Index: 189.23



Purchasing Power Index	126.37	Very High
Safety Index	74.55	High
Health Care Index	72.40	High
Climate Index	79.24	High
Cost of Living Index	111.03	Very High
Property Price to Income Ratio	11.10	Moderate
Traffic Commute Time Index	33.56	Low
Pollution Index	22.48	Low

f Quality of Life Index: 189.23 **Very High**
 Minimum contributors for an underlying section: 348
 Maximum contributors for an underlying section: 1485
 Last update: February 2024
 Our data for each country are based on all entries from all cities in that country.

Figure 3. Comparing the quality of life in Greece and Switzerland: life metrics in Greece & Switzerland.

For 2024, Greece is ranked 47th out of the 85 entries with 127.2 points, while Switzerland is ranked 7th with 186.7 points and Luxembourg is on top of the list with 207.3 points [70]. Additionally, when comparing the quality of life between the two major cities in Greece, Athens and Thessaloniki (Figure 4 [71]), we can see that their ranking is below the national score of 127.2 points (117.6–113.06) and the quality-of-life index in both cities is described by the tool as low, in respect of the IMD Smart City Index mentioned earlier. Although there are not enough data for all the Greek cities, the best achieved score is measured in Heraklion, Crete, with 155.65 points and a high index description [72].

Quality of Life Comparison Between Thessaloniki and Athens

Index
Quality of Life Index: 113.06 117.60

	Thessaloniki	Athens
Purchasing Power Index	Low 40.96	Low 46.44
Safety Index	Moderate 46.23	Moderate 43.82
Health Care Index	Moderate 55.36	Moderate 56.69
Climate Index	Very High 88.39	Very High 95.18
Cost of Living Index	Low 55.40	Low 55.47
Property Price to Income Ratio	High 14.63	High 14.50
Traffic Commute Time Index	Low 29.69	Moderate 38.25
Pollution Index	High 64.54	Moderate 57.18
Quality of Life Index	Low 113.06	Low 117.60
Minimum contributors in an underlying section:	81	276
Maximum contributors in an underlying section:	372	919
Last Update:	February 2024	February 2024

Figure 4. Comparing the quality of life in Greek cities: life metrics in Thessaloniki & Athens.

As can be seen from the description of smart city solutions in Greek municipalities and the above results, smart city solutions are now an emerging global phenomenon and they are tailored to meet the specific requirements and needs of local communities, while at the same time, they expect to promote sustainable development and improve the quality of life. In addition, smart city solutions consider various cultural, political, and economic factors. Some municipalities have adopted smart transport systems, others water management

systems, while others focus on better information and service to citizens by municipal authorities. On the other hand, it should be noted that smart city applications are complex systems, involving the integration of different technologies, stakeholders, and scientific fields. Their successful development is not challenge-free, and these challenges are generally technical, economic, legal, social, and cultural. To begin with, technical challenges are among the most important factors that slow down the implementation of smart cities. The lack of standardization and interoperability of devices and technologies [2,14,73–75] and the involvement of different companies and organizations can lead to fragmentation, complexity, and incompatibility and result in increased costs and delays so better data models, protocols, or standards must be proposed for a more advanced smart city ecosystem.

Financial and legal challenges are also important factors that block smart city actions. Funding is usually low, projects are often costly, and municipal budgets are usually limited [2,14,76,77]. Moreover, these types of projects often require long-term investments, and cities need to develop innovative financing models or work closely with national or European organizations to cope. In addition, legal and regulatory challenges, such as privacy and data ownership, can create barriers to the adoption and implementation of smart city technologies [65,66,75]; therefore, municipal authorities should turn to legal experts to address these challenges.

Finally, social or cultural parameters, behaviors, or beliefs can block smart city implementation. We have already noticed that there is not even a common understanding of what is considered smart action in a city, and the will not to change anything is a common challenge that public or private authorities can face when implementing smart city projects [5,63,64,78]. Some citizens are reluctant to adopt or use new technologies. In addition, privacy and security concerns are always matters of consideration in every technological project; citizens should always be concerned about how or why their data are collected, stored, or processed [79,80], and it is very critical for any smart city developer to provide credible answers to those concerns. At the level of smart city action planning, areas of focus should include understanding the advantages and disadvantages of technology, addressing the challenges of financing projects, researching and developing practices that address citizen governance and major community issues, and creating roadmaps for resilient, secure, and scalable infrastructure for smart city project development.

5. Conclusions

Smart city applications provide the opportunity to use measurable data obtained from many sources, and by using the latest cloud, IoT, or AI tools and technologies to analyze and lead to conclusions and decisions that increase operational efficiency, while reducing costs and waste can lead to a better quality of life for citizens who live in crowded cities. In the present research work, exploring the framework for the development of smart cities is initially tried and secondly, examining the current state of smart cities in Greece is tried. The smart city development efforts in Greece, apart from very few cases, are either sporadic or the strategy plans that have been developed reflect a time horizon of at least 5 years from 2022 and they have not yet concluded to derive safe results at the national level. Our future research will be focused on measuring the aspects of Greek citizens about smart city/smart working applications and defining the key factors for their successful implementation.

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