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Analyzing the Challenges for Future Smart and Sustainable Cities

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Abstract: The fast growth of the urban population increases the demand for energy, water, and transportation, amongst other needs. This study explores the current state and future scenarios of Smart Cities and the environmental, economic, and social challenges that must be overcome. We used the Rapid Review method to understand the challenges of implementing Smart Cities in different urban contexts and the potential impact of research on Smart City planning in future Smart Cities. The study offers insights into the potential for Smart City growth while identifying obstacles that must be addressed to ensure sustainability. Results serve as a foundation for planning and decision-making, highlighting aspects such as the adoption of alternative energies, reduction in car use, preservation of ecosystems, waste reduction, citizen participation, infrastructure, and citizen data privacy, among others. These aspects are essential to overcome obstacles and promoting Smart Cities' development.

Keywords: Smart Cities; Sustainable Cities; Internet of Things; Foresight; Futures Studies

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1. Introduction

Cities have always kept their growth rate in line with the evolution of human civilization, playing a key role in commerce, security, and people's quality of life. Urban areas are often associated with environmental deterioration [1–3], elevating the quality of life [4] and acting as a catalyst for economic growth [5]. Currently, urban centers concentrate 55% of the world's population, which is expected to reach 70% by 2050 [6]. According to Valdez et al. [7], the infrastructure of cities is under constant pressure and transformation due to the fast growth of the urban population as their managers struggle with the increasing demand for energy, water, and transportation, amongst other needs and demands. The population increase also demands more space. All of this contributes to adverse environmental events, such as global warming, extreme climate events, scarcity of water resources, poor air quality, and loss of biodiversity [8]. New technology trends are transforming traditional cities, emphasizing that the Internet of Things (IoT) is essential in developing smarter cities [9].

The Internet of Things is a digital transformation process that adapts to various aspects of our daily life. The Internet of Things encourages constructing intelligent and autonomous solutions [10], therefore, has great technological and strategic value. Using sensors increases the ability to fill specific gaps between the physical and virtual worlds, such as information to avoid wasting resources, control, ambient air quality, and physical well-being. Sensors can be embedded in any object and use machine-to-machine (M2M) communication [11].

Groundbreaking applications involving the IoT have allowed new sustainable initiatives to emerge worldwide. Among these initiatives, we highlight Smart Cities: well-planned and automated cities integrated with technologies and services that are increasingly efficient, reliable, and intelligent, with residents that are self-determined, independent, and conscious citizens [12–14]. In this scenario, monitoring, management, and control capabilities are provided over remote devices, helping to create new insights and actionable information from real-time data flow [15]. In an accelerated and dynamic environment, such as Smart Cities, various interconnecting forces, trends, and conditioning factors to visualize alternative futures become an even more significant challenge. Hence, the importance and difficulty of companies' endeavors to actively monitor emerging trends and to develop alternative scenarios that reflect potential business opportunities that may arise and face the challenges of the future [16]. Local and national governments can also use smart cities to surveil citizens, playing a central role in advancing political control [17]. Many traditional urban centers are becoming increasingly inadequate to face the new paradigms of the 21st century, failing to address the challenges associated with improving quality of life, sustainability, safety, transport efficiency, and health. To meet these challenges, the United Nations established the Sustainable Development Goals (SDGs) in 2015, with 17 global goals aimed at transforming the quality of life in cities by 2030 [18]. However, achieving these goals requires environmental, social, and economic actions to promote more sustainable land use, preserve the biodiversity of natural ecosystems, and reduce pressure on city services, aiming to improve economic and social outcomes [19]. In other words, understanding, planning, and managing cities efficiently and innovatively are necessary for the SDGs. We think the concept and implementation of Smart Cities is the answer to achieving these goals.

The main objective of this study is to analyze future trends and challenges related to implementing Smart Cities. Specifically, our objectives are (i) to identify the various challenges and approaches to implementing Smart Cities in different urban contexts, and (ii) to understand how current research on Smart Cities planning can inform future trends and challenges in Smart Cities implementation. This study will provide valuable insights into Smart Cities planning and serve as a helpful resource for foresight planning, a structured and coordinated process whose function is to formulate strategies to achieve objectives and guide the decisions and actions of the present [20]. For Bibri [21], the main goal of studying the future is to understand better future opportunities and alternatives with their differences and viability. Futures studies can contribute to planning the design, development, implementation, evaluation, improvement, and advancement of sustainable Smart Cities [21]. There are several methods [22] for performing futures studies, which can be supported by specialized software [23–28], producing relevant scenarios [29–38] that add value to governmental and private organizations that will affect future Smart Cities.

By investigating research areas that grow the most within the Smart City scenario and the challenges that make part of this growth unfeasible, we can have a broader awareness of the research opportunities in Smart Cities. This work allows researchers to understand the challenges of the current research areas of Smart Cities and present a range of possibilities for new studies focused on better solutions for each identified challenge. Therefore, we expect cities' technological and sustainable growth to continue toward an even more promising future. By anticipating changes, Smart Cities will be better equipped to deal with future challenges, leading to more sustainable growth. Understanding the challenges and obstacles faced in the development of Smart Cities is crucial for addressing them and improving the success of these cities. Finally, by identifying key research areas, we can focus efforts and resources on the most critical and impactful research areas for advancing Smart Cities, leading to even more promising future developments.

We suggest, from our main findings, that we should view Information Technologies as a tool for solving specific problems. Utilizing them may give rise to several issues, including security concerns, which we must address. We also discovered that local interests highly influence the challenges faced in implementing Smart Cities projects, making it difficult to generalize the specific challenges in Smart Cities projects worldwide. However, we identified several overarching challenges, including environmental, social, economic, and technological factors familiar to many Smart Cities projects.

The remaining text has four main sections: Literature (Section 2), Materials and Methods (Section 3), Results and Discussion (Section 4), and Conclusions (Section 5). In Section 2, definitions of Smart and Sustainable Cities are presented, with a discussion of the relationship between these two concepts. Section 3 outlines the Rapid Review methodology, the literature review methodology we selected for this study. Section 4 is divided into two sub-sections, addressing the research questions raised in the literature review. Section 4.1 examines various approaches for implementing Smart Cities in diverse urban contexts, Section 4.2 addresses trends and challenges related to Smart Cities implementation, and Section 4.3 discusses our findings facing other studies. Finally, Section 5 summarizes the work contributions and presents our conclusions.

2. Literature

The growing urbanization and the need to improve inhabitants' quality of life in 21st-century cities have propelled the growth of approaches focused on more technological and intelligent cities, highlighting the importance of efficient infrastructure and service management to ensure inclusive benefits for all residents [39].

By 2025, 60% of the world's GDP will be generated by 600 cities [40], making urbanization an increasingly important phenomenon in the economy of cities, which currently house 55% of the global population, despite occupying only 2% of the geographical space. This number is expected to increase, highlighting the importance of these urban centers as vital for global economic growth [39]. Urbanization relates to other processes, such as population migration, economic growth, industrial diversification, infrastructure transformations, energy intensity, and technological development. Urbanization has a direct and positive impact on carbon emissions during its early stages, but as it continues, during its later stages of development, carbon emissions levels decrease. Efforts to enhance environmental performance through policies can aid in reducing the negative effects of urbanization during its initial phases and steer it toward sustainable methods. It is crucial to ensure the successful management of cities' infrastructure and services to ensure that the benefits of urbanization are inclusive for all city residents [41].

The transformation of a traditional city into a Smart City, which is crucial due to urbanization, requires adopting good practices to build, nurture, and improve each aspect of the city. Smart Cities should consider the values and principles of the 21st century—particularly governance—while integrating technology and processes are essential to promote smart growth and replace the more costly traditional city configuration [42].

Smart City definitions often highlight the importance of sustainability, innovation, efficiency, and quality of life. According to Wamba and Queiroz [6], a Smart City is an urban area that integrates traditional infrastructure with the IoT, seeking a sustainable economy, improved quality of life growth, wise management of natural resources, and participatory governance. A Smart City changes the city's urban planning, engineering, and design, involving multiple disciplines and technologies, to promote inclusive and sustainable economic growth [43]. For Honnurvali et al. [44], a Smart City aims to mitigate the complications raised due to rapid population growth and urbanization by optimizing the efficient use of resources. According to Min et al. [45] and Honnurvali et al. [44], the concept of a Smart City is controversial and ambiguous.

In this context, without a general definition, there was the emergence of different types of cities and related concepts [46], with the Smart City being an advanced concept related to Information Technology, Digital City, and Sustainability [45].

Multiple studies present varying conceptualizations of Smart Cities, which, although traditionally associated with adopting new technologies, is understood as a multifaceted and comprehensive concept [39,47–49]. The Smart City concept generally refers to intelligent solutions for greater energy efficiency, urban mobility, data collection and application, physical and digital infrastructure, and housing solutions [44]. There are many studies conceptualizing Smart Cities. However, standardized organizations, such as the International Telecommunication Union (ITU), the International Standards Organization (ISO), and the British Standards Institution (BSI), already have this definition. ITU defines a Smart City using some characteristics, such as innovative, competitive, sustainable, technological, and provider of improved quality of life [50]. ISO considers a Smart City a city that integrates new information technologies, which facilitates the planning, construction, and management, aiming at greater convenience and intelligence in the services provided to the population [51]. BSI defines a Smart City as effectively integrating physical, digital, and human systems in its environment, offering its inhabitants a sustainable, prosperous, and inclusive future [52].

The addition of environmental sustainability to the concept of a Smart City, related to the EU2020 agenda, links the notion of a Smart City to the concept of a "resilient city" and includes research on energy generation and consumption, as well as engineering-based studies on the impact of intelligent devices on urban energy efficiency [47]. The very definitions of Smart City evidence the intrinsic relationship between sustainable development and Smart City highlighted, which seeks to promote a sustainable economy, efficient use of natural resources, inclusion, and democracy, as well as the improvement of the well-being of its inhabitants, demanding the approach to problems such as slow growth, increasing inequality, and environmental degradation [39].

Sustainable Cities can be considered an extensive term that encompasses the ecological, economic, and social dimensions of the pillars of sustainable development. According to Parlina et al. [46], the Sustainable City is one of the emerging concepts of the city, providing benefits and quality of life for its inhabitants and future generations without exceeding local environmental limitations. In a complementary way, for Bibri [19], the models of Sustainable Cities have compact cities and eco-cities as central paradigms of sustainable urbanism. The compact city can provide the expected benefits of environmental, economic, and social sustainability, albeit to varying degrees, emphasizing density, compactness, diversity, and mixed land use. Additionally, eco-cities, with a greater focus on environmental benefits, also include some economic benefits related to green technologies focusing on environmental management, diversity, and renewable resources such as solar energy.

To exemplify a smart and sustainable city, consider implementing clean transport solutions, such as electric mobility, which uses renewable energy sources. Integrating electric vehicles into an intelligent grid system can also ensure efficient energy flow and more conscious and sustainable use. Promoting sustainable mobility solutions and other circular economy initiatives, such as recycling and material reuse, can transform cities into cleaner, healthier, and more livable environments for all inhabitants [53].

A city can be sustainable without being smart when it aims for sustainability without combining technology with human capital. However, a city cannot be truly smart without sustainability, as when technology and population have disordered growth and consumption [46]. Smart Cities and Sustainable Cities have been used interchangeably. Cities that take advantage of the ecological, economic, and social benefits of sustainability combined with the information and communication technology of Smart Cities are often named Sustainable Smart Cities.

This study highlights that the Smart City and sustainable development go hand in hand and should be considered interdependent in pursuing more livable and equitable cities. These elements enable better, faster, and cheaper decision-making, making cities more sustainable.

3. Materials and Methods

Cities have been increasingly demanding more dynamism in diverse research areas, driven by the need to adapt, evolve, and respond to accelerated population growth's changing demands and challenges. [7]. Smart Cities aim to provide solutions integrating sustainability and technology into cities experiencing rapid population growth to minimize the negative impacts of activities that harm the environment and humans [15,19]. Therefore, we used the Rapid Review process to conduct a literature review to understand and address the main trends and challenges related to the Smart Cities scenario. Such a review can help identify the current state of knowledge, identify research gaps, and provide insights to support the growth of future cities.

Rapid Review is a systematic literature review approach that has gained popularity over time [54]. The Rapid Review process is an evidence-based approach focusing on practical issues and delivering evidence within a shorter timeframe [55]. It simplifies and omits some steps of a complete systematic review in exchange for a faster and less costly method, successfully achieving the objective of quickly gaining insights and understanding the complexities and opportunities of Smart Cities [56]. This approach is particularly relevant considering the dynamic and rapidly changing nature of cities, where a complete literature review could be time-consuming and potentially outdated by the time it is completed.

Although some steps of a complete systematic review are omitted, the Rapid Review approach utilizes a systematic protocol, a replicable systematic method [56]. The protocol has three main stages:

Planning: in this step, we establish the practical problem to be answered by the RR, list the research questions, and define the research protocol;

Extraction Procedure: during this phase, we extract information from the selected studies based on the criteria defined in the study protocol; and

Report: in this phase, we synthesize and present the identified data in the study's results.

3.1. Planning

Urban areas increasingly seek innovation in various research fields to adapt, evolve, and meet the changing demands and challenges of rapid population growth. Integrating sustainability and technology to minimize negative impacts on the environment and human well-being is one of the main challenges of Smart Cities. Therefore, we must understand the main trends and challenges of implementing Smart Cities.

We formulated two research questions to answer this practical problem, as shown in Table 1. The first research question (RQ1) focuses on the challenges and approaches to implementing Smart Cities in different urban contexts. In contrast, the second research question (RQ2) explores how research on Smart City planning can identify future trends and challenges in implementing Smart Cities. By answering these research questions, we aim to gain insights that will contribute to the discussion of implementing Smart Cities in future cities.

Table 1. Research questions.

Number	Question
RQ1	What are the challenges and approaches to implementing Smart Cities in different urban contexts?
RQ2	How can research on Smart City planning help identify future trends and challenges in Smart City implementation?

After defining the research questions, we have to define the search strategy. We used the Scopus engine to search for the studies and conduct the Rapid Review. We based our choice on this search engine's great prominence and relevance, integrating works from many other digital libraries in its collection [56,57]. Combined with snowballing procedures, including articles cited or citing articles found in the Rapid Review, this approach can mitigate database gaps and provide a representative set of articles on the topic of interest [58].

The next step of the planning stage is to define the inclusion and exclusion criteria. These criteria, shown in Table 2, will be used in the Rapid Review extraction procedure stage to define which studies contribute to answering the practical problem.

Table 2. Inclusion and exclusion criteria.

Criteria	Description
Inclusion Criteria	Must answer at least one of the research questions Full text must be available
Exclusion Criteria	Duplicated studies Secondary studies Studies older than 2016 Not written in English Not article nor conference paper

Next, we used all previous information to build a search string that matched the Rapid Review criteria already defined. The search string also automatically filters studies that do not match some criteria independent of human intervention. The search string used in the Scopus engine to search for related studies can be seen in Table 3.

Table 3. Search expression used in Scopus database.

For Investigation by Search Expression:	
Population	"Smart" AND ("City" OR "Cities")
Intervention	"Future" OR "Roadmap" OR "Research Avenue" OR "Research Agenda" OR "Trend"
Final Search String:	
TITLE ("Smart" AND ("City" OR "Cities") AND ("FUTURE" OR "ROADMAP" OR "RESEARCH AVENUE" OR "RESEARCH AGENDA" OR "TREND") AND NOT "REVIEW") AND (PUBYEAR > 2015) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (LANGUAGE, "English"))	

3.2. Extraction Procedure

In this stage, we selected and extracted the information from the selected studies. The first extraction step is defining the filter strategy, i.e., how the articles will be assessed according to the criteria defined in the previous stage. In this step, we defined a strategy that consists of the title analysis followed by abstract analysis. If the title of a study demonstrated that this study answers none of the research questions, the study was filtered and not considered for the next filter. The same process was made with the abstract of studies that passed by the title filter. If the abstract demonstrated that this study answers none of the research questions, the study was filtered and not considered for the next filter. Finally, all studies that passed the title and abstract filter were analyzed by a full read. If the study answered at least one research question, it was considered in the final list of studies to extract.

After defining the filter strategy, we searched the Scopus engine using the search string and found 234 documents in the Scopus database. After the analysis of the title and abstract filter, we reduced the number of selected documents to 68. Then, we applied the full read filter, reducing it to 33 documents for extracting and analyzing information relevant to the study, as shown in Figure 1. Three researchers made the whole filtering process individually to minimize the chance of bias, and the results were compared and discussed to reach a consensus.

Finally, the results were extracted using a data collection protocol in the last step of the extraction procedure stage. This protocol involves using a standardized form for each selected document. We utilized a form to extract pertinent information from the documents for subsequent analyses, as outlined in Table 4.

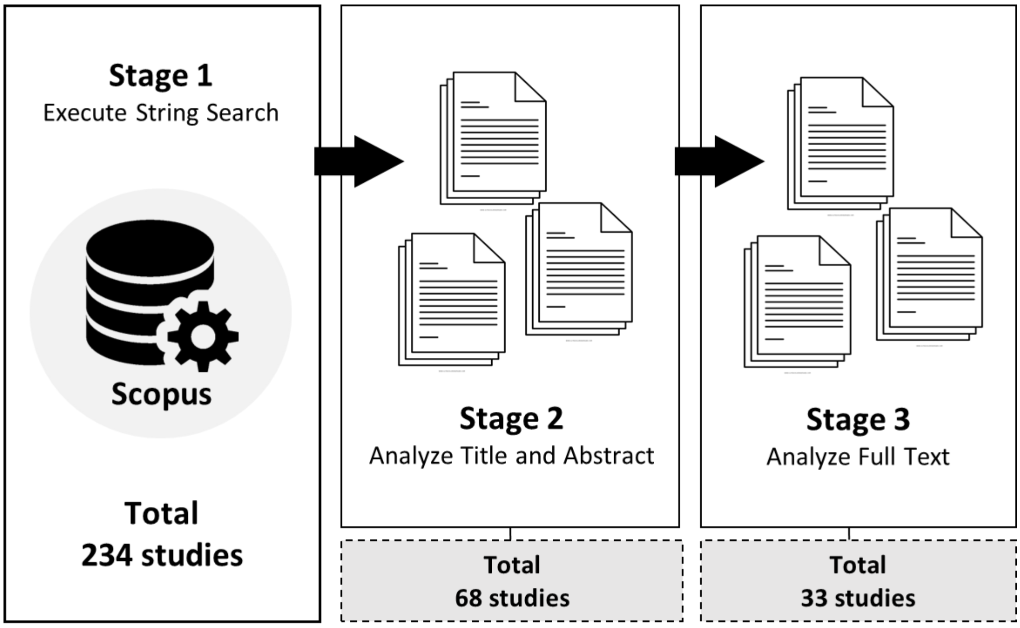

Figure 1. Mapping Data Filtering.

Table 4. Data Collection Fields.

(a) Publication:	
Title	Indicates the article title
Author(s)	Lists the author's name
Source	Indicates the journal or conference proceedings or book in which the article was published
Year	Indicates the year in which the article was published
Abstract	Copy of the abstract to facilitate further analysis
(b) Data Derived from the Objective:	
RQ1	The response of the study for the RQ1
RQ2	The response of the study for the RQ2

3.3. Report

After the data extraction, we started analyzing the results based on the answers to each data extraction form, as shown in Table 3. The subsequent analysis and discussion are detailed in the following section.

4. Results and Discussion

This work aims to investigate the scenario of Smart Cities from a future perspective, presenting the main trends and challenges through prospective studies. Each case of Smart Cities is unique, as they depend on local and/or national interests to set their goals, making it difficult to be assertive about the difficulties. In this work, we focus, in a general way, on smart cities in use around the world to determine their trends and challenges and thus project the following years. Our results indicate that Information Technologies are only tools to solve specific problems [59]. Data-driven Smart Cities primarily focus on technological promises, which may be at odds with broader societal concerns, such as commercial and security [60,61].

The popularity of Smart Cities and the lucrative IoT market increase competitiveness. Governments try to get as much economic return as possible without worrying about the growing increase in human monitoring activities, corporations setting Smart Cities' guidelines instead of citizens, and regardless of social values [62,63]. Competition may not be favorable in all social and political spheres, as is evident in the case of China and the

US. They dispute the launch of Huawei's 5G technology, resulting in an additional variable negatively affecting trade relations between the two countries [62,63].

There is still no recognized framework for the formal evaluation of Smart City policies as it is still in its early stages of development. This allows corporations to use the term Smart City for commercial purposes and for municipalities to invest in new communication and information technologies according to their objectives [62,63].

4.1. Exploring Approaches of Smart City Implementation (RQ1)

In this section, we aim to answer RQ1 by analyzing, within the identified studies, the main approaches focused on the implementation of Smart Cities, presenting their use in different urban contexts, including Environment, Health, Mobility, Management, Energy, Emergency, Pollution Reduction, Network Connectivity, and Smart Homes. In this way, we can abstract from these studies the scenarios that are most poised for growth and will most rapidly receive updates based on our current technological progress intensifying.

The main scenarios of Smart Cities application are focused on the benefits to the city, improving the population's quality of life, resources, and services, which is a critical element in generating urban problems [64]. The trend is that the urban population will increase considerably in the future. More than 50% of the world's population lives in urban areas, and approximately 75% of people are expected to live in one by 2050 [59,64,65]. The population increase brings negative consequences for the city, such as (i) the increased demand for energy and water, (ii) increased cost to build, operate, and maintain the infrastructure running [7,64], (iii) reduced quality of life of its inhabitants, with the expansion of poverty, (iv) scarcity of natural resources, and (v) urban pollution [66]. There has never been a greater need for cities to become smarter in resource consumption [6].

There are several areas where Smart City technologies will impact the lives of citizens. Some research areas are more popular, but all with a vision to improve many aspects of cities [6,59,60,67]. We identified in the surveyed studies the research areas that have been gaining visibility in works that seek solutions to many of the challenges involving Smart Cities (Figure 2).

Smart Environment: Smart environments will become increasingly important and will be accompanied by small-scale climate monitoring in each city with several sensors [62,68].

Smart Healthcare: smart healthcare systems will take advantage of Smart City sensors. Heart rate, blood pressure, oxygen saturation level, and so on, can be measured full-time [60,67].

Smart Mobility, Smart Transportation, and Smart Traffic Systems: With advances in sensors, optics, and integrated processors, pedestrian safety will be improved [59]. Vehicles will be connected to the network along the road and directly to each other. Vehicle connectivity facilitates real-time traffic analysis [60,67].

Smart Management and Smart Governance: New technologies will improve the transparency and efficiency of governments and urban planning. Planning will be more collaborative with the population rather than being led exclusively by the government [59,62,68].

Smart Electricity Systems: The future smart grid system implements networked sensors and measurement devices to collect real-time data from energy generation, transmission, and distribution systems [59].

Smart Water Systems: The smart water management system integrates sensors, controllers, and analytical elements to ensure that water circulates only when and where needed, performing real-time water quality monitoring [59].

Smart Energy: Potential alternative energy systems for future Smart Cities include distribution networks, fuel cell production systems, small modular thorium reactors, renovation of tall buildings with transparent solar batteries, and coastal cities with live landfills capable of producing energy from tidal forces [62,68].

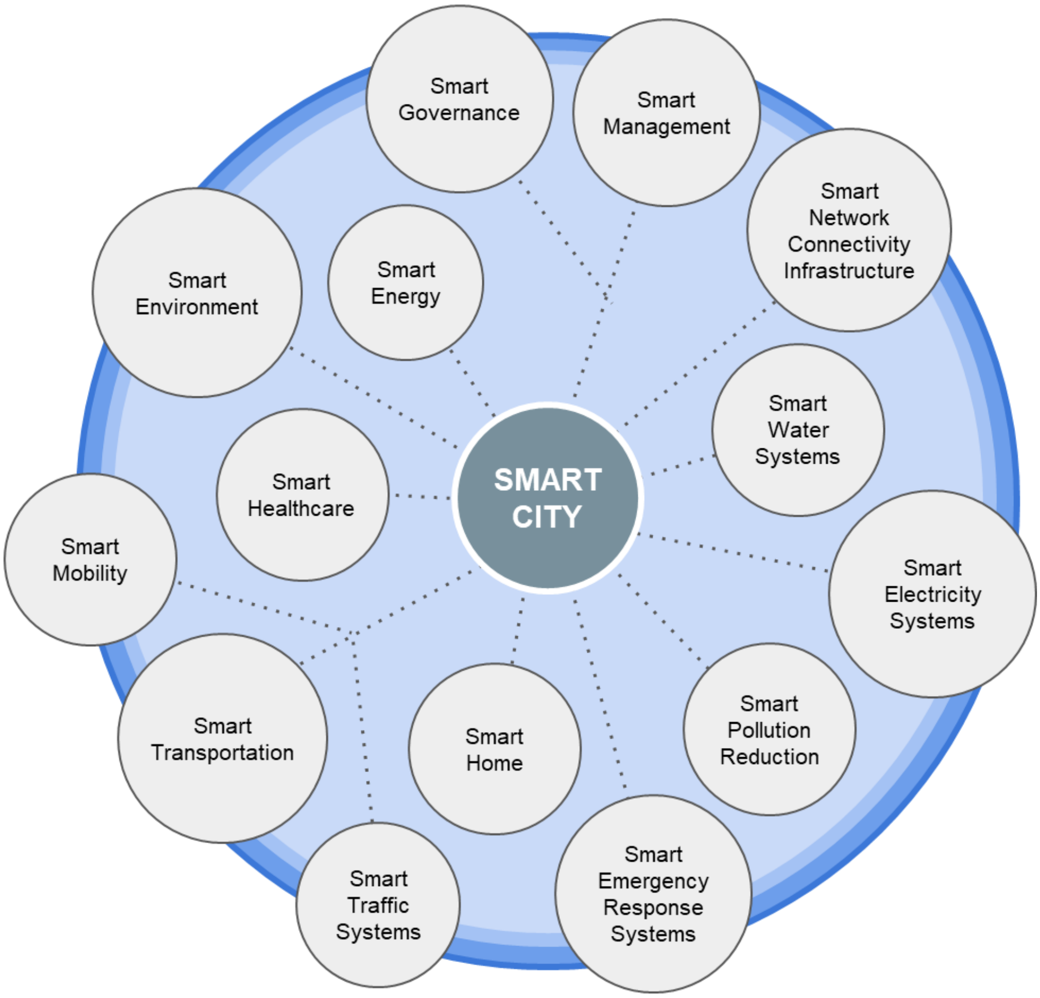

Figure 2. Smart city research areas.

Smart Emergency Response Systems: Smart cities can face emergencies, which will require relevant agencies to have smart devices with high resilience to deal with the risks. The system will be able to receive messages and other information from citizens about the state of emergency, which allows any citizen to contribute to the safety and functioning of the city [59].

Smart Pollution Reduction: New smart sensor technologies can be designed to be compact and connected to mobile devices, helping municipalities monitor pollution levels and reduce costs related to the health and well-being of the population [59].

Smart Network Connectivity Infrastructure: Connectivity is now the backbone of any Smart City. Wireless sensor networks are one of the most widely used connections for IoT-based networks. Network infrastructure has to act intelligently through load balancing, automatic network metering, malicious traffic detection, threat analysis, network backup provisioning, remote maintenance, and emergency decision-making, among others [62,68].

Smart Home: A smart home is based on sensors, IoT devices, GPS, alarm systems, and dedicated network connections, among others. Solar energy is now integrated into smart homes. As a smart home is connected to the internet, the data produced must be stored and processed in a safe and reliable environment [9,62].

Building and developing Smart Cities is an inevitable trend of the industry 4.0 era, given the speed and extent to which cities employ smart features. They are gaining more and more visibility and importance in the agenda of governments, and their development will be the goal of several countries worldwide [59].

With this demand and advances in information and communication technologies, the number of IoT devices will also increase considerably, as IoT plays an essential role in implementing Smart Cities and smart manufacturing [69]. According to data from the Department of Statistical Research, the number of IoT devices is predicted to increase continually, surpassing 75 billion connected devices by 2025 [63,70]. The demand for more connectivity capabilities, ensuring faster and more ubiquitous communication between devices, makes 5G popular [62,63].

The full implementation of 5G will change people's behavior and experience in cities [62,63]. There will be greater reliance on digitization and many possibilities for automation. People will have better opportunities to gather information and actively shape the city in which they live and its social processes [6,62,68]. Future generations will be digital natives, i.e., they will grow up with digital technologies present in their experiences [62,68].

As technological development accelerates, new technologies become obsolete faster, and even 5G already has limitations and a reduced lifetime [62,63]. For this reason, further research is already under development, seeking new opportunities for wireless connection with the 6G. The 6G technology can open new frontiers of connectivity, energy efficiency, and the full exploitation of artificial intelligence in all its spectrums. 6G is still in the research and development phase and is not expected to emerge until 2025; it faces challenges that need to be overcome and is not likely to be fully operational until 2030 [63].

While promising, there is not much evidence of progress directly associated with Smart Cities, and their popularity is based on a few highly successful pilots. Increasingly investments are still needed to drive their growth [47,68]. Many factors, such as economic and social, can hamper the adoption speed of Smart Cities.

Smart cities are not equally implemented around the world. Some empirical studies suggest they are more likely to be implemented in denser, prosperous urban areas and towns with Smart City characteristics [47,67]. Nevertheless, overcoming the barriers in developing countries is needed for Smart Cities to be widely adopted, which is not a benefit restricted to developed countries [47,68].

Big Data and IoT are the leading technologies that permeate the Smart City, promoting a better quality of life for citizens and an increase in the performance of companies [65]. Therefore, Smart Cities' infrastructure will merge with IoT devices by integrating, collecting, and sharing information through sensors and devices [6].

4.2. Exploring the Future Landscape: Identifying and Separating Key Challenges of Smart Cities (RQ2)

In this section, we aim to answer RQ2 by identifying the challenges that must be overcome in implementing intelligent and sustainable solutions within Smart City contexts. We have identified distinct dimensions that are specific to such scenarios. By grouping the challenges within these dimensions, we can better understand the main obstacles that must be addressed to implement intelligent solutions for sustainability in Smart Cities. Overcoming these challenges is crucial to promoting a better quality of life for citizens in urban areas.

Smart cities emphasize the importance of cyber–physical integration of districts, whether new or revamped, sustainable urban planning, efficient use of existing space, and city monitoring through data analysis and cloud technologies. However, each city has its own unique needs and priorities. Despite these differences, all cities strive for similar outcomes, such as attracting new residents, businesses, and visitors, establishing partnerships between cities and the private sector, and promoting economic growth. Cities must achieve these goals balanced and sustainably [71].

Based on the perspectives of challenges identified in the Rapid Review, it is possible to divide them into four dimensions specific to the context of sustainable actions within the Smart City scenarios. According to Bibri [19], sustainable cities constantly transform to meet internal and external challenges, such as climate change, urbanization, technological change, economic crisis, pandemics, and demographic shifts. The city management needs the interconnectivity of research areas to achieve sustainable development, supported by three pillars of sustainability. The three initial dimensions derive from the sustainability pillars: environmental, economic, and social [19,61,72], to which we propose including a fourth one, the technological dimension.

The environmental dimension encompasses the management of renewable and non-renewable natural resources and their limitations. The environmental dimension aims at conscious use, preservation of ecosystems, and reduction of ecological impact [64,72]. In other words, the environmental dimension seeks to preserve green spaces and corridors, ecological habitat diversity, carbon sink and temporary water storage functions (to mitigate climate change and flooding) as well as air and water quality, and protecting the health of its inhabitants by reducing chemical contamination and pollution [19,73].

The economic dimension seeks positive results in using available, accessible and affordable resources in the city's public and private businesses, thus increasing the inhabitants' income and standard of living [64,74]. This dimension also seeks ways to enhance and optimize the use of city resources, for example, by implementing adequate infrastructure, positively impacting its economy, and generating new business opportunities [74,75]. In addition, it aims to provide new jobs, intellectual development of the workforce, and improved productivity [19,75–77].

The social dimension encompasses governance, people, and communities, dialoguing directly with other dimensions, such as environmental and economic. The government aims to make plans and policies to solve city problems and develop practices and services, directly impacting the different dimensions [9,64,72,77,78]. Governance is also responsible for initiatives that make city dwellers active participants in managing their cities. Governance is characterized by the search for a just, inclusive, and democratic society, aiming for better social justice and equity and, therefore, a better quality of life for citizens [19,64,73,74].

The technological dimension of the city provides complete solutions and service support for smart decisions. Featuring hardware, software, and network technologies, they seek interoperability and heterogeneity of their components for monitoring and controlling services [9,19,64,70,72,75–78].

The challenges identified in the mapped studies were grouped into each of the specified dimensions, providing a view of the main ones to be faced in implementing intelligent solutions in the Smart City sustainability scenarios, highlighted in Table 5.

Table 5. Challenges relating to sustainable Smart Cities.

Dimension	Challenges
Environment	Adoption of alternative energies Reduction in car/van/lorry use Preservation of ecosystems Waste reduction
Social	Governance Culture and habits of citizens Citizen participation Citizens' quality of life Public health
Economic	Infrastructure Investments in alternative energies Cooperation between government, industry, and academia
Technological	Electronic devices and sensors Adoption of sustainable materials Use of Big Data technology Resource security and citizen data privacy

In the environmental dimension, the highlighted challenges emerged from the need to employ more appropriate reductions in greenhouse gas emissions, energy efficiency, and ecological impact [21,64,72], in addition to targeted reductions in air pollution and noise, attributed to traffic noise and gas emissions by cars/vans/lorries [19,64,73–75]. Preserving open spaces with ecosystems sensitive to sound, water, soil, and air pollution [74] requires sustainable practices to reduce the landfill of domestic and other waste. These practices work with increased material recovery for reuse, recycling, and energy sources, such as heat and electricity [19,74,75].

Faced with environmental challenges, we note the blockage involving advancing future cities and preserving biodiversity and the ecosystem. Many essential elements are being considered when seeking an ecological balance, such as air quality and decreased household, business, and other waste landfills, significantly reducing diseases and irregular accumulation of debris that negatively affect the environment.

The main challenge in this scenario is to increase the efficiency of improved resources with minimal environmental impact and greater use of sustainable materials. The increase in the number of inhabitants in large cities, added to the availability of electronic devices, leads to a greater demand for energy consumption and other natural resources. The greater energy demand provides challenges to reducing the consumption and waste of resources in cities and industries, requiring adopting new alternative energy sources and fuels and recycling practices.

In the social dimension, we initially based the challenges on government actions, the engagement of policies, planning, and decisions to solve the city's problems [9,64,72,78]. However, most of the difficulties associated with the social dimension are directly linked to the actions of citizens themselves, such as the need to change behavior focused on minimizing waste concerning the use of water, energy, and garbage [8]. Greater involvement and consultation with the citizen is also necessary to consolidate the plurality of citizenship in political decisions for the city, which adds greater social justice and equity in decision-making [73]. We also emphasize with the existence of challenges associated with the health network of cities, which should assist in reducing stress linked to mental and physical well-being and hindering the development of diseases, providing favorable conditions for a healthy life [19].

The virtue of citizen participation, active users, and consumers in the use and management of city services derive from its ability to balance the involvement in reducing waste of city resources and controlling domestic and other debris. Engaging citizens is vital for building a sustainable Smart City, using citizen support for strong representations in decision-making processes and future city developments [19]. However, achieving this engagement presents itself as a challenge because there is still resistance on the part of citizens to get actively involved in politics, in the adoption of new technologies, due to the cost of new equipment, and in the changes in behavior and habits to reduce disorderly consumption.

In the economic dimension, among the challenges identified, we have the question of the city's infrastructure, which has an extensive set of demands for services in various sectors, such as transport and communication [74,75]. Within this dimension are the challenges associated with investments to use alternative energies, maximize energy efficiency, and reduce energy costs [19,75,76]. Cooperation between government, industry, and academia must also establish strategic links for the planning and execution of projects and scientific research focused on green technological innovation directed toward industrial and technological investment [8,19,75,76].

Technological changes have increased data storage capacity and the processing capacity of computer systems, have accelerated the expansion of wireless connectivity, and have decreased costs due to the miniaturization of electronics. The growth of demand causes overloads around the local infrastructure of cities and forces an upgrade. The main challenges are in the planning to replace the existing infrastructure, the time to execute the projects, and their high costs.

Finally, in the technological dimension, the potential challenges faced by Smart Cities include the cheapening and dissemination of electronic devices and sensors, which are responsible for a large part of the intelligent performance in the environment [9,77]. We also produce high-performance materials using sustainable resources (recycled and reused) and minimize construction waste [75,76].

Using technologies such as Big Data is also a challenge to the optimal use of data to improve, advance, maintain, and support intelligent decisions derived from a large volume of data [9,75–77]. In this same context, ensuring the security of resources and the privacy of citizens' data are the primary concerns. Most Smart Cities are created using real and virtual connectivity technologies, making them a potential target for cyberattacks. Its infrastructure opens up a considerable surface vulnerable to known and unknown attack strategies, even with the security controls across all its subsystems and networks. Governments and companies that work in city planning also face many other threats, such as terrorism, population growth rates, financial insecurity, increasing social inequality, and human security due to the development of artificial intelligence, among others [59].

The insecurity risks originate primarily from the fact that many applications cannot provide robust security in their services (e.g., automation control software vulnerable to hacker attacks). Furthermore, managers cannot or cannot test the security features of products and systems, resulting in a gap for hackers to exploit and attack them on a large scale when solutions are connected to the Internet. There are security threats in some critical Smart Cities services [59].

The difficult challenge of ensuring the safety and security of the Smart City is a problem that governments need to solve when building these cities. Everything will be connected and dependent on the internet and other communication networks. Without an effective network security strategy, hackers will quickly attack and paralyze cities [59].

4.3. Related Work

Several studies have explored the challenges and opportunities associated with smart and sustainable cities. This paper similarly investigates the current state and future scenarios of Smart Cities, focusing on the environmental, economic, and social challenges that cities must overcome to ensure their sustainability. The study provides insights into the potential for Smart City growth, while identifying obstacles that cities must address to advance new technologies for Smart Cities.

A recent study by Kourtit et al. [79] discusses how technological innovation can create smart and sustainable cities by integrating new technologies to address transportation, energy, and waste management challenges. They address the importance of having a knowledge-based economy for cities to be competitive in the global market. The authors argue that integrating new technologies can help cities address related challenges to improving their economic performance.

Another point highlighted in the literature is the importance of citizen participation and engagement in planning and developing Smart Cities to foster social sustainability. Caragliu et al. [80] analyze Smart Cities in Europe, defining it as a city's ability to use information and communication technologies in governance, mobility, and sustainability. They suggest cooperation among city governments, the private sector, and citizens is necessary for innovative solutions.

Deakin and Al Waer [81] discuss intelligent and smart cities, highlighting citizen needs and aspirations as critical for creating livable smart cities. Smart cities need an intelligent infrastructure to integrate systems and provide real-time data to authorities, businesses, and citizens.

Nam and Pardo [82] conceptualize the smart city using technology, people, and institutions, promoting citizen-centric approaches, transparency, and stakeholder collaboration. A comprehensive governance framework is necessary for smart city sustainability.

Bibri and Krogstie [83] discuss smart cities' potential benefits and challenges in another relevant study. They note that while smart technologies can enhance urban efficiency and sustainability, there are also concerns related to privacy, security, and equity. The authors suggest that urban governance should be adaptive and flexible to accommodate the rapid pace of technological advancements and that citizen participation can help ensure that the implementation of smart technologies is equitable and benefits everyone in the community.

5. Conclusions

Traditional urban centers are proving inadequate to meet society's various current and future demands, increasing the need for applying the Smart Cities idea. Smart Cities can significantly impact several areas, such as health, transport, leisure, and industry.

This work delves into the crucial role of Smart Cities in today's society by analyzing relevant studies. Through this analysis, we identify the important dimensions that are the basis of smart cities, such as people's engagement, the cost of implementation, resource consumption, and the preservation of biodiversity and the ecosystem. Additionally, this study sheds light on the obstacles and difficulties in implementing smart city concepts on a large scale and their significance for the future development of cities. By understanding these challenges, we can better harness the potential of technological advancements in smart cities to create more sustainable and livable urban environments for residents.

With the help of IoT devices, future Smart Cities will be covered by sensors that constantly send signals to other devices that act in response to the data. The Internet of Things devices will be integrated into a high-speed network, efficiently transporting large amounts of data. Therefore, Smart Cities provide new opportunities for paradigm shifts, such as the development of new businesses and new ways of doing business, and an increase in the quality of life and well-being that comes with cybersecurity concerns resulting in new political agendas of governments.

Examples of public policies to address the challenges of Smart Cities, listed in Table 5, can include: implementing a smart transportation system that uses artificial intelligence and data analytics to optimize transportation routes, reduce traffic congestion, and provide real-time information to citizens; developing a gamification app that rewards citizens for adopting sustainable habits and encourages them to compete with friends and family to achieve sustainability goals; developing a health monitoring system that uses wearable devices and data analytics to provide citizens with personalized health recommendations and alerts, enabling health professionals to detect and prevent health issues; and developing a self-healing infrastructure system that uses sensors and artificial intelligence to detect and repair infrastructure issues in real-time, reducing maintenance costs and improving safety.

Our contribution provides a comprehensive understanding of the current state of Smart Cities, including the importance of sustainable development and the environmental, economic, and social challenges they face. Additionally, using the Rapid Review method provides valuable insights into the key research areas for advancing the field of Smart Cities.

Overall, this paper contributes to the literature on smart and sustainable cities by comprehensively analyzing the challenges and opportunities associated with their development. The results can help cities plan and make decisions to adopt new technologies while ensuring the sustainability of their communities.

We emphasize the significance of further study, continued development in Smart Cities, and research opportunities for future endeavors. Our findings highlight the importance of overcoming barriers to the utilization and progress of new technologies, as well as the critical role that governments, companies, and institutions play in forming the framework and regulations that propel the development of these cities. These points evidence the potential for numerous research avenues in this area. We can strive towards constructing more intelligent and sustainable urban environments by addressing these challenges.

Finally, we highlight that cities will eventually apply the new concepts of Smart Cities due to the new demands of society that arise from cities' growth and social changes.

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References

1. Ferreira, C.S.S.; Walsh, R.P.D.; Ferreira, A.J.D. Degradation in Urban Areas. *Curr. Opin. Environ. Sci. Health* **2018**, *5*, 19–25. [CrossRef]
2. He, C.; Gao, B.; Huang, Q.; Ma, Q.; Dou, Y. Environmental Degradation in the Urban Areas of China: Evidence from Multi-Source Remote Sensing Data. *Remote Sens. Environ.* **2017**, *193*, 65–75. [CrossRef]
3. El Araby, M. Urban Growth and Environmental Degradation: The Case of Cairo, Egypt. *Cities* **2002**, *19*, 389–400. [CrossRef]
4. Sharida, A.; Hamdan, A.; AL-Hashimi, M. Smart Cities: The Next Urban Evolution in Delivering a Better Quality of Life. In *Toward Social Internet of Things (SIoT): Enabling Technologies, Architectures and Applications: Emerging Technologies for Connected and Smart Social Objects*; Hassanien, A.E., Bhatnagar, R., Khalifa, N.E.M., Taha, M.H.N., Eds.; Studies in Computational Intelligence; Springer International Publishing: Cham, Switzerland, 2020; pp. 287–298. ISBN 978-3-030-24513-9.
5. Henderson, J.V. *The Effects of Urban Concentration on Economic Growth*; National Bureau of Economic Research: Cambridge, MA, USA, 2000; p. w7503.
6. Wamba, S.F.; Queiroz, M. A Bibliometric Analysis and Research Agenda on Smart Cities. In Proceedings of the IFIP WG 8.6 International Conference on Transfer and Diffusion of IT, TDIT 2019, Accra, Ghana, 21–22 June 2019; Volume AICT-558, p. 325.
7. Valdez, A.-M.; Cook, M.; Potter, S. Roadmaps to Utopia: Tales of the Smart City. *Urban Stud.* **2018**, *55*, 3385–3403. [CrossRef]
8. Martínez-Bello, N.; Cruz-Prieto, M.J.; Güemes-Castorena, D.; Mendoza-Domínguez, A. A Methodology for Designing Smart Urban Living Labs from the University for the Cities of the Future. *Sensors* **2021**, *21*, 6712. [CrossRef]
9. Malik, F.; Shah, M.A. Smart City: A Roadmap towards Implementation. In Proceedings of the 2017 23rd International Conference on Automation and Computing (ICAC), Huddersfield, UK, 7–8 September 2017; pp. 1–6.
10. Kahlert, M. Understanding Customer Acceptance of Internet of Things Services in Retailing: An Empirical Study about the Moderating Effect of Degree of Technological Autonomy and Shopping Motivations. Master's Thesis, University of Twente, Enschede, The Netherlands, 2016.
11. Aldowah, H.; Ul Rehman, S.; Ghazal, S.; Naufal Umar, I. Internet of Things in Higher Education: A Study on Future Learning. *J. Phys. Conf. Ser.* **2017**, *892*, 012017. [CrossRef]
12. Nidhya, R.; Kumar, M.; Ravi, R.V.; Deepak, V. Enhanced Route Selection (ERS) Algorithm for IoT Enabled Smart Waste Management System. *Environ. Technol. Innov.* **2020**, *20*, 101116. [CrossRef]
13. Hosseinloo, S.H. An Introduction On Literature Of Smart City. *CiVEJ* **2016**, *3*, 1–10. [CrossRef]
14. Anwar, N.; Xiong, G.; Lu, W.; Ye, P.; Zhao, H.; Wei, Q. Cyber-Physical -Social Systems for Smart Cities: An Overview. In Proceedings of the 2021 IEEE 1st International Conference on Digital Twins and Parallel Intelligence (DTPI), Beijing, China, 15 July–15 August 2021; pp. 348–353.
15. Kim, T.; Ramos, C.; Mohammed, S. Smart City and IoT. *Future Gener. Comput. Syst.* **2017**, *76*, 159–162. [CrossRef]
16. Battistella, C.; De Toni, A.F. A Methodology of Technological Foresight: A Proposal and Field Study. *Technol. Forecast. Soc. Chang.* **2011**, *78*, 1029–1048. [CrossRef]
17. Hoffman, S. China's Tech-Enhanced Authoritarianism. *J. Democr.* **2022**, *33*, 76–89. [CrossRef]
18. United Nations Sustainable Development Goals. Available online: https://sdgs.un.org/goals (accessed on 8 November 2022).
19. Bibri, S.E. A Novel Model for Data-Driven Smart Sustainable Cities of the Future: The Institutional Transformations Required for Balancing and Advancing the Three Goals of Sustainability. *Energy Inform.* **2021**, *4*, 4. [CrossRef]
20. Cardoso, L.R.d.A.; Abiko, A.K.; Haga, H.C.R.; Inouye, K.P.; Gonçalves, O.M. Prospecção de Futuro e Método Delphi: Uma Aplicação Para a Cadeia Produtiva Da Construção Habitacional. *Ambiente Construído* **2005**, *5*, 63–78.
21. Bibri, S.E. A Methodological Framework for Futures Studies: Integrating Normative Backcasting Approaches and Descriptive Case Study Design for Strategic Data-Driven Smart Sustainable City Planning. *Energy Inform.* **2020**, *3*, 31. [CrossRef]
22. Gordon, T.J.; Glenn, J.C. *Futures Research Methodology*; The Millennium Project: Washington, DC, USA, 2009; Volume 3, ISBN 978-0-9818941-1-9.
23. Zhang, Y.; Huang, Y.; Chiavetta, D.; Porter, A.L. An Introduction of Advanced Tech Mining: Technical Emergence Indicators and Measurements. *Technol. Forecast. Soc. Chang.* **2022**, *182*, 121855. [CrossRef]
24. Barbosa, C.E.; Lima, Y.; Emerick, M.; Ferman, F.; Ribeiro, F.C.; Souza, J.M. Supporting Distributed and Integrated Execution of Future-Oriented Technology Analysis. *Futures Foresight Sci.* **2022**, *5*, e136. [CrossRef]

25. Raford, N. Online Foresight Platforms: Evidence for Their Impact on Scenario Planning & Strategic Foresight. *Technol. Forecast. Soc. Chang.* **2015**, *97*, 65–76. [CrossRef]
26. Rohrbeck, R.; Thom, N.; Arnold, H. IT Tools for Foresight: The Integrated Insight and Response System of Deutsche Telekom Innovation Laboratories. *Technol. Forecast. Soc. Chang.* **2015**, *97*, 115–126. [CrossRef]
27. Lyra, A.; Barbosa, C.E.; Lima, Y.; Salazar, H.; Souza, J. NERMAP: Collaborative Building of Technological Roadmaps Using Named Entity Recognition. In Proceedings of the 2022 IEEE 25th International Conference on Computer Supported Cooperative Work in Design (CSCWD), Hangzhou, China, 4–6 May 2022; pp. 986–991.
28. Lyra, A.d.O.; Barbosa, C.E.; de Lima, Y.O.; dos Santos, H.S.; Argôlo, M.; de Souza, J.M. Toward Computer-Supported Semi-Automated Timelines of Future Events. *Eur. J. Futures Res.* **2023**, *11*, 4. [CrossRef]
29. Lei, Y.; Wang, Z.; Zhang, X.; Che, H.; Yue, X.; Tian, C.; Zhong, J.; Guo, L.; Li, L.; Zhou, H. Avoided Population Exposure to Extreme Heat under Two Scenarios of Global Carbon Neutrality by 2050 and 2060. *Environ. Res. Lett.* **2022**, *17*, 094041. [CrossRef]
30. Bernardi, E.; Miyake, M.Y.; dos Santos, A.S.; Merichelli, M.P.; Pereira, M.J.; Polkorny, M. Brazilian Scenarios for Smart Cities Deployment from Public Policies Perspectives. In Proceedings of the 2020 IEEE International Smart Cities Conference (ISC2), Piscataway, NJ, USA, 28 September–1 October 2020; pp. 1–8.
31. Berna-Escriche, C.; Vargas-Salgado, C.; Alfonso-Solar, D.; Escrivá-Castells, A. Can a Fully Renewable System with Storage Cost-Effectively Cover the Total Demand of a Big Scale Standalone Grid? Analysis of Three Scenarios Applied to the Grand Canary Island, Spain by 2040. *J. Energy Storage* **2022**, *52*, 104774. [CrossRef]
32. Angelidou, M.; Politis, C.; Panori, A.; Bakratsas, T.; Fellnhofer, K. Emerging Smart City, Transport and Energy Trends in Urban Settings: Results of a Pan-European Foresight Exercise with 120 Experts. *Technol. Forecast. Soc. Chang.* **2022**, *183*, 121915. [CrossRef]
33. Szpilko, D. Foresight as a Tool for the Planning and Implementation of Visions for Smart City Development. *Energies* **2020**, *13*, 1782. [CrossRef]
34. Barbosa, C.E.; de Lima, Y.O.; Costa, L.F.C.; dos Santos, H.S.; Lyra, A.; Argôlo, M.; da Silva, J.A.; de Souza, J.M. Future of Work in 2050: Thinking beyond the COVID-19 Pandemic. *Eur. J. Futures Res.* **2022**, *10*, 25. [CrossRef]
35. Barbosa, C.E.; Lima, Y.; Lyra, A.d.O.; dos Santos, H.S.; de Oliveira, D.V.; de Souza, A.F.; Neto, B.H.; Almeida, D.; Metello, I.M.; da Silva, J.A.; et al. *Healthcare 2030: A View of How Changes on Technology Will Impact Healthcare in 2030*; Laboratório do Futuro: Rio de Janeiro, Brazil, 2019.
36. Shadowen, N.; Lodato, T.; Loi, D. Participatory Governance in Smart Cities: Future Scenarios and Opportunities. In Proceedings of the Distributed, Ambient and Pervasive Interactions; Streitz, N., Konomi, S., Eds.; Springer International Publishing: Cham, Switzerland, 2020; pp. 443–463.
37. Kaandorp, C.; Miedema, T.; Verhagen, J.; van de Giesen, N.; Abraham, E. Reducing Committed Emissions of Heating towards 2050: Analysis of Scenarios for the Insulation of Buildings and the Decarbonisation of Electricity Generation. *Appl. Energy* **2022**, *325*, 119759. [CrossRef]
38. Reis, J.; Marques, P.A.; Marques, P.C. Where Are Smart Cities Heading? A Meta-Review and Guidelines for Future Research. *Appl. Sci.* **2022**, *12*, 8328. [CrossRef]
39. Costales, E. Identifying Sources of Innovation: Building a Conceptual Framework of the Smart City through a Social Innovation Perspective. *Cities* **2022**, *120*, 103459. [CrossRef]
40. Dobbs, R.; Smit, S.; Remes, J.; Manyika, J.; Roxburgh, C.; Restrepo, A. *Urban World: Mapping the Economic Power of Cities*; McKinsey Global Institute: New York, NY, USA, 2011; Volume 62.
41. Nuţă, F.M.; Nuţă, A.C.; Zamfir, C.G.; Petrea, S.-M.; Munteanu, D.; Cristea, D.S. National Carbon Accounting—Analyzing the Impact of Urbanization and Energy-Related Factors upon CO_2 Emissions in Central–Eastern European Countries by Using Machine Learning Algorithms and Panel Data Analysis. *Energies* **2021**, *14*, 2775. [CrossRef]
42. Camboim, G.F.; Zawislak, P.A.; Pufal, N.A. Driving Elements to Make Cities Smarter: Evidences from European Projects. *Technol. Forecast. Soc. Chang.* **2019**, *142*, 154–167. [CrossRef]
43. De Marco, A.; Mangano, G. Evolutionary Trends in Smart City Initiatives. *Sustain. Futures* **2021**, *3*, 100052. [CrossRef]
44. Honnurvali, M.S.; Gupta, N.; Goh, K.; Umar, T.; Kabbani, A.; Nazecma, N. Can Future Smart Cities Powered by 100% Renewables and Made Cyber Secured-A Analytical Approach. In Proceedings of the 2019 IEEE 12th International Conference on Global Security, Safety and Sustainability (ICGS3), London, UK, 16–18 January 2019; pp. 206–212.
45. Min, K.; Yoon, M.; Furuya, K. A Comparison of a Smart City's Trends in Urban Planning before and after 2016 through Keyword Network Analysis. *Sustainability* **2019**, *11*, 3155. [CrossRef]
46. Parlina, A.; Ramli, K.; Murfi, H. Exposing Emerging Trends in Smart Sustainable City Research Using Deep Autoencoders-Based Fuzzy C-Means. *Sustainability* **2021**, *13*, 2876. [CrossRef]
47. Caragliu, A.; Del Bo, C.F. Do Smart Cities Invest in Smarter Policies? Learning From the Past, Planning for the Future. *Soc. Sci. Comput. Rev.* **2016**, *34*, 657–672. [CrossRef]
48. Nilssen, M. To the Smart City and beyond? Developing a Typology of Smart Urban Innovation. *Technol. Forecast. Soc. Chang.* **2019**, *142*, 98–104. [CrossRef]
49. Mekhdiev, E.T.; Prokhorova, V.V.; Makar, S.V.; Salikhov, G.G.; Bondarenko, A.V. Smart Cities in Future Energy System Architecture. *Int. J. Energy Econ. Policy* **2018**, *8*, 259–266.
50. ITU. *Smart Sustainable Cities: An Analysis of Definitions*; Focus Group on Smart Sustainable Cities: Geneva, Switzerland, 2014.

51. *IEC JTC 1*; Smart Cities Preliminary Report 2014. ISO: Geneva, Switzerland, 2015.
52. *PAS 180*; Smart Cities Vocabulary. BSI: London, UK, 2014.
53. Leal Filho, W.; Abubakar, I.R.; Kotter, R.; Grindsted, T.S.; Balogun, A.-L.; Salvia, A.L.; Aina, Y.A.; Wolf, F. Framing Electric Mobility for Urban Sustainability in a Circular Economy Context: An Overview of the Literature. *Sustainability* **2021**, *13*, 7786. [CrossRef]
54. Tricco, A.C.; Antony, J.; Zarin, W.; Strifler, L.; Ghassemi, M.; Ivory, J.; Perrier, L.; Hutton, B.; Moher, D.; Straus, S.E. A Scoping Review of Rapid Review Methods. *BMC Med.* **2015**, *13*, 224. [CrossRef]
55. Moher, D.; Stewart, L.; Shekelle, P. All in the Family: Systematic Reviews, Rapid Reviews, Scoping Reviews, Realist Reviews, and More. *Syst. Rev.* **2015**, *4*, 183. [CrossRef]
56. Cartaxo, B.; Pinto, G.; Soares, S. The Role of Rapid Reviews in Supporting Decision-Making in Software Engineering Practice. In Proceedings of the 22nd International Conference on Evaluation and Assessment in Software Engineering, Christchurch, New Zealand, 28–29 June 2018; pp. 24–34.
57. Mourão, E.; Pimentel, J.F.; Murta, L.; Kalinowski, M.; Mendes, E.; Wohlin, C. On the Performance of Hybrid Search Strategies for Systematic Literature Reviews in Software Engineering. *Inf. Softw. Technol.* **2020**, *123*, 106294. [CrossRef]
58. Motta, R.C.; de Oliveira, K.M.; Travassos, G.H. A Conceptual Perspective on Interoperability in Context-Aware Software Systems. *Inf. Softw. Technol.* **2019**, *114*, 231–257. [CrossRef]
59. Hong, V.N.H.; Anh, L.T. Development Trends of Smart Cities in the Future—Potential Security Risks and Responsive Solutions. *Adv. Sci. Technol. Eng. Syst. J.* **2020**, *5*, 548–556. [CrossRef]
60. Meadows, M.; Kouw, M. Future-Making: Inclusive Design and Smart Cities. *Interactions* **2017**, *24*, 52–56. [CrossRef]
61. Bibri, S.E. Data-Driven Smart Sustainable Cities of the Future: An Evidence Synthesis Approach to a Comprehensive State-of-the-Art Literature Review. *Sustain. Futures* **2021**, *3*, 100047. [CrossRef]
62. Schima, R.; Paschen, M.; Dietrich, P.; Bumberger, J.; Goblirsch, T. City of the Future: Urban Monitoring Based on Smart Sensors and Open Technologies. In Proceedings of the 8th International Conference on Sensor Networks; SCITEPRESS—Science and Technology Publications: Prague, Czech Republic, 2019; pp. 116–120.
63. Allam, Z.; Jones, D.S. Future (Post-COVID) Digital, Smart and Sustainable Cities in the Wake of 6G: Digital Twins, Immersive Realities and New Urban Economies. *Land Use Policy* **2021**, *101*, 105–201. [CrossRef]
64. He, Z.; Haasis, H.-D. A Theoretical Research Framework of Future Sustainable Urban Freight Transport for Smart Cities. *Sustainability* **2020**, *12*, 1975. [CrossRef]
65. Ahmed, S.H.; Rani, S. A Hybrid Approach, Smart Street Use Case and Future Aspects for Internet of Things in Smart Cities. *Future Gener. Comput. Syst.* **2018**, *79*, 941–951. [CrossRef]
66. Ibrahim, M.; El-Zaart, A.; Adams, C. Smart Sustainable Cities Roadmap: Readiness for Transformation towards Urban Sustainability. *Sustain. Cities Soc.* **2018**, *37*, 530–540. [CrossRef]
67. Haque, A.K.M.B.; Bhushan, B.; Dhiman, G. Conceptualizing Smart City Applications: Requirements, Architecture, Security Issues, and Emerging Trends. *Expert Syst.* **2022**, *39*, e12753. [CrossRef]
68. Ugolini, M.; Smith, E. A Closer Look to the Future of Smart Cities. In Proceedings of the 2019 CTTE-FITCE: Smart Cities & Information and Communication Technology (CTTE-FITCE), Ghent, Belgium, 25–27 September 2019; pp. 1–6.
69. Phuyal, S.; Bista, D.; Bista, R. Challenges, Opportunities and Future Directions of Smart Manufacturing: A State of Art Review. *Sustain. Futures* **2020**, *2*, 100023. [CrossRef]
70. Statista Research Department Internet of Things (IoT) Connected Devices Installed Base Worldwide from 2015 to 2025. Available online: https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/ (accessed on 24 February 2022).
71. Anthopoulos, L.G. *Understanding Smart Cities: A Tool for Smart Government or an Industrial Trick?* Public Administration and Information Technology; Springer International Publishing: Cham, Switzerland, 2017; Volume 22, ISBN 978-3-319-57014-3.
72. Mohamed, N.; Al-Jaroodi, J.; Jawhar, I.; Idries, A.; Mohammed, F. Unmanned Aerial Vehicles Applications in Future Smart Cities. *Technol. Forecast. Soc. Chang.* **2020**, *153*, 119293. [CrossRef]
73. Bibri, S.E.; Krogstie, J. A Novel Model for Data-Driven Smart Sustainable Cities of the Future: A Strategic Roadmap to Transformational Change in the Era of Big Data. *Future Cities Environ.* **2021**, *7*, 3. [CrossRef]
74. Wey, W.-M.; Ching, C.-H. The Application of Innovation and Catapult Research Techniques to Future Smart Cities Assessment Framework. In Proceedings of the 2018 International Conference on System Science and Engineering (ICSSE), Taipei, Taiwan, 28–30 June 2018; pp. 1–6.
75. Bibri, S.E.; Krogstie, J. Data-Driven Smart Sustainable Cities of the Future: A Novel Model of Urbanism and Its Core Dimensions, Strategies, and Solutions. *J. Futures Stud.* **2020**, *25*, 77–94.
76. Monreal, C.O. Future Urban Mobility Group: Smart Cities Research Institute Swinburne University of Technology, Melbourne Australia [ITS Research Lab]. *IEEE Intell. Transport. Syst. Mag.* **2018**, *10*, 203–205. [CrossRef]
77. Bibri, S.E.; Krogstie, J. A Scholarly Backcasting Approach to a Novel Model for Smart Sustainable Cities of the Future: Strategic Problem Orientation. *City Territ Arch.* **2019**, *6*, 3. [CrossRef]
78. Bibri, S.E.; Krogstie, J. Generating a Vision for Smart Sustainable Cities of the Future: A Scholarly Backcasting Approach. *Eur. J. Futures Res.* **2019**, *7*, 5. [CrossRef]
79. Kourtit, K.; Nijkamp, P.; Arribas, D. Smart Cities in Perspective—A Comparative European Study by Means of Self-Organizing Maps. *Innov. Eur. J. Soc. Sci. Res.* **2012**, *25*, 229–246. [CrossRef]
80. Caragliu, A.; Del Bo, C.; Nijkamp, P. Smart Cities in Europe. *J. Urban Technol.* **2011**, *18*, 65–82. [CrossRef]

81. Deakin, M.; Al Waer, H. From Intelligent to Smart Cities. *Intell. Build. Int.* **2011**, *3*, 140–152. [CrossRef]
82. Nam, T.; Pardo, T.A. Conceptualizing Smart City with Dimensions of Technology, People, and Institutions. In Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times, College Park, MD, USA, 12–15 June 2011; pp. 282–291.
83. Bibri, S.E.; Krogstie, J. Smart Sustainable Cities of the Future: An Extensive Interdisciplinary Literature Review. *Sustain. Cities Soc.* **2017**, *31*, 183–212. [CrossRef]