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Review

Smart, Sustainable, Green Cities: A State-of-the-Art Review

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Abstract: This state-of-the-art review paper aims to provide an overview of the current research on three categories of liveable cities, Smart, Sustainable, and Green (SSG). It explores how the discussions about these three categories have been brought together in the literature and identifies an integrated approach to developing more liveable cities of the future. The paper begins by introducing the research topic and methodology, setting out a broad definition for SSG cities as a starting point. Then, the review focuses on recent publications and research trends, with an emphasis on the most significant contributions to the convergence of the SSG categories. Special attention is paid to identifying gaps in current knowledge and suggesting areas for future research. Reviewing recent resources based on our inclusion and exclusion criteria in depth, using 11 relevant themes within the three aforementioned categories, provides a comprehensive and up-to-date summary of the current state of research in developing more liveable cities. Moreover, a summary of the main findings, providing a holistic view of the liveable future cities and implications for further research, policy, and practice offers a helpful resource for scholars, practitioners, policymakers, city authorities, consultants, and solution providers for SSG cities.

Keywords: smart cities; sustainable cities; green cities; sustainability; city systems integration; sustainable development; livability; well-being; net-zero; environment

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1. Introduction

1.1. Context

Urbanisation is a trend that has been growing for several decades and is expected to continue in the coming years. Already over half of the global population lives in urbanised areas and according to the United Nations, it is projected that by 2050, approximately two-thirds of the world's population will be living in urban areas. The continued trend of rapid urbanisation presents both opportunities and challenges for cities and the people who live in them [1,2]. While cities only take up approximately 2% of land and are hailed as potentially offering efficiencies, diversity and societal and economic advancement, ironically they currently consume approximately 60–80% of global energy [3].

Urbanisation challenges include increased demand for good quality and affordable housing, transportation, and other infrastructure, as well as environmental issues, such as air pollution, water scarcity, and climate change impacts (e.g., increased occurrences and intensities of heatwaves, flooding and storms) [4]. The rapid growth of urban areas can also lead to social and economic inequality, as not all residents may have equal access to the benefits of urban life [5]. To address these challenges, it is important for cities to adopt sustainable and inclusive urban development strategies. This can include measures such as improving public transportation, promoting green spaces and energy-efficient buildings, and investing in affordable housing and social services. It is also important to engage residents and communities in the planning and decision-making process to ensure that the needs and priorities of all residents are taken into account [6]. In practice, these challenges are often addressed within separate sectoral "silos" that limit the integration

of policies [7,8]. In parallel, the academic literature is bursting with new or alternative categories of sustainable city/urban development.

On the other hand, there is a global challenge related to the link between population growth, material consumption and sustainability [9–11]. Population growth and increased levels of living standards can put a strain on natural resources, such as water, land, and energy, and negatively impact the integrity and health of ecosystems. As the population grows, there is an increased demand for these resources. If these resources are not used in a sustainable way (which is in most cases), they become depleted or polluted, leading to environmental degradation and a decline in the quality of life for people and other species [12]. For example, in the United Kingdom, there is a significant challenge in how it uses and manages its finite land resources. Indeed, there are unrealistic expectations of the ability of finite land resources to meet society's multiple demands [13].

Concepts such as sustainability, sustainable development, sustainable city, green city, smart city, or eco-city, often appear to be used uncritically and interchangeably [14]. De Jong et al. [15] considered the relatively weak theoretical basis for these categories and suggests only six are conceptually robust; 'sustainable city', 'smart city', 'eco-city', 'low carbon city', 'resilient city' and 'knowledge city'.

Smart cities are an innovative response to the challenges presented by urbanisation. As more people move to cities, the need for efficient infrastructure and services, enabled by cutting-edge digital technologies and useable information, appears to offer promising solutions [16]. According to [17], the concept of a smart city involves the integration of processes, people, technology, and data into various aspects of urban life, including transportation, healthcare, energy, education, and so on. By using data analytics, enabled by technologies (e.g., sensor, digital twin, machine learning, and so on), efficient information can be generated and carried by city processes (designed and accepted by city authorities and citizens) across the city sectors, so that smart cities are able to optimise the use of resources, reduce waste, and improve the quality of life for residents [17,18]. This can help address a range of urban challenges, such as traffic congestion, air pollution, water scarcity, and public safety. For example, [19] highlight that smart transportation systems can use real-time data to optimise traffic flows and reduce congestion, while smart buildings can use sensors and automation to improve energy efficiency and reduce environmental impact. They also comment that smart cities can foster innovation and economic growth. By creating an ecosystem of technology companies, start-ups, and research institutions, smart cities can attract investment and talent, and generate new business opportunities [19].

1.2. The Motivation for the Research and Formulation of Research Questions

It is generally understood that a smart city must also be sustainable [20,21]. Yet, there is limited or sparse evidence for the alleged and wider sustainability benefits of smart cities, including attention to the smart city governance [22,23]. The literature suggests that social, environmental and community aspects of the smart city have not been sufficiently integrated into the smart city research and policy agendas [24–26]. This has underplayed the role of social and environmental capital and participation by its citizens [27]. Even the Natural (or Biophilic) city paradigm represents a silo based on nature-based solutions to urbanisation challenges [28,29].

Limited attention has been paid to the convergence of 'green' or 'natural' cities and smart cities, though [30,31] developed a hierarchical target system for smart-compact-green cities, considering compact cities as spatially more sustainable. Similarly, explicit attention to the added value and benefits for the urban environment and its citizens from

integrating Smart, Sustainable, and Green (SSG) in the context of cities and urban communities has to date been scarce [32]. Furthermore, awareness of the impacts of the COVID-19 pandemic andthe importance of tackling climate and biodiversity emergencies through spatial planning and management, with city regions playing a crucial role, requires that we reconsider these categories in an integrated and holistic manner [33,34]. The convergence is essential if we are to make the best use of land and other resources, achieve a just transition to Net Zero Carbon, enhance public well-being and improve access to enhanced nature and biodiversity.

The purpose of this state-of-the-art research is to move beyond the multiple and numerous categories of city design and format; hence, it aims to better understand the current situation in the body of knowledge regarding the explanation of the relationship between smart, sustainable, and green in the context of future liveable cities. Thus, we have sought to explore how the academic literature is integrating the key themes of SSG cities. In turn, we expect this to help us identify how to address narrowly framed and disintegrated working that is a barrier to improving cities and urban places for current and future generations. This would create a foundation for providing guidelines, roadmaps, and frameworks, as well as catalyse more holistic approaches to future research to help develop tools and techniques to adjust city development trajectories towards being sustainable, smart, and green.

Therefore, this research will try to address the following research questions in general:

1. What are the noticeable developments/achievements in research regarding the convergence of 'smart', 'sustainable', and 'green' cities?
2. What are the most important research areas that have been overlooked, but need to be developed for future SSG research, as well as for practitioners?

The introduction section of this study, which provided a background on the topic and the research questions, is followed by a materials and methods section that outlines the study design, the review approach, resource selection and analysis used to answer the research questions. Next, the results section presents the findings of the study, with the help of tables and figures to initiate a discussion about the existing research about the convergence of smart, sustainable, and green concepts for developing liveable cities of the future. In Section 4, the findings of the state-of-the-art review are integrated and discussed and a holistic view of a liveable city incorporating the concepts of SSG is offered. Finally, in Section 5, the conclusions are presented summarising the main findings of the study and contributions to the field. In addition, this section offers several recommendations for further studies based on the findings of this research. It also explains the limitations of the study and how the authors attempted to minimise them.

2. Materials and Methods

To address the aim of this research and answer the research questions, a State-of-The-Art (SoTA) review of the literature was carried out. We undertook this in three phases: Material Search, Material Selection and Material Analysis (material refers to all documents including journal articles, conference papers, and book chapters) identified by this study. The steps within these three phases are summarised in Figure 1.

As illustrated in this figure, the review and analysis of this research included nine main activities, which are categorized in three phases, material search, material selection, and material analysis, and are explained in the following sections.

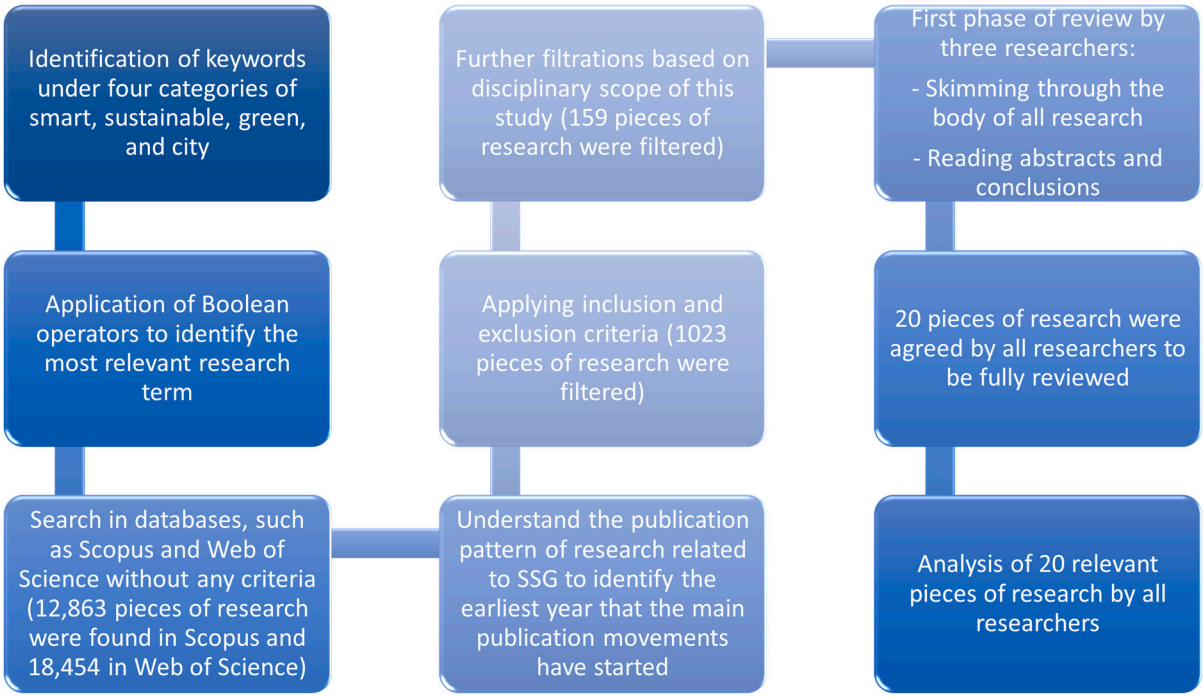

Figure 1. A summary of the steps to conduct SoTA review in this study.

2.1. Material Search (Search Terms, Databases)

The review focused on identifying research relating to SSG cities and associated keywords. Our study identified groups of keywords under the following four headings to find relevant papers for analysis:

- Group-1 (Smart): there have been several SoTA research reviews on smart cities (e.g., [35–39], each of which used various keywords and search terms for identifying research regarding smart cities. Assessing the previous search terms led us to prepare the following list of commonly used keywords for this group: 'smart', 'intelligent', and 'digital'.
- Group-2 (Sustainable): 'sustainable' seems to be the most used word by previous researchers when studying the future of cities. There are also a few keywords related to the sustainability of cities listed as follows: 'sustainable', 'liveable', and 'maintainable'.
- Group-3 (Green): this keyword has been utilised interchangeably (in the existing research) with other keywords for the future city agenda. The members of this group are: 'green', 'zero emission', 'net zero', 'low carbon', zero carbon', and 'natural'.
- Group-4 (City): for the purpose of this study, all of the keywords listed in the above three groups have been added to 'city', 'cities', 'places', and 'urban areas'.

For these four groups, we applied Boolean operators to identify the most relevant research term for this study: ('smart' OR 'intelligent' OR 'digital') AND ('sustainable' OR 'liveable' OR 'maintainable') AND ('green' OR 'zero AND emission' OR 'net AND zero' OR 'low AND carbon' OR 'zero AND carbon' OR 'natural') AND ('city' OR 'cities' OR 'places' OR 'urban AND areas').

We first used the Scopus and Web of Science databases to identify relevant publications without applying inclusion/exclusion criteria and filtrations. Our initial search found 12,863 documents through the Scopus database and 18,454 in Web of Science. As illustrated in Figure 2, this helped us to better understand the pattern of publication by year. The figure shows that the majority of research publication movements within this research topic was from 2011 to 2012, initially increasing slowly and then more steeply from 2017, with the most significant increase in 2021.

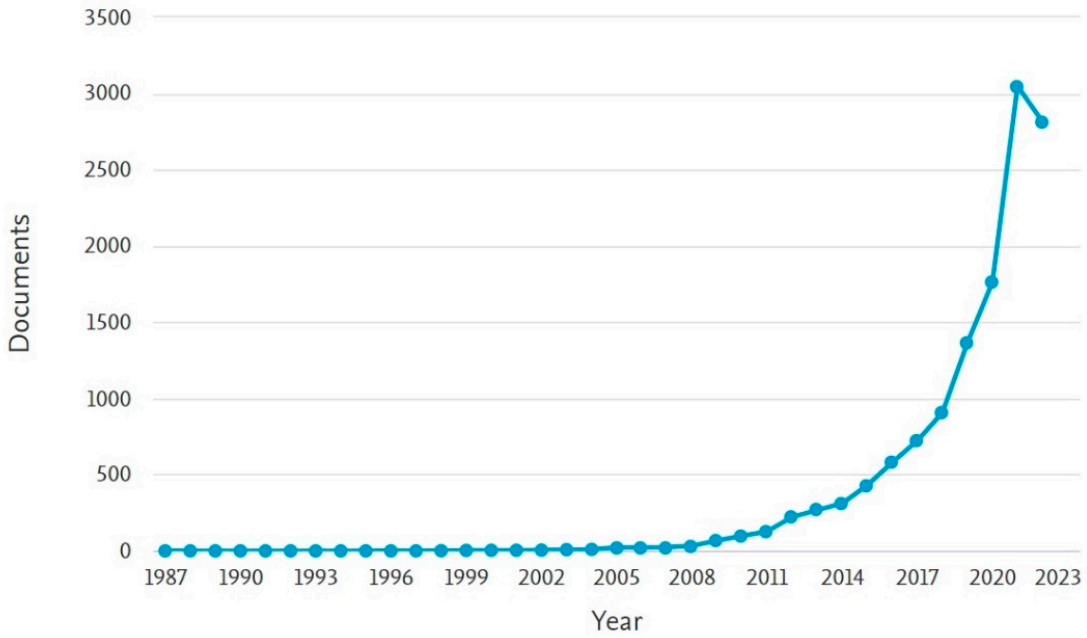

Figure 2. The publication pattern for papers related to SSG cities based on this study's search terms.

2.2. Material Selection (Filtration)

We consequently used these findings to help set inclusion/exclusion criteria and improve our search. We based the targeted search on using the following inclusion and exclusion criteria:

- Inclusion criteria:
  - The paper must address at least one of the members of each of the search term groups;
  - The approach used in the publication must be clear and rigorous;
  - The publishing year must fall between 2017 and 2022;
  - Only journal articles, conference papers, and book chapters are included;
  - The paper must be written in the English language.
- Exclusion criteria:
  - Articles that are not peer-reviewed are excluded;
  - Papers published before 2017 are excluded;
  - White papers are excluded;
  - Non-indexed conference papers are excluded;
  - Articles written in languages other than English are excluded;
  - Articles irrelevant to the search term groups of the study explained above are excluded.

This filtration reduced the number of documents to 1023 in Scopus and 863 in Web of Science. However, several research publications were identical in the two databases and the number was thereby further reduced.

We found that several research publications were still out of the disciplinary scope of this study, even though they were presented by the database. Hence, we subsequently identified five relevant subject categories, including management, computer science, energy, environmental science, and social science, which were provided by the databases to filter the results. Within these categories, several fields were also irrelevant and reviewing the papers in those fields revealed that the research papers were not aligned with the purpose of SSG cities. Applying the most relevant subjects based on the Scopus and Web of Science filtration facilities, we filtered the identified documents within the following subject areas:

- Business, Management, and Accounting => Management Information Systems, Management of Technology and Innovation, Strategy and Management

- Computer Science => Information systems
- Energy => Renewable Energy, Sustainability and the Environment
- Environmental Science
- Multidisciplinary
- Social Science => Communication, Development, Urban Studies

Consequently, a total of 159 papers were identified to move through the first phase of review. The authors independently skimmed through all 159 papers and identified the papers that had elements related to SSG. Next, the authors analysed and merged the results from these independent reviews and found that 20 publications included a discussion regarding all three topics of SSG. The abstracts and conclusion sections of these 20 pieces were fully read and assessed in this phase to assure their relevance. The other sections were mainly skimmed through, except in a few cases where other sections were also fully read to assure coverage of all three parts of SSG was evident.

2.3. Material Analysis

In this phase, the researchers fully reviewed the material based on the characteristics of SSG cities, extracted from the main themes, which are common across most of the definitions suggested by existing researchers, summarised in Table 1.

Table 1. Key themes within the definitions of Smart, Sustainable and Green Cities.

Context	Definitions
Smart city	The use of Smart Computing technologies to make the critical infrastructure components and services of a city—including city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient [40] (p. 9).
	The smart city refers to a local entity, i.e., a distinct city, region or small locality that takes a holistic approach to employ information technologies with real-time analysis to encourage sustainable economic development [41] (pp. 661–662).
	A system of systems in which integration of cross-sectoral city systems has been accomplished, enabling access to real-time information and knowledge by all the city sectors, providing integrated services, and enhancing liveability, workability, and sustainability for the citizens [17] (p. 108025).
	Smart cities/smart neighbourhoods/smart urban places are the those that use innovative concepts, technological advancements, and non-technological resolutions to provide better services to their residents and enhance their quality of life [42] (p. 8).
	A city that provides innovative solutions, in collaboration with its citizens and with the support of technology, to solve the specific challenges of its territory in the domains of mobility, economy, governance, environment, living, and people [43] (p. 1).
Sustainable city	A city/society that can be maintained for many centuries [44] (p. 7).
	"A Sustainable city is one that is able to retain the supply of natural resources while achieving economic, physical, and social progress, and remaining safe against the environmental risks that can undermine any development achievement" (United Nations, cited in [45]) (p. 1271).
	For a city to be considered sustainable, certain important elements must be present. These elements (sustainable education, renewable energy, energy efficiency, sustainable transportation, sustainable buildings, waste management, etc.), when combined with informed and willing inhabitants, may realize dividends of sustainability [3] (pp 973–974).
	A sustainable city can be described as an urban environment designed with the primary aim of contributing to improved environmental quality and protection and social equity and well–being over the long run, which can be attained through adopting sustainable development strategies to foster advancement and innovation in the built environment and related infrastructure, operational functioning, planning, and ecosystem and human service provisioning, while continuously optimizing efficiency gains [46] (p. 193).

Table 1. *Cont.*

Context	Definitions
	A sustainable city is 'a city that works so that all of its citizens are able to meet their own needs without endangering the well-being of the natural world or the living conditions of other people, now or in the future [47] (p. 13).
Green city	The greening of cities requires some, or preferably all, of the following: (i) reduction of chemical and physical hazards, (ii) control over environmental impacts on health, (iii) the creation of quality environments for all, (iv) minimized ecological footprints outside the urban area, (v) ensured sustainable consumption, and (vi) adaptation to climate change impacts [48] (pp. 24–25).
	A Green City is a city that takes responsible political and societal action in order to achieve high environmental quality. In particular, through green and blue infrastructure that enables the enhancement of urban ecosystems, ecological recovery and access to greenspace, which by itself contributes to human well-being [49] (p. 6).
	A Green City is a city which shows high environmental performance relative to established benchmarks in terms of (i) quality of environmental assets (air, water, land/soil and biodiversity), (ii) efficient use of resources (water, energy, land and materials) and (iii) mitigating and adapting to risks deriving from climate change, while maximising the economic and social co-benefits and considering its context (population size, socio-economic structure and geographical and climate characteristics) [50] (p. 46).
	The green cities concept (GCC) and its strategies are considered an optimum approach to achieve sustainable development objectives and overcome these challenges, by enhancing performance for the existing infrastructure, reducing natural resource consumption, decreasing CO_2 emission, and engaging citizens in decision-making [51] (pp. 1–2).

The themes extracted from the above definitions are set out in Table 2.

Table 2. Key themes within the definitions of Smart, Sustainable and Green Cities.

Context	Key Themes
Smart	IT-enabled services, city systems, integration, integrated services, system of systems (SoS), city sectors
Sustainable	Retaining natural sources, economic well-being, social well-being, physical/environmental well-being, reducing environmental risks
Green	Political and societal actions, carbon neutral/net zero, ecological recovery, increasing biodiversity

This research phase is illustrated in Figure 3. As shown in this figure, when the alignment of the material with the inclusion and exclusion criteria was justified and the resources were fully read and reviewed, the areas of the text which were relevant to these key themes were highlighted, assessed, and discussed within the research team, so that the relevance of every material to smart, sustainable, and green were identified and recorded. When a new theme emerged, it was added to the list of themes. This was carried out for every category (i.e., smart, sustainable, and green separately). Finally, we realised that some of the themes were similar, so they were merged to enhance the efficiency of the analysis The design of this analysis was mainly carried out using Creswell's research design approach [52].

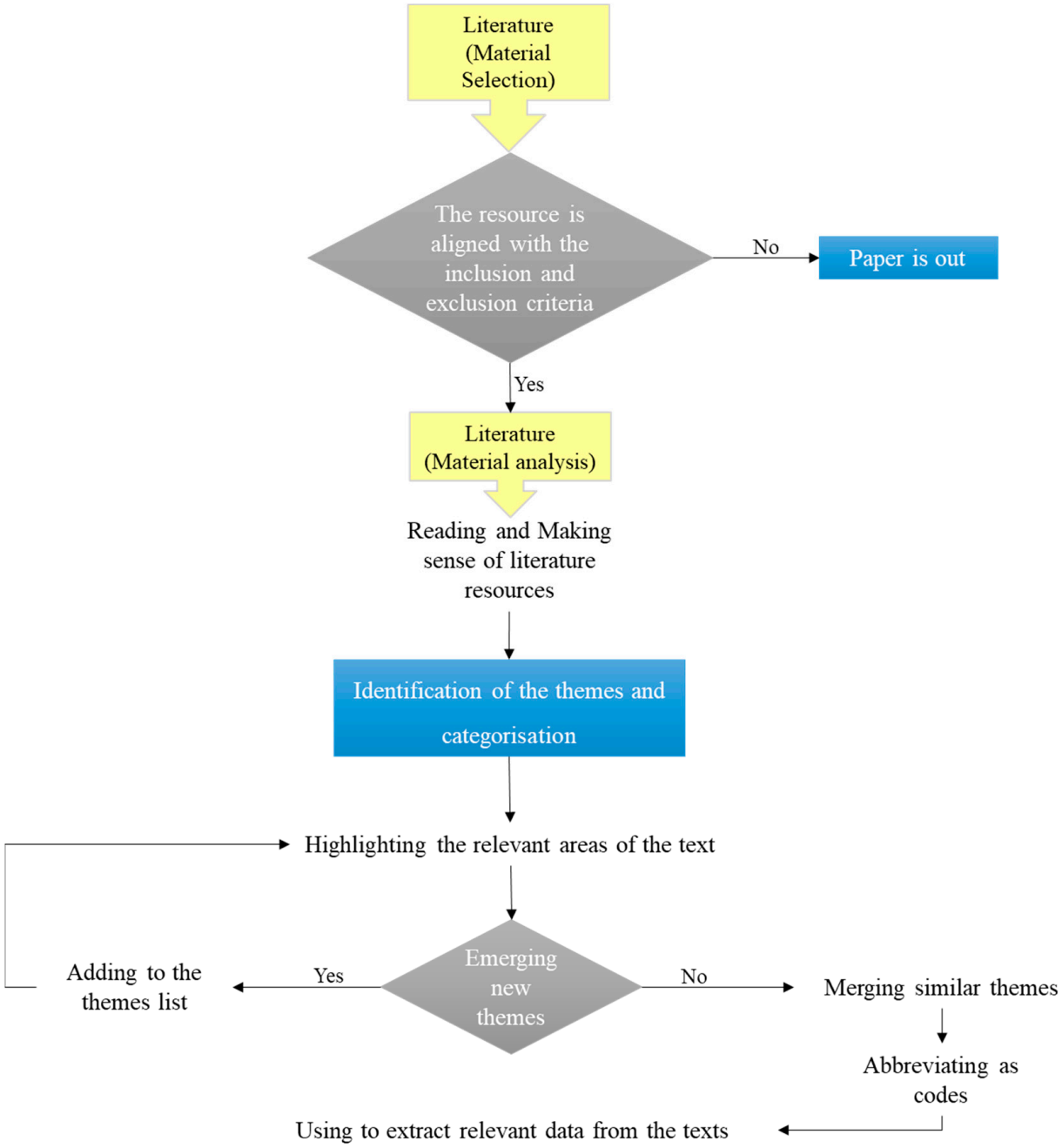

Figure 3. The publication pattern for papers related to SSG cities based on this study's search terms.

3. Results

As noted, 20 pieces of research were identified as the most relevant studies, which aligned with the inclusion and exclusion criteria of this study for conducting the SoTA research. Table 3 provides a list of these research publications along with a note on their focus which was extracted after the first full review of each of them. For the convenience of analysis and report, the pieces (P) of research have been coded from P1 to P20 in descending chronological order of publication. Next, the pieces of research will be introduced in more detail.

Table 3. List of identified papers for SoTA review in this study.

Code	Focus	Reference
P1	Sustainability and green management	[53]
P2	Low-carbon, city policy, green technology, sustainable development	[54]
P3	Digital transformation, sustainability	[55]
P4	Green environment, reducing carbon emission	[56]
P5	Digital transformation, energy efficiency	[57]
P6	Smart city concept, sustainability	[58]
P7	Digitalization, environmental sustainability	[59]
P8	Sustainable development, social-economic-natural ecosystem	[60]
P9	Carbon-neutral cities, urban computing/analytics, and climate actions	[61]
P10	Climate change and COP26, digital technologies, information management	[62]
P11	Sustainable, green, and resilient city	[63]
P12	Smart city, sustainability, decarbonization	[64]
P13	Sustainability, environmental risks	[65]
P14	Smart cities, renewable energies, sustainability	[66]
P15	Smart cities, sustainable urbanism, big data	[67]
P16	Urban sustainability, smart cities, green cities	[68]
P17	Sustainability, enhancing people's awareness of environmental issues	[69]
P18	Governance, climate change	[70]
P19	Sustainable urban development, net zero	[71]
P20	Smart sustainable cities, ICT enablers	[72]

3.1. Summaries of the 20 Pieces of Research

P1 is a literature review-driven paper which suggests a theoretical model linking societal environmental strategies with business organisational strategies in order to increase levels of integrity in 'green' credentials (for businesses). The paper does not provide any sense of the scale of 'integrity' that can be achieved. It connects societal/environmental and organisational strategies at the city scale, but not in a smart system of systems sense. It concludes that organisations can develop green management styles linked to the environment and resource protection strategies, and so become green organisations.

P2 also explores the relationship between city-wide low carbon policy (in China) and the impact of business organisations' innovation in green technology. It finds that China's state low-carbon pilot city policy can significantly promote (small and medium) enterprises' green technology innovation and therefore, China's green and low-carbon development. Therefore, the state can encourage enterprises to develop digital transformation. Green technology innovation is of great significance to enterprises' sustainable development. As such, the paper does address societal sustainable development through the connection between policy and business 'green innovation'. Generally, this is not a paper which looks at city systems and cross-sectoral integration, nor does it explore various dimensions of smart city development. However, since digital transformation is found to be an important topic of this paper, it can be said that systems integration and viewing a city as a system of systems can be inferred from the research.

P3 is a literature review to address the question of 'how digital transformation can assist sustainability improvement' with a focus on business and management. This is a growing area of interest for academic research and there is an absence of strategic academic studies on 'digital sustainability'. 'Smart' and 'Systems integration' is not significantly discussed in this paper. 'Place' is hardly noted, biodiversity and nature are not component

terms of sustainable or green. However, the concept of systems integration and connectivity for smart cities can also be inferred from this paper. It leans on the notion that, although sustainability is unarguably one of the growing trends, it has been insufficiently discussed as an application for digital technology. This is a uniqueness in the management literature, as it is widely known that leading organisations are increasingly using such technologies to transform their business models with the purpose of better tackling societal challenges. The proposed research joins the current conversation on the reconciliation between sustainability challenges and innovation practices, further advancing it with a critical focus on digital transformation. Looking to clarify the comprehensive use of digital transformation for sustainability purposes, this work analyses the extant academic literature on the relationship between digitalization and sustainability.

P4 describes mathematical modelling undertaken to assess the benefits of green infrastructure (GI) for reducing temperatures in microclimates and for carbon sequestration. The results show the practical benefits of GI applications around buildings and places. This is at the level of local design rather than city systems or integration of multiple systems.

P5 highlights the role of the high-tech industrial sector to achieve energy efficiencies and develop low-carbon economies. Promoting energy efficiency in the hi-tech sector generates a positive impact because of the nature of their business and innovative practices. The paper relates to 'sustainability' very strongly and 'green-related topics' are addressed directly through the issue of carbon and sector-scale societal actions. The conclusions may have relevance (but are not explicit in terms of 'smart') to urban systems and industrial strategy in the UK. First, actions should be taken to develop high-tech industries. Especially, the productivity and spatial agglomeration of high-tech industries should receive more attention than scale expansion for improving energy efficiency, and further achieving sustainable economics. Promoting technological innovation is viewed as being critical for higher energy efficiency, which further helps to achieve climate change goals. Thus, technological innovation should be set as the goal of strengthening industrial productivity and agglomeration. Efforts should be made to promote the transformation and upgrading of industrial structure, in order to increase energy efficiency.

P6 relates to a discussion within Romania about the move towards more sustainable practice in four areas the authors identified as important from the literature: transport, waste management, e-governance, and renewable energy. It frames this within a progression to 'smarter' cities, considering four Romanian cities. The themes are considered at a project level, rather than city systems or system of systems. The authors conducted two types of research. The first was a comparative analysis of the most important results of smart city projects implemented in the four reference cities compared to London (this being taken as representative of a smart city). Second, a quantitative analysis was conducted to identify the opinions, attitudes and perceptions of citizens (from the four reference cities) regarding the smart city concept. The paper proposes the development of a smart-sustainable city index to show progress and the division of cities from a Smart City point of view. It is not explained how this will be done or whether it will be an improvement on existing indices and lacks detailed insights on the delivery of smart, sustainable and green urban development goals. The authors suggest the value of this paper lies in the analysis of the concept from both parties: what the authorities did to become a Smart City and the point of view of consumers; the paper shows that the barriers to Smart City development primarily consist of a lack of information and lacking education of the population. They conclude that the concept, and especially the philosophy, of a Smart City, presupposes the transition from a passive consumer of resources (transport, infrastructure, health, education, etc.) to a prosumer, a person who creates resources (by producing more than they consume).

P7 directly connects digital transformation with environmental protection and considers the latter in its whole breadth, including biodiversity and ecosystems. It references the actions of companies and then uses national datasets to analyse the nexus between environment and digital. It describes the relationships between different environmental issues and the transformational impact of digital skills, services, etc. The results and conclusions seem

mostly aimed at informing policy. The replacement of physical with virtual mechanisms is seen as positive, though the energy consumption by digital is negative. It points towards considering the interplay of themes and therefore, city systems. In the paper, some systems thinking also alluded to the impact of digitalization on the relationship between ecosystems and human well-being under industrialization and urbanization. It notes that the adoption of digital technologies—such as big data, cloud computing, and artificial intelligence—can address the problems of resource shortages, traffic congestion, and air pollution.

P8 aims to help policymakers integrate systems that collectively deliver sustainable development. It takes an integrating and systems approach and identifies natural, economic and social sub-systems and 21 indices for a particular case study region. It finds that the natural sub-system is the most important (of the three) and needs greater protection and enforcement. As such, the research generally addresses smart, green and sustainable. Based on the analysis of this research paper, recent studies of sustainable urban development from the perspective of compound ecosystems show that attention must be paid to the synchronous and balanced development of economic, social, and ecological infrastructures.

In P9, inter-collaboration and interoperability across the city sectors were considered significant elements to progress towards green cities. Hence, the convergence of smart and green was properly addressed. However, the paper then concentrates on urban intelligence and the necessity of data analytics and knowledge generation for moving towards carbon-neutral cities. Hence, the paper provides a diagram to connect smartness (mainly focusing on urban data intelligence) and carbon naturality. The paper then discusses the importance of considering the fact that smartness would not always guarantee a green city, while sustainability and green are core values of smart cities. It also mentions the use of more sustainable resources and the necessity of reducing carbon emissions when becoming smarter and enabled by technology. It also emphasises that achieving the objectives of carbon reduction and green cities requires considering socio-technical challenges. The paper then adds ecological aspects and connects them to the intercommunication between sub-systems of the city system to explain the pathway towards carbon neutral city. In addition, the paper nicely explains the significant role of 'process' after obtaining insight from the data using data analytics tools and techniques, in order to take appropriate actions to move toward a carbon-neutral city. Finally, the authors recommend further research on the ecological-technical-social transformation challenges of becoming a carbon-neutral city.

P10 is a paper by 37 listed authors that is mainly about the importance of the role of technology and digital transformation in achieving the objectives of Net Zero; however, at the same time, it can be problematic if this then creates a large amount of e-waste, which is counterproductive to Net Zero goals. The paper provides some discussion regarding the benefits of technology for reducing carbon emissions and improving the efficiency of business processes in various industries such as manufacturing and agriculture. On the other hand, the study highlights the drawbacks of using high-tech-enabled advancements, such as bitcoin mining and its need to use a huge amount of electricity, which negatively contributes to Net Zero by 2050. In addition, the paper describes a smart city as a digital transformation, which includes concerns about energy management, ICT waste management, and emission management to provide long-term sustainability and viability. This is the most significant point of the paper, which clarifies the relationship between smart, green, and sustainable concepts, and contributes to the purpose of our research. Next, the paper suggests several solutions to reduce carbon footprints through the use of technology for making processes smarter. In addition, it provides several insights from contributors who mainly believe that 'sustainability' can be achieved, but acknowledge that there is uncertainty if using advanced tech-enabled devices, vehicles, etc., actually reduce carbon emission in the environment as a whole or actually negatively affect climate change. This has been specifically recommended as a future research agenda by one of the contributors to this research paper. The paper provides two useful tables summarising the adverse and positive effects of digital technologies on climate change. Furthermore, the paper emphasises sustainability transition by employing a trans-disciplinary approach

and the use of socio-technical digital transformation and redesigning the higher education frameworks to generate knowledge in a different way, considering all aspects of digital transformation including human and green IT, instead of concentrating merely on the positive aspects of technology. Accordingly, the paper offers a socio-technical sustainability design cycle. The study then relates this to smart city development, which also requires considering all aspects of a socio-technical approach.

P11 focuses on sustainable, green and resilient (SGR) cities and reviews several SGR action plans, as well as companion projects funded by Multilateral Development Banks (MDBs) between 2014 and 2021. It first offers useful definitions for each term and then introduces the most significant MBDs. Next, it starts the review of the action plans based on six items: timeframes, recipients, financial costs, action plan priorities, project priorities, and the translation of action plans into companion projects. As the most significant items for the purpose of our research, the action plan and project priorities offer useful discussions. For example, based on their reviews, the intersection of green, social protection and climate resilience was identified as the most highlighted subject by the MBDs. In addition, infrastructure development, especially in transport, sanitation, energy, and water, was found to be the most prioritised project by the MBDs. In addition, based on the findings of this research, insufficient attention has been paid to social aspects of gender, youth, and poverty alleviation. Moreover, the paper provides the objectives and detailed actions for a few cities (such as Tirana) for their SGR action plans and projects.

P12 mainly focuses on smart city development and after the authors describe what they mean by smart city, the study introduces the smart city concept as one of the tools to support sustainable development. As one of the dimensions of the smart city ecosystem, the paper also introduces 'decarbonisation' as part of the smart environment and one of the requirements/dimensions of the smart city. Hence, from a Net Zero and decarbonisation viewpoint, it can be inferred that the authors consider 'green' as a significant necessity of smart city development. Next, the study also discusses sustainable development as part of a smart city, by explaining that in enabling smart cities, local governments should include creating a new system of developing and implementing services while ensuring their economic and energy efficiency and being environmentally-friendly, as well as the continuity of the services. However, in a figure, when they try to illustrate the relations between different kinds of smart city concepts, they demonstrate 'sustainable city' to include 'smart city 4-T (Trust, Tolerance, Talent, and Technology), which is based on their study of the latest version of the smart city concept. The study utilises a qualitative survey, including a questionnaire and interviews of residents and city authorities, to understand how the authorities of the selected cities incorporate smart-city and 4T-capital topics into local policies. Then, the paper reviews the literature on the concept of a smart city and explains various types of a smart city from smart city 1.0 to smart city 4.0, which includes sustainability and decarbonisation, as well as smart citizens, smart governance including smart business processes, efficient technologies and digital transformation procedures.

P13 is about the sustainability projects carried out at the University of Genoa. They used a campus within the university as a small city (based on several similar characteristics) to become smart and sustainable. The research describes a smart city as a city which respects the environment and observes/meets citizens' needs. Hence, the authors consider environmental sympathies as being part of the smart city definition, meaning that developing smart cities should also improve environmental sustainability. The paper then focuses on the smart energy element of the smart campus assessing the requirements of smart city development. Thus, the paper explains how they implemented several smart energy facilities including thermal slack, electric vehicle charging points, etc., which allowed the university to save 30% on their energy bills and helped them to better understand energy sustainability good practices.

P14 takes a conservative approach to 'smart' and (weak) sustainability considerations, focusing on innovation with little attention to 'green' beyond the term 'ecological modernization' (which links to sustainability and green). Social sustainability (equity

and inclusion) is made explicit and economic growth is assumed as a given. The 'green' and 'sustainable' city focus centres largely on 'natural resources' and urban and regional innovation. The authors see their article as bridging the gap between IT-based approaches and urban/regional innovation. Transformative qualities of 'broadband of technologies' are a key concern. The 'environment' is characterised as consisting of 'stocks' and 'flows' which are measurable. Replacing non-renewable energy with renewable energy in the built environment is seen as ecological modernization without paying attention to ecosystems or a more holistic framing and perspectives. Intellectual capital for/ICT and resulting wealth creation is a key focus. Smart, sustainable, and inclusive growth are also emphasised in the paper. The authors' core approach is the calculation of energy consumption, and carbon emission per household, reviewing and calculating retrofit 'smart' urban with their baseline, focusing on three stages: informatics, energetic and metabolic of the case study.

P15 is a state-of-the-art review addressing conceptual, theoretical, discursive and practical dimensions of ecological/green/smart/sustainable urbanism. It acts as a structured literature review, which tries to bring different strands together under the umbrella of smart and eco/sustainable. The eco-city is described as encompassing "a wide range of urban-ecological proposals that aim to achieve sustainability" [67], (p. 71). In addition to energy consideration, ecological and cultural diversity are highlighted, as well as social, management and institutional aspects and policies. The eco-city is characterised as management and integrated decision-making focused, in contrast to the compact city which is built from focus. Both, compact cities and eco-cities, are characterised by including attention to open green space and sustainable transportation. Urban growth is considered critically and realistically as imposing strains and challenges, jeopardizing rather than easily facilitating sustainability, straining urban systems and negatively impacting ecosystems and their services. Hence, smart and sustainable cities are seen as two main urbanism approaches that warrant being brought together. In addition, this paper sees 'Big Data' technologies as being able to address urban sustainability challenges. Green urbanism is described as being more ideologically driven compared to ecological or sustainable urbanism, and as adopting a triple zero framework: zero fossil-fuel energy use, zero waste, and zero emissions. Moreover, green urbanism is seen as the closest to sustainable urbanism (strong energy and waste focus). In terms of future research, policy and practice, smart sustainable urbanism is viewed as finding traction globally, but critical examination and questioning are needed to elicit the assumptions, relevance and actual performance of ICT in advancing sustainability.

P16 is the editorial to a special issue and considers urban sustainability to include smart and green approaches. A holistic framing is highlighted which cuts across science, technology, political, economic and ecological dimensions and also addresses ethics. The paper explores the links and conflicts between different approaches to urban sustainability and the need for developing a shared understanding of the synergies and trade-offs between them. The paper draws attention to the multidimensionality of urban sustainability and of the need for integrating social, economic, ecological, and technological systems as well as governance structures. The authors do not specifically focus on 'smart', but observations and arguments are included as far as smart is part of urban sustainability. Moreover, they emphasise the need for issues around inclusion (such as participatory approaches, co-ownership models, and the importance of equity) to be at the forefront of urban sustainability discussions. In terms of the degree of integration and holistic approaches, they found that papers that are evaluations or assessments are stronger at considering the integration of different aspects of sustainability, whereas papers which address a particular issue or problem do less so.

P17 is mainly focused on sustainability and the necessity of living in a greener environment. In this research, after providing some examples and statistics regarding the use of paper around the world and its impact on the environment, the authors analysed the existing work regarding sustainability issues mainly focusing on three categories: data visualisation, AR features to engage communities, and public installations to increase awareness regarding sustainability issues. Next, the authors utilised an integrated ap-

proach to visualise and provide more information about the impact of reducing the use of paper, saving trees, air pollution, etc., to provoke reactions and enhance awareness and positive behaviour in line with addressing sustainability issues. There is no direct relationship between the findings of this research and smart city development, and the authors did not attempt to generalise their findings towards addressing smart sustainable cities. However, the use of digital tools in monitoring air pollution, as well as connecting the tools and techniques to create an integrated approach for increasing awareness and enhancing people's behaviour in relation to environmental and sustainability issues, make this paper relevant to at least two focal points of our study.

P18 highlights the role of ICT to combat climate change and the need to focus more on governance issues of environmental sustainability. The paper develops and promotes two governmentality mechanisms: the 'good citizen' and the 'model city'. The authors thus emphasise the need to pay attention to citizens and an effective governance regime. Their key finding is that a smart sustainable city should not just focus on policies and mechanisms, but needs to bring the people/citizens/actors with it. In terms of 'green' and 'sustainability,' the paper focuses on energy and environmental thresholds, respectively. Regarding the smart cities discourse, the paper focused on the 'smart environment' which impacts 'smart living' and 'smart governance'; furthermore, the paper highlights smart solutions management (its organisation and processes) rather than the provision of ICT infrastructure (which seems common in many other smart city publications).

P19 takes a specific interest in social sustainability (and understandings/definitions) of 'eco-cities' alongside economic and environmental impacts, using an exploratory qualitative literature-based case study approach. The authors also emphasise the role of technological innovation, integrated sustainability planning and civic empowerment, explaining that their case study, Masdar City, uses technological innovation as their implementation focus. Masdar City embarked on new city extensions (new city infrastructure) rather than retrofit approaches for the existing urban area; furthermore, this 'project' is driven by a government-owned development company acting as the patron. In the authors' words: "This case study, thus, investigated the social, environmental and economic performance of Masdar City to ascertain its contribution to sustainable development and provide analysis of the social imperative in sustainable urban development." [71] (p. 3–13). Efforts in Masdar City are largely focused on energy and transport infrastructure with a goal of public transport being within 250 metres of every citizen and no petrol or diesel cars allowed. This case study has a strong techno-economic focus rather than promoting social or institutional change.

P20 focuses on smart sustainable cities. Four dimensions are highlighted as key to achieving the smart form of sustainability: physical, environmental, economic and social. They are to be enhanced through goal setting and adopting a long-term perspective. The author views any endeavour on this topic as requiring trans- or interdisciplinary perspectives and approaches due to its complexity. The complex and multiple possible dimensions of the smart sustainable city concept also mean multiple definitions are found in the literature. The study reviews relevant/associated concepts, underlying theories and associated disciplines and based on these, creates a transdisciplinary theoretical and conceptual framework for developing smart sustainable cities. The capacity of advanced ICT to achieve smart forms of sustainability is viewed as transformative, exerting power and change through innovative, sophisticated, disruptive and synergetic characteristics, outputs and outcomes; thus, ICT becomes an enabling, integrating and a constitutive part of cities' operations, functions, design and services, justifying ICT investment for its potential capacity to address environmental concerns and socioeconomic needs. In fact, ICT is seen as advancing a paradigm shift (urban, cultural and societal shifts) through the 'Social Shaping of Technology' (SST) and the embedding of ICT into the fabric of human lives and cities, shaping political thinking and social norms. However, what is smart is not necessarily sustainable. While the key focus is on sustainable and smart, green city elements (as in open space, ecological habitats, reducing environmental risks, zero-carbon/low energy and resource use) are touched on, and seen as a fundamental part of sustainable cities, but are

not the primary focus of the paper. Urban planning and development pose intricate and real challenges in terms of balancing the wide range of needs and interests, and thus require not only good design, but also good governance structures to deal with the tensions in planning sustainable cities and to work out the necessary trade-offs between environmental, economic and social goals (and hence in practice only achieving sustainable development partially/approximately) and good management (clarity and enforcement) to work towards equitable outcomes.

3.2. Thematic Analysis of the Reviewed Pieces of Research

A thematic analysis of these 20 papers used the themes identified in Table 2. This provided more information about the focus of each of the reviewed publications.

Table 4 presents a summary of the extent to which each paper addressed the themes within the smart, sustainable and green categories.

Table 4. The result of the thematic analysis of the identified papers in this study.

Papers	Smart			Sustainable					Green			
	System of Systems/City Sectors	City Systems Integration	IT-Enabled and/or Integrated Services	Retaining Natural Sources	Economic Well-Being	Social Well-Being	Environmental Well-Being	Reducing Environmental Risks	Political and Societal Actions	Carbon Neutral/Net Zero	Ecological Recovery	Increasing Biodiversity
P1		✓		✓	✓	✓	✓	✓	✓		✓	✓
P2			✓		✓	✓	✓	✓	✓	✓		
P3			✓	✓	✓				✓			
P4			✓	✓		✓	✓	✓	✓	✓	✓	✓
P5		✓		✓	✓			✓	✓	✓		
P6			✓	✓	✓	✓		✓	✓	✓		
P7		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
P9	✓	✓	✓	✓				✓		✓	✓	
P10			✓	✓		✓		✓		✓		
P11	✓			✓	✓	✓		✓	✓			✓
P12	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
P13			✓	✓				✓		✓		
P14	✓	✓	✓	✓	✓	✓				✓		
P15	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
P16			✓	✓	✓	✓			✓	✓		
P17			✓	✓				✓		✓		
P18	✓		✓		✓	✓		✓	✓	✓	✓	
P19			✓		✓	✓			✓	✓		
P20	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

This analysis provided the basis for further thematic interpretation of each paper, focusing specifically on how SSG was defined, interpreted, or applied within each piece. Table 5 characterizes the emphasis for each.

Table 5. Further thematic analysis of the papers in each category.

Papers	Smart Category	Sustainable Category	Green Category
P1	Less relevance to smart in the text, but the systems approach is strongly inferred.	The UN's SDGs are important topics of discussion. The governance systems are at the heart of the outputs.	Green management to the fore.
P2	Limited relevancy to the smart category in general.	Mainly focused on low-carbon cities.	Green and environment is part of the discussion, but mainly in the context of industrial technology.
P3	Systems, smart and digital are all referenced. The business focuses on sustainability.	Does not reference natural resources, the environment is clearly in scope.	Nature and Green are not noted, but a little discussion about social actions can be found in this paper.
P4	Suggests urban modelling for GI, but not systems integration.	Addresses risks and solutions via GI/trees.	Environmental quality and well-being to the fore.
P5	Smart is not referenced. Systems integration is hardly mentioned. However, smartness using technological changes can be inferred from this paper.	Resources referenced in the context of the industry.	Green and natural are hardly referenced. A little discussion about carbon emissions and social/political actions.
P6	Explicitly considers smart and systems approach.	A sustainable city is the main purpose.	Discusses natural resources rather than nature.
P7	Digital approaches more than smart systems are discussed.	Sustainable cities and environment are addressed.	Ecosystems and environment are parts of the discussion.
P8	Systems integration is covered.	Sustainability aspects are explicitly addressed.	Ecosystems and nature are addressed.
P9	Smart is one of the significant focuses of the paper; mainly from a data analytics viewpoint.	There are a few mentions about using sustainable resources when becoming smart.	Carbon neutrality is the main focus of this research. The author introduces a green city pathway using smart (urban intelligence) elements.
P10	Smart is not too significant in this paper. However, there are arguments for smart cities in a few places; mainly focusing on digital technology.	The main contribution of the paper is about bringing sustainability to technology-enabled changes.	Climate change, using green IT and reducing waste by using technologies are the most important focuses of this research.
P11	The paper does not discuss the smartness aspect of future cities in detail, but it discusses various city sectors and prioritises them for sustainable, green, and resilient (SGR) cities.	Sustainability (along with resilience) is one of the significant focuses of the research and the paper reviews the actions and projects regarding that.	Green is another important focus of this research.
P12	A smart city is the focal point of this research, in which the concept of smart was comprehensively explained.	Sustainable development is explained as an objective to develop smart city 4.0, which should include efficient use of resources and so on.	The paper emphasises the fact that decarbonisation and environmental smartness must be addressed when developing smart cities.
P13	Focus on smart and sustainable energy and implementing several facilities in order to convert a university campus to a smart and sustainable campus aligned with the requirements of a smart city.	Mainly focuses on sustainable energy and improving the sustainability of a city/place using sustainable energy.	Some discussion about zero carbon and the use of low carbon energies is provided in this study.
P14	The smart city is assumed as self-evident; the focus is on internet-based developments.	The paper focuses on 'energy' and claims that it provides an addition to SMART by linking it to sustainability aspects.	Alluded to via urban and regional 'innovation' and local/regional/national planning, but not explicitly addressed. 'Ecological modernization' is mentioned, but not explored in detail.
P15	Comprehensive approach as based on extensive literature review and own research in the area. Uses an interdisciplinary, holistic framing	Comprehensive approach as based on extensive literature review and own research in the area. Uses an interdisciplinary, holistic framing.	A comprehensive approach to cover 'green'. Uses 'eco-city as a core concept. While environmental sustainability is central, the need to balance this with social and economic interests and awareness of the political and planning context is evident.

Table 5. *Cont.*

Papers	Smart Category	Sustainable Category	Green Category
P16	Smart growth and urbanisation are defined as focusing on compact, multiuse, and dense urban design and structures.	Emphasises the multidimensionality of urban sustainability and its integration of social, ecological, economic, and technological systems.	Green here seems to include nature-based solutions, biomimicry, zero carbon and resource efficiency; also, the positive impacts on human health and well-being.
P17	Limited attention to smart. However, according to the paper, using innovative technologies such as AI-enabled data visualisation, AR, and sensor technologies promotes the sustainable development of cities, which refers to a smart concept. It can also be inferred that the use of emerging technologies enhances the awareness of people who are an imperative element of SSG development; this is seen to facilitate successful SSG cities implementation.	Sustainability is the most important focus of this research aiming to increase the awareness of people regarding sustainability issues and convey their sustainable behaviour.	Green is another focal point of this research, mainly when discussing the importance of reducing tree-cutting by decreasing paper usage and increasing digital replacements, as well as planting trees in their case studies.
P18	Discusses smart city as the use of ICT to meet the citizen needs in an efficient way without compromising meeting the future generations' needs and through the three dimensions: (i) technology and infrastructures, (ii) population, and (iii) governance and policy. It also discusses interconnection of smart with being sustainable and addressing environmental issues.	Follows in spirit the Brundtland definition that is being slightly rewritten to include environmental thresholds/planetary boundaries.	Green/environmental largely focused on in terms of 'energy' use as part of the overall focus on the city's contribution to climate change (CC), CC mitigation and CC adaptation.
P19	Discusses that SMART and ECO-city are often seen as being synonymous. Also emphasises the importance of IT to provide efficient and integrated services.	Implicitly defined as consisting of social, environmental and economic improvements, but also emphasises ethical and equity aspects.	Uses the term eco rather than green and considers it as same or similar to smart.
P20	Discusses the concept of integration which involves the application of a set of integrative foundational elements drawn from urban planning, urban design, sustainability, sustainable development, sustainability science, data science, computer science, complexity science, and ICT. Moreover, discusses the concept of systems integration by highlighting the role of innovative solutions and sophisticated ICT-enabled approaches. Although the study does not directly look at the 'system of systems' concept for developing smart cities, it can be inferred from the research, especially when discussing the necessity of integrating several principles for developing smart sustainable cities.	Sustainable city development is characterised as a holistic inter- and transdisciplinary endeavour. It discusses the principles of sustainable cities including contributing to improved environmental quality, protection, social equity and well-being over the long run. It also highlights the importance of three models being key to sustainable urban forms: (1) compact city, (2) eco-city, and (3) neotraditional development (new urbanism).	Discusses eco-city and green urbanism, as related terms to 'green cities'. It talks about the ecological agenda emphasising environmental management, as a strong strand of the concept promoting a wide range of environmental, social and institutional policies directed at urban spaces to achieve sustainability.

4. Discussion

Our findings show that increased attention has been given to developing sustainable and green cities during the last five years. In addition, nearly all the authors have directly or indirectly discussed the significance of 'smart' in urban development, enabled by digital technologies, to achieve sustainable and green cities. Nevertheless, the relationship between these three concepts has not been the explicit and detailed focus of the resources reviewed in this study.

In three papers (P7, P12, P15) most of the themes and categories of smart, sustainable, and green can be identified, and two publications (P8, P20) discuss all themes of this study (Table 4). Some publications, such as P17, P18 and P19, discuss only a limited number of the themes within the smart, sustainable, and green categories. Only in one paper (P11) is there a very limited explicit discussion about 'smart'.

In summary, the reviewed publications mainly concentrate on specific aspects within one, or between two or three of the categories, but have not explicitly and properly con-

nected 'smart', 'sustainable' and 'green'. However, the relationships between these three categories can be inferred from the findings of these papers. Hence, there are forms of discussions about all three categories in nearly all selected pieces.

4.1. Integration of Smart, Sustainable, and Green Agendas

Generally, the SoTA review of the existing studies revealed that certain themes are strongly represented in all studies, especially carbon reduction and energy and, to a lesser extent, waste management. It was also evident that social aspects (of sustainability) are underplayed although it is sometimes acknowledged that technology plays a role in enhancing community engagement. There were very few mentions of nature/biodiversity, which may suggest that the green urban sustainable city research agenda largely places its environmental focus on energy rather than ecosystems, and/or that the practitioner and policymaker's concern with the nature emergency and the role of cities has overtaken the academic.

What was not clearly seen across the existing research was a description of a systemic approach to the various layers of cities and how they could be integrated or reconciled or even support each other, although this was hinted at in a few papers such as P9. There were a couple of examples of research generating new concepts/models, such as Smart City 4-T (in P12) and sustainable, green, and resilient (in P11). However, IT-enabled systems integration to create proper interconnection across the multiple sectors of a city and its connections with and impact on sustainability and green, have not been fully discussed. At the risk of adding to the many city indexes already in the public domain, the Smart City 4-T does also beg the question of whether there would be a benefit in creating weighted scoring and relationship-working models across the SSG spectrum.

Two papers (P15 and P7) seem to be substantial pieces which have similar aims to our goal, as they review the body of knowledge and attempt to create an integrated language. However, neither fully cover the themes of each category. In addition, they do not draw a clear relationship amongst and between smart, sustainable, and green concepts in the context of developing future cities.

P15 tries to bring different strands (specifically smart and eco/sustainable) together. It takes a holistic perspective to address conceptual, theoretical, discursive, and practical dimensions of ecological, green, smart, and sustainable urbanism, by looking at overlaps, but also distinct differences. P15 sees the eco-city as a central paradigm of sustainable urbanism. In this category, the economic and power relations have been mentioned, but in comparison with environmental (especially energy and resource aspects), general social equity, and well-being, the discussions are less well-elicited. Moreover, the economic aspects of sustainability are largely interpreted as 'agglomeration' rather than with its actual political context and lobbying influence.

That noted, the study in P15 clearly understands the political dimension of (land use/spatial/urban) planning. Regarding 'green', it adopts a triple zero framework: zero fossil-fuel energy use, zero waste, and zero emissions, and defines 'green' as being more ideological than ecological or sustainable urbanism. P15 also looks at various models and approaches in cities, such as London and Barcelona. The danger of lacking a holistic approach to design and management is recognised, and thus trade-offs and the economic-political reality may inadvertently be ignored; this may result in lock-in (development trajectories are set and difficult to change) and islands/neighbourhoods becoming 'sustainable', but not the whole urban conurbation actually becoming an eco-city. Transport and energy alongside built environment and local cohesion/capital were the focus of this paper, thus also a partial rather than holistic approach. In common with many mainstream viewpoints, 'simplicity' as a useful guiding principle for sustainability and sustainable solutions is marginalised, and a smart data-driven approach is seen as the way forward. A more holistic SSG framing needed to include data resource needs and consider/assess the actual environmental and social impacts of high-tech solutions. Instead, optimisation and new developments are seen as crucial, perpetuating a somewhat naïve hope in technological

solutions, yet ignoring their actual contribution over the past decades to the climate and ecological break-down.

Overall, P15 is a strong paper in terms of the themes of our research, but ignores some of the thorny issues of developing a holistic and strong SSG perspective. It addresses systems integration, IT-enabled integrated services, the collaboration between various sectors, economic, social, and environmental well-being, and carbon neutrality, whilst ecological recovery can be implicitly extracted from the study.

The focus of P7 is to analyse empirically the impact of digitalization on environmental performance. It uses two dimensions, human health protection and ecosystem protection. This paper suggests that the positive effect of digitization on environmental performance only appears in the long term. The paper emphasizes the importance of business digitization and digital public services on environmental health, digital connectivity, digital skills, and business digitization on ecosystem vitality. Although the paper does not clearly explain the relationships between the main categories of smart, sustainable, and green, the conclusions consider systems integration and the linkages and trade-offs between different thematic areas. These include climate change, biodiversity, environment, and health, as well as environmental policies and sectoral policies. Moreover, digitalization is captured by digital connectivity, human capital with digital skills, use of the Internet, integration of digital technology in business, and digital public services in this paper. It specifically notes that digital technologies may help to alleviate pressure on the natural environment and improve biodiversity in different ways. For instance, ICT can help increase the efficiency of policies and public awareness through visualizing and communicating biological data, enabling business models that help prevent the degradation of biodiversity. Circular economy, agricultural waste, carbon emissions and air pollution are all noted early in the paper. P7 also alludes to some systems thinking including the impact of digitalization on the relationship between ecosystems and human well-being under industrialization and urbanization. It notes that the adoption of digital technologies, such as big data, cloud computing, and artificial intelligence, can address the problems of resource shortages, traffic congestion, and air pollution. Furthermore, the study suggests that digital technologies be applied to create urban sustainability, which is a combination of smart and sustainable cities, through improving social well-being in association with ecosystems.

Overall, P7 is the closest study which implicitly relates to the themes of our review. Similarly, in P12, although not all themes of our study have been explicitly discussed, the paper creates a relationship between smart and sustainable cities, by knowing the smart city as a tool to achieve sustainable development of cities. Then, P12 brings carbon reduction as one of the goals of smart sustainable cities. Finally, the paper defines the fourth generation of smart cities, as a convergence between smart, sustainable, and net zero cities.

P8 and P20 are the only studies that cover all themes of the smart, sustainable, and green categories as analysed in this research. P8 considers the sustainable development of the Hong Kong–Macao Greater Bay Area. The study is placed in the context of UN goals for sustainable development and China's policies towards more sustainable cities. It specifically looks at how to closely integrate nature protection with economic and social development. This is with a view to improving the sustainable development of what it describes as the social-economic-natural compound ecosystem. This would then inform the coordinated development of the system. The authors explain that the compound ecosystem is a composition of three subsystems: society, economy and nature. The study proposes an evaluation model based on complex network modelling.

P8 concludes that there should be more attention to the sustainable development of the natural subsystem and the promotion of environmental governance in depth, instead of focusing solely on economic benefits. In turn, the paper suggests the government should play an active role in promoting the green transformation of economic and social development in an all-around way; in particular, the green transformation of the industry alongside energy-saving, emission-reduction, and carbon-reduction actions for all citizens. Generally, the biodiversity and smart themes of our study were not directly discussed, but

are strongly implied by explicit reference to, for example, ecology and habitats. Its focus is on a small region in China, yet this is one of very few papers which attempts to connect smart, sustainable, and green in the context of the city.

As explained earlier, P20 is also a comprehensive study which properly connects smart and sustainable concepts and builds a framework for the smart sustainable city of the future. From probing into smart cities, the study highlights the use of ICT that creates various faces of smart cities, based on how it is applied, the digital means by which it is coordinated and integrated, the extensiveness of its use, and the degree of its pervasiveness. Six distinct dimensions of a smart city, including smart mobility, smart environment, smart living, smart people, smart economy, and smart governance are discussed. In addition, 'smarter cities' is highlighted because of the increasing interest in and prevalence of big data and the role of ICT in the operations, functions, design and services of cities. The author defines smarter cities as "a city where advanced ICT is combined with physical, infrastructural, architectural, operational, functional, and ecological systems across many spatial scales, as well as with urban planning approaches, with the aim of improving efficiency, sustainability, equity, and liveability." [46] (p. 47). Although the focus here is on sustainable development rather than technology and efficiency of smart solutions, from the definition it can be inferred that the author believes in the necessity of sustainability and green aspects for developing a smart(er) city of the future. The paper also highlights the increasing use of smart and sustainable in combination, based on the potential of ICT as an enabler, integrator, and constitution for achieving the environmental, social, and economic goals of sustainability. Hence, although this paper concentrated mainly on smart and sustainable cities, green elements (e.g., open space, ecological habitats, reducing environmental risks, zero-carbon/low energy and resource use) are touched on, and the study tries to bring components of green to smart sustainable cities and makes this study the most relevant one to our research. Thus, we believe developing guidelines, frameworks, and roadmaps to develop SSG cities should build on the findings which have been generated in research such as P20.

The starting point for our review was to understand if the academic literature was addressing SSG cities in an integrated way. This was on the premise that smart, sustainable, and green agendas must be integrated to develop a (real) smart(er) city of the future.

We know that so-called sustainability and green initiatives can bring several benefits to cities to help reduce the carbon footprint, conserve natural resources, improve air and water quality, and create a better quality of life for residents [73,74]. However, ecological systems (nature) as the foundations for human life and the need for considering long-term sustainable consumption, production and living patterns in urban environments are still largely addressed in a piecemeal and somewhat naïve way. Most studies lack a (complex) systems approach and critical realism lens to their work, thus focusing more on expected or limited benefits rather than the actual range of interactions, flows, processes, and impacts. In a similar vein, smart cities that prioritize sustainability and green initiatives are not just promoted for their own good, but also to attract investment, create jobs, and drive economic growth [75]; although from an SSG perspective replacing 'growth' with 'well-being' seems to make sense. We argue that by incorporating sustainable and green practices into the design and development of smart cities, they can become more resilient, efficient, and liveable places. Yet, our review confirms that smart cities are not necessarily sustainable and green or vice versa.

The existing research (based on the search terms, inclusion/exclusion, and filtration of this study) is not rich in terms of actually integrating SSG, and more often addresses issues in parallel and selectively rather than developing a strong holistic and cross-cutting approach. The papers we have reviewed do not provide some guidelines, a framework, approach, technique, and/or roadmap to convert existing cities to SSG cities of the future. Moreover, mainly due to the overlaps between the various requirements and the concepts of liveable, SSG cities, ambiguities still persist [74].

4.2. Liveable Cities of the Future

The concept of liveable cities has gained significant attention in recent years as the world becomes more urbanised and people flock to cities in search of better job opportunities, education, and social services [76,77]. From the findings of existing research (e.g., [78,79], a liveable city is one that provides its residents with a high quality of life, including access to on-time and efficient services, green spaces, clean air, and a healthy environment. In this context, the convergence of smart, sustainable, and green has become an important consideration in the development of liveable cities.

In simple terms, smart cities leverage technology and data to provide efficient and effective services and improve the quality of life for their residents. They use intelligent systems to manage resources, such as energy and water, and to provide services such as transportation, education, and healthcare [74,80]. Smart cities also use data to inform decision-making and to improve the delivery of efficient services (generated through an inter-collaboration and integration amongst city systems) to residents [81]. For example, in a liveable city, smart technology can be used to improve sustainability by reducing waste and energy consumption, reducing emissions, and improving air quality (e.g., a smart grid system can be used to manage energy consumption and reduce energy waste, while smart transportation systems can be used to reduce traffic congestion and emissions). There is, however, little debate about where and how 'smart' solutions work best and how to manage expectations in line with the realities of strong sustainability (i.e., without further losses in ecological and climate integrity). Discussions of smart solutions tend to focus on their envisaged benefits and not necessarily their life cycle impacts, or questioning their role across the range of possible applications (some may be environmentally and socially unsustainable). On the other hand, sustainability is a key aspect of liveable cities [82,83]. Cities consume a large proportion of the world's energy and resources and are responsible for a significant amount of greenhouse gas emissions [84,85]. In order to create liveable cities, it is important to reduce the environmental impact of cities and to ensure that they are sustainable over the long term. This can partly be achieved through the use of renewable energy sources, such as wind and solar power, and through the development of green infrastructure, such as parks and green spaces, but also requires more joined-up planning and explicit attention to ecological and material thresholds and the health and functioning of natural cycles. Sustainable transportation options, such as bike lanes and public transportation systems (which considerably reduce material use and pollution compared to private car use), can also help reduce the environmental impact of cities and improve the quality of life for residents.

The visible manifestation of a 'green' city is through its blue and green infrastructure (GI). This is an essential component of liveable cities. Green spaces provide numerous benefits, including improved air and water quality, increased biodiversity, and improved mental and physical health for residents. As with 'sustainability, for the Green City, multi-functional GI generates multiple benefits aside from biodiversity. Urban cooling mitigates the heat island effect, saves lives and reduces the need for energy-intensive air conditioning. In addition to these environmental benefits, green spaces also provide recreational opportunities and contribute to the aesthetic appeal of cities [86].

The findings of this research have identified some papers (e.g., P8) which recognise the natural and environmental sub-systems of the city as significant components. Yet, a conclusion was also inferred that it can only be achieved through behaviour changes towards more sustainable practices. Others, such as P2, suggest that technological innovation can drive change towards more sustainable practices and so help deliver wider place-based policy ambitions towards net zero, but without a robust assessment of the whole life-cycle.

We can work on an assumption that which one of these three principles (i.e., SSG) should be considered more than the other(s) is likely to vary from place to place and based on underlying political and development viewpoints. Similarly, 'which one should be implemented first' may be the wrong question, as essentially by bringing SSG together a similar perspective may actually arise, akin to transdisciplinary working that creates

new ways of looking at challenges and conceiving more integrated and connected ways of addressing challenges. We hence see the most significant discussion as needing to be on the convergence and integration of these three principles and this has been illustrated in Figure 4.

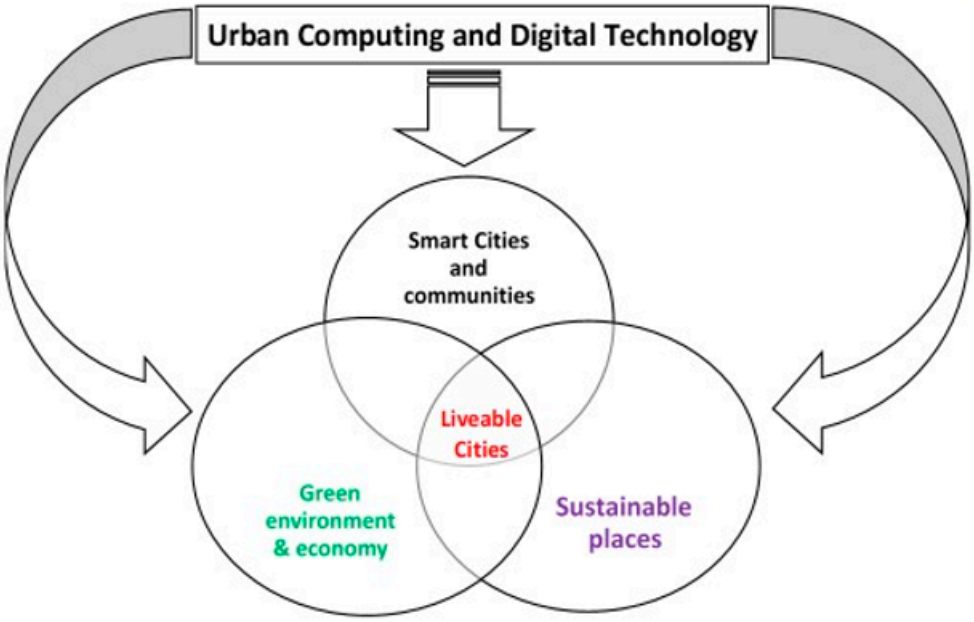

Figure 4. Liveable cities of the future.

From the reviews of this study, it can be inferred that if the concept of 'smartness' is thought of thoroughly and implemented properly in cities, typically it should include the concepts of 'sustainability' and 'green'. When discussing the leverage of technology and data to improve the quality of life, cross-sectoral systems integration, and providing real-time services for citizens, we are mainly discussing the smartness of the cities. However, this also includes addressing environmental concerns, such as reducing material and energy consumption, reducing waste, improving air quality, and promoting or enabling sustainable practices. Moreover, urban computing and digital technology would also have a direct effect on the development of sustainable and green cities, but their positive impacts need to outweigh their material consumption and waste problems.

Hence, it can be concluded that these are enablers of developing an SSG city in a comprehensive and holistic manner to achieve the best (most meaningful to all of society over the long term) results. This means considering the interconnections between smart, sustainable, and green agendas are necessary to comprehend how these can complement and inform each other to improve the overall liveability of the cities of the future. This integration also requires a comprehensive and holistic approach that considers the interconnections between different areas, sectors, and interests, and considers trade-offs. As shown in Figure 5, it was also understood that the main characteristics of smart, sustainable, and green agenda in the context of liveable cities (as explained in Section 3), extracted from the definitions of these concepts, have been covered by the research papers identified and reviewed in this study (based on the search terms and criteria of this study). Therefore, those characteristics were added to the previous figure to create a preliminary conceptual framework for a holistic view of the future liveable cities (Figure 5).

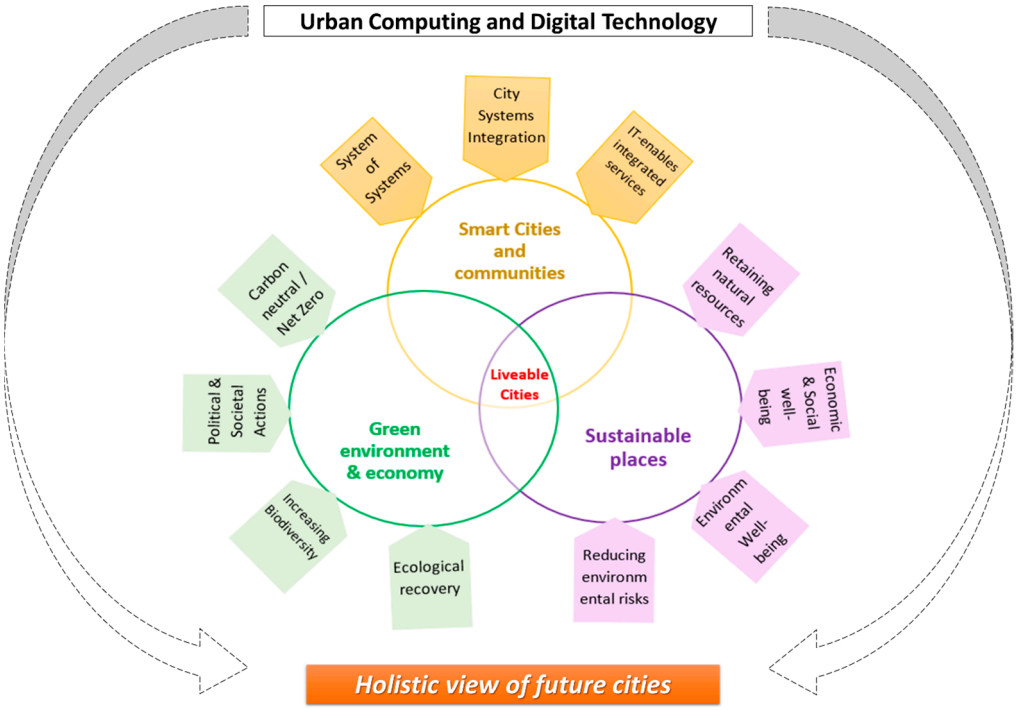

Figure 5. Holistic view of future cities (fully developed/real/smarter city).

The above discussion signals that the interconnections between different sectors, such as transportation, energy, education, waste management, and developing comprehensive plans that take these interconnections into account, must be taken into account for developing liveable cities of the future. Hence, Figure 4 can be expanded further to include various city sectors (e.g., healthcare, education, transport, energy), as well as the six dimensions of smart city development (i.e., Smart Government, Smart Economy, Smart Environment, Smart Living, Smart Mobility, and Smart People).

5. Conclusions, Recommendations for Further Research, and Limitations of the Study

The findings of this SoTA research showed that planning for the development of SSG cities should be integrated and coordinated, taking all the considerations, measures, challenges, and best practices from the three concepts of SSG into account. In this SSG city, if developed, all stakeholders, including government agencies, private sector companies, community organisations, and residents, should work together to develop a shared vision for the city [87]. A more integrated and creative starting point for SSG urban planning can help develop greater synergies across sectors, areas and interests and reduce, or at least aim to help redress, negative trade-offs. This would require stakeholders to be willing to engage with broader perspectives beyond their own main interests and place societal long-term well-being and equity at the core of decision-making. This can involve collaboration between different departments and agencies, as well as planning with, rather than for, residents and communities. Moreover, green and blue infrastructure, such as parks, allotments and sustainable urban drainage systems, will be integrated into the fabric of the city, be that through the creation of new blue and green infrastructure habitats or the protection and preservation of existing ones. Finally, the last, but not the least, important consideration is the financing of the development of SSG cities, which requires appropriate models, such as public–private partnerships that should be developed to ensure that cities have access to the resources and funding needed to implement these initiatives. However, by exploiting more of the synergies and better cross-sectorial planning, some financial savings may be achieved, but also more communal and community-driven changes can be delivered.

5.1. Recommendations for Further Research

The findings of this study also suggested that although the current research is significant, it is not sufficiently integrated and comprehensive to help fully develop an SSG city. While there has been much interest and progress in the development of technology for smart cities, much more research is needed to fully realise the potential of SSG cities.

Hence, further research is needed on the convergence and integration of smart, sustainable, and green agendas, their overlaps, and the requirements of each agenda in various cities. Importantly, and beyond this, by looking at SSG cities holistically, new approaches and greater synergies may be unlocked or created, that while more diverse and complex, may ultimately help switch cities from being greater consumers and polluters to actually becoming more green, sustainable and smart.

One of the biggest challenges in developing SSG cities is the integration of the elements of every SSG theme, such as technology and nature-based solutions and socially equitable measures in infrastructure provision and maintenance. Developing integrated systems with experts, users, policy- and decision-makers requires new platforms for collaboration and ways of working to help seamlessly connect different appropriate technologies and infrastructures in a city that is affordable and fit for purpose. For the smart element, it is essential to develop data analytics and management systems that can effectively utilize the large amounts of data generated by smart cities without using excessive or rare resources or adding to carbon emissions and pollution.

Another challenge is the cost of implementing smart, sustainable, and green technologies and infrastructure. There is a need for research to develop cost-effective solutions that can be scaled up and replicated in different cities. This will require the development of new financing models, such as public–private–community partnerships, that can help cities to access financial and human resources to develop and implement these solutions.

Finally, there is a need for research to better understand the social and cultural aspects of liveable cities and rather than seeing it as an add-on, take this as the starting point. While technology and infrastructure are important, it is crucial to understand the social, economic, and cultural needs of residents and to provide more opportunities to make decisions with them rather than for them. This requires the development of more nuanced and interdisciplinary approaches that take into account the different perspectives and needs of different groups of residents.

5.2. Limitations of the Study

Despite the significant contributions of this SoTA study to advancing knowledge in the field of smart, sustainable, and green cities, there are some limitations that should be acknowledged. One major limitation is the reliance on existing literature, which can result in a biased selection of studies. For example, well-respected perspectives from the literature and current practice to formulate these definitions, but we recognise that other interpretations could be possible. In addition, we also had to recognise that academic authors interpret the terms smart, sustainable and green differently. In particular, the boundaries between sustainable and green are often vague.

Furthermore, the quality and validity of the literature reviewed can also impact the accuracy of the findings. However, by using the most suitable inclusion and exclusion criteria (extracted from various high-quality publications), we attempted to maximise the accuracy of the findings.

Generally, state-of-the-art studies are also limited by the scope of the research question and the available data, which may not fully capture the complexity and diversity of a topic. This was also the case in our research which only concentrated on the integration of SSG concepts. Hence, we recommend further research to explore broader scope related to these topics in the future.

As any other SoTA study, in this research, the authors also exercised their expert judgement through the analysis of the resources to expose the strengths and weaknesses of the extent of the integration of the three SSG categories. However, we tried to min-

imise the potential for subjectivity and bias, so that the selection and interpretation of the research would not be influenced by our own beliefs and values. Accordingly, we analysed the resources in multiple steps and in an iterative manner, carried out by all authors independently.

Finally, it is important to note that SoTA studies are not meant to provide a solution to a general research question, but rather to synthesize and critically evaluate existing knowledge. Hence, we defined our research questions for this purpose, not offering a solution. However, we offered a conceptual diagram regarding a holistic view of liveable SSG cities that can act as a guide for further research, intended to develop solutions and answer broader research questions related to SSG cities and communities.

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References

1. United Nations. *World Population Prospects 2022 World Population Prospects 2022 Summary of Results*; United Nations: New York, NY, USA, 2022.
2. United Nations. Urbanization | Population Division. 2018. Available online: https://www.un.org/development/desa/pd/content/urbanization-0 (accessed on 1 February 2023).
3. Sodiq, A.; Baloch, A.A.B.; Khan, S.A.; Sezer, N.; Mahmoud, S.; Jama, M.; Abdelaal, A. Towards modern sustainable cities: Review of sustainability principles and trends. *J. Clean. Prod.* **2019**, *227*, 972–1001. [CrossRef]
4. Oni-Jimoh, T.; Liyanage, C. *Urbanization and Meeting the Need for Affordable Housing in Nigeria*; IntechOpen: London, UK, 2018.
5. Mishra, A.; Agarwal, A. Do infrastructure development and urbanisation lead to rural-urban income inequality? Evidence from some Asian countries. *Int. J. Sustain. Econ.* **2019**, *11*, 167–183. [CrossRef]
6. Konbr, U. Smart Sustainable Cities—Vision and Reality. In *Towards Green Cities in Developing Countries*; International Experts for Research Enrichment and Knowledge Exchange (IEREK): Alexandria, Egypt, 2019; Volume 2, pp. 101–127.
7. Lennon, M. Green infrastructure and planning policy: A critical assessment. *Local Environ.* **2014**, *20*, 957–980. [CrossRef]
8. Scott, A.J.; Carter, C.; Reed, M.R.; Larkham, P.; Adams, D.; Morton, N.; Waters, R.; Collier, D.; Crean, C.; Curzon, R.; et al. Disintegrated development at the rural–urban fringe: Re-connecting spatial planning theory and practice. *Prog. Plann.* **2013**, *83*, 1–52. [CrossRef]
9. Cohen, M.J. The Emergent Environmental Policy Discourse on Sustainable Consumption. *Explor. Sustain. Consum.* **2001**, 21–37. [CrossRef]
10. Edeme, R.K.; Chibuzo, N.P. Urban Population Growth and Environmental Sustainability in Nigeria. *Artic. J. Empir. Stud.* **2018**, *5*. [CrossRef]
11. Zhang, X.Q. The trends, promises and challenges of urbanisation in the world. *Habitat Int.* **2016**, *54*, 241–252. [CrossRef]
12. Chen, W.; Zeng, J.; Li, N. Change in land-use structure due to urbanisation in China. *J. Clean. Prod.* **2021**, *321*, 128986. [CrossRef]
13. The Royal Society. *Multifunctional Landscapes Informing a Long-Term Vision for Managing the UK's Land Multifunctional Landscapes: Informing a Long-Term Vision for Managing the UK's Land*; The U.K. National Academy of Sciences: London, UK, 2023.
14. Caprotti, F.; Cowley, R.; Flynn, A.; Joss, S.; Yu, L. *Smart-Eco Cities in the UK: Trends and City Profiles 2016*; University of Exeter (SMART-ECO Project): Exeter, Australia, 2016.
15. De Jong, M.; Joss, S.; Schraven, D.; Zhan, C.; Weijnen, M. Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. *J. Clean. Prod.* **2015**, *109*, 25–38. [CrossRef]
16. Silva, B.N.; Khan, M.; Han, K. Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustain. Cities Soc.* **2018**, *38*, 697–713. [CrossRef]
17. Javidroozi, V.; Shah, H.; Feldman, G. Urban Computing and Smart Cities: Towards Changing City Processes by Applying Enterprise Systems Integration Practices. *IEEE Access* **2019**, *7*, 108023–108034. [CrossRef]

18. Dessai, A.; Javidroozi, V. Cross-sectoral process modelling for smart city development. *Bus. Process Manag. J.* **2021**, *27*, 2051–2074. [CrossRef]
19. Tan, S.Y.; Taeihagh, A. Smart City Governance in Developing Countries: A Systematic Literature Review. *Sustainability* **2020**, *12*, 899. [CrossRef]
20. 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. *Futur. Cities Environ.* **2021**, *7*, 3. [CrossRef]
21. Bibri, S.E.; Krogstie, J. Generating a vision for smart sustainable cities of the future: A scholarly backcasting approach. *Eur. J. Futur. Res.* **2019**, *7*, 5. [CrossRef]
22. Tomor, Z.; Meijer, A.; Michels, A.; Geertman, S. Smart Governance For Sustainable Cities: Findings from a Systematic Literature Review. *J. Urban Technol.* **2019**, *26*, 3–27. [CrossRef]
23. Yigitcanlar, T.; Kamruzzaman, M.; Foth, M.; Sabatini-Marques, J.; da Costa, E.; Ioppolo, G. Can cities become smart without being sustainable? A systematic review of the literature. *Sustain. Cities Soc.* **2019**, *45*, 348–365. [CrossRef]
24. Capdevila, I.; Zarlenga, M.I. Smart city or smart citizens? The Barcelona case. *J. Strateg. Manag.* **2015**, *8*, 266–282. [CrossRef]
25. Colding, J.; Barthel, S. An urban ecology critique on the "Smart City" model. *J. Clean. Prod.* **2017**, *164*, 95–101. [CrossRef]
26. Joss, S.; Sengers, F.; Schraven, D.; Caprotti, F.; Dayot, Y. The Smart City as Global Discourse: Storylines and Critical Junctures across 27 Cities. *J. Urban Technol.* **2019**, *26*, 3–34. [CrossRef]
27. Mora, L.; Deakin, M. *Untangling Smart Cities: From Utopian Dreams to Innovation Systems for a Technology-Enabled Urban Sustainability*; Elsevier: Amsterdam, The Netherlands, 2019; pp. 1–403. [CrossRef]
28. Reeve, A.C.; Desha, C.; Hargreaves, D.; Hargroves, K. Biophilic urbanism: Contributions to holistic urban greening for urban renewal. *Smart Sustain. Built Environ.* **2015**, *4*, 215–233. [CrossRef]
29. Newman, P. Biophilic urbanism: A case study on Singapore. *Aust. Plan.* **2014**, *51*, 47–65. [CrossRef]
30. Artmann, M.; Kohler, M.; Meinel, G.; Gan, J.; Ioja, I.C. How smart growth and green infrastructure can mutually support each other—A conceptual framework for compact and green cities. *Ecol. Indic.* **2019**, *96*, 10–22. [CrossRef]
31. Gazzola, P.; Del Campo, A.G.; Onyango, V. Going green vs going smart for sustainable development: Quo vadis? *J. Clean. Prod.* **2019**, *214*, 881–892. [CrossRef]
32. Grace, M.; Scott, A.J.; Sadler, J.P.; Proverbs, D.G.; Grayson, N.; Pedro, M.; Bolívar, R.; Ludlow, D. Exploring the smart-natural city interface; re-imagining and re-integrating urban planning and governance. *Emerald Open Res.* **2021**, *2*, 7. [CrossRef]
33. United Nations (UN). *Forests, Desertification and Biodiversity—United Nations Sustainable Development. The Sustainable Development Goals Report 2022*; Cambridge University Press: Cambridge, UK, 2022; Available online: https://www.un.org/sustainabledevelopment/biodiversity/ (accessed on 2 February 2023).
34. Ainsworth, D.; Collins, T.; d'Amico, F. Nations Adopt Four Goals, 23 Targets for 2030 In Landmark UN Biodiversity Agreement | Convention on Biological Diversity. In Proceedings of the Convention on Biological Diversity (CBD) COP15, Montreal, QC, Canada, 7–19 December 2022.
35. Giovannella, C.; Dascalu, M.; Scaccia, F. Smart city analytics: State of the art and future perspectives. *Interact. Des. Archit.* **2015**, 72–87. [CrossRef]
36. Mallapuram, S.; Ngwum, N.; Yuan, F.; Lu, C.; Yu, W. Smart City: The State of the Art, Datasets, and Evaluation Platforms. In Proceedings of the 2017 IEEE/ACIS 16th International Conference on Computer and Information Science (ICIS), Wuhan, China, 24–26 May 2017; pp. 447–452. [CrossRef]
37. Chamoso, P.; González-Briones, A.; Rodríguez, S.; Corchado, J.M. Tendencies of Technologies and Platforms in Smart Cities: A State-of-the-Art Review. *Wirel. Commun. Mob. Comput.* **2018**, *2018*, 3086854. [CrossRef]
38. Vasudavan, H.; Gunasekaran, S.S.; Balakrishnan, S. Smart City: The state of the art, definitions, characteristics and dimensions. *J. Comput. Theor. Nanosci.* **2019**, *16*, 3525–3531. [CrossRef]
39. Zhao, F.; Fashola, O.I.; Olarewaju, T.I.; Onwumere, I. Smart city research: A holistic and state-of-the-art literature review. *Cities* **2021**, *119*, 103406. [CrossRef]
40. Washburn, D.; Sindhu, U. Helping CIOs Understand "Smart City" Initiatives. *Growth* **2009**, *17*, 1–17.
41. Kulkarni, P.; Farnham, T. Smart City Wireless Connectivity Considerations and Cost Analysis: Lessons Learnt from Smart Water Case Studies. *IEEE Access* **2016**, *4*, 660–672. [CrossRef]
42. Keshavarzi, G.; Yildirim, Y.; Arefi, M. Does scale matter? An overview of the "smart cities" literature. *Sustain. Cities Soc.* **2021**, *74*, 103151. [CrossRef]
43. Clarinval, A.; Simonofski, A.; Henry, J.; Vanderose, B.; Dumas, B. Introducing the Smart City to Children: Lessons Learned from Hands-On Workshops in Classes. *Sustainability* **2023**, *15*, 1774. [CrossRef]
44. Heinberg, R. What Is a Sustainable City? *Edmont. Sustain. Pap.* **2010**, *5*, 1–15.
45. Hassan, A.M.; Lee, H. The paradox of the sustainable city: Definitions and examples. *Environ. Dev. Sustain.* **2015**, *17*, 1267–1285. [CrossRef]
46. Bibri, S.E. *Smart Sustainable Cities of the Future*; The Urban Book Series; Springer International Publishing: Cham, Switzerland, 2018; ISBN 978-3-319-73980-9.
47. Girardet, H. Sustainable Cities: A contradiction in Terms? In *The Earthscan Reader in Sustainable Cities*; Satterthwaite, D., Ed.; Routledge: England, UK, 2021.
48. Lindfield, M.; Steinberg, F. *Green Cities*; © Asian Development Bank: Metro Manila, Philippines, 2012.

49. Pace, R.; Churkina, G.; Rivera, M. How green is a " Green City "? A review of existing indicators and approaches. *IASS Work. Pap.* **2016**, *27*. [CrossRef]
50. The European Bank for Reconstruction and Development (EBRD). *Green City Action Plan Methodology*; EBRD: London, UK, 2016.
51. Selim, A.M.; Saeed, D.M. Infrastructure projects for green cities between implementation challenges and efficiency indicators. *Civ. Eng. Archit.* **2021**, *9*, 347–356. [CrossRef]
52. Creswell, J.W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*; SAGE Publications: Los Angeles, CA, USA; London, UK; New Delhi, Indian; Singapore, 2009; ISBN 1412965578.
53. Sołoducho-Pelc, L.; Sulich, A. Natural Environment Protection Strategies and Green Management Style: Literature Review. *Sustainability* **2022**, *14*, 10595. [CrossRef]
54. Wang, J.; Liu, Z.; Shi, L.; Tan, J. The Impact of Low-Carbon Pilot City Policy on Corporate Green Technology Innovation in a Sustainable Development Context— Evidence from Chinese Listed Companies. *Sustainability* **2022**, *14*, 10953. [CrossRef]
55. Guandalini, I. Sustainability through digital transformation: A systematic literature review for research guidance. *J. Bus. Res.* **2022**, *148*, 456–471. [CrossRef]
56. Xi, C.; Ding, J.; Wang, J.; Feng, Z.; Cao, S.J. Nature-based solution of greenery configuration design by comprehensive benefit evaluation of microclimate environment and carbon sequestration. *Energy Build.* **2022**, *270*, 112264. [CrossRef]
57. Zou, Y.; Xiang, W.; Lu, L.; Lu, Y.; Gao, J.; Cheng, Y. The Impact of High-Tech Industry Development on Energy Efficiency and its Influencing Mechanisms. *SSRN Electron. J.* **2022**, *10*, 1–19. [CrossRef]
58. Bălășescu, S.; Neacșu, N.A.; Madar, A.; Zamfirache, A.; Bălășescu, M. Research of the Smart City Concept in Romanian Cities. *Sustainability* **2022**, *14*, 10004. [CrossRef]
59. Ha, L.T.; Huong, T.T.L.; Thanh, T.T. Is digitalization a driver to enhance environmental performance? An empirical investigation of European countries. *Sustain. Prod. Consum.* **2022**, *32*, 230–247. [CrossRef]
60. Feng, Z.; Chen, Z.; Cai, H.; Yang, Z. Evaluation of the Sustainable Development of the Social-Economic-Natural Compound Ecosystem in the Guangdong-Hong Kong-Macao Greater Bay Area Urban Agglomeration (China): Based on Complex Network Analysis. *Front. Environ. Sci.* **2022**, *10*, 938450. [CrossRef]
61. Lai, Y. Urban Intelligence for Carbon Neutral Cities: Creating Synergy among Data, Analytics, and Climate Actions. *Sustainability* **2022**, *14*, 7286. [CrossRef]
62. Dwivedi, Y.K.; Hughes, L.; Kar, A.K.; Baabdullah, A.M.; Grover, P.; Abbas, R.; Andreini, D.; Abumoghli, I.; Barlette, Y.; Bunker, D.; et al. Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. *Int. J. Inf. Manag.* **2022**, *63*, 102456. [CrossRef]
63. Bazbauers, A.R. Translating climate strategies into action: An analysis of the sustainable, green, and resilient city action plans of the multilateral development banks. *Dev. Policy Rev.* **2022**, *40*, e12577. [CrossRef]
64. Kinelski, G. Smart-city trends in the environment of sustainability as support for decarbonization processes. *Polityka Energ.* **2022**, *25*, 109–136. [CrossRef]
65. Laiolo, P.; Procopio, R.; Delfino, F.; Andreotti, A.; Angrisani, L. The University of Genoa Savona Campus Sustainability Projects. In Proceedings of the 2021 IEEE 6th International Forum on Research and Technology for Society and Industry (RTSI), Naples, Italy, 6–9 September 2021; pp. 115–120. [CrossRef]
66. Deakin, M.; Reid, A.; Mora, L. Smart Cities: The Metrics of Future Internet-Based Developments and Renewable Energies of Urban and Regional Innovation. *J. Urban Technol.* **2021**, *27*, 59–78. [CrossRef]
67. Bibri, S.E. The eco–city paradigm of sustainable urbanism in the era of big data revolution: A comprehensive state–of–the–art literature review. In *Advances in the Leading Paradigms of Urbanism and their Amalgamation*; Advances in Science, Technology & Innovation; Springer: Cham, Switzerland, 2020; pp. 71–101. [CrossRef]
68. Kremer, P.; Haase, A.; Haase, D. The future of urban sustainability: Smart, efficient, green or just? Introduction to the special issue. *Sustain. Cities Soc.* **2019**, *51*, 101761. [CrossRef]
69. Prandi, C.; Ceccarini, C.; Salomoni, P. Augmenting good behaviour: Mixing digital and reality to promote sustainability in a campus community. In Proceedings of the 5th EAI International Conference on Smart Objects and Technologies for Social Good, Valencia, Spain, 25–27 September 2019; pp. 189–194. [CrossRef]
70. Berquier, R.; Gibassier, D. Governing the "good citizen" and shaping the "model city" to tackle climate change: Materiality, economic discourse and exemplarity. *Sustain. Account. Manag. Policy J.* **2019**, *10*, 710–744. [CrossRef]
71. Randeree, K.; Ahmed, N. The social imperative in sustainable urban development: The case of Masdar City in the United Arab Emirates. *Smart Sustain. Built Environ.* **2019**, *8*, 138–149. [CrossRef]
72. Bibri, S.E. Conceptual, Theoretical, Disciplinary, and Discursive Foundations: A Multidimensional Framework. In *Smart Sustainable Cities of the Future: The Untapped Potential of Big Data Analytics and Context–Aware Computing for Advancing Sustainability*; Springer: Berlin/Heidelberg, Germany, 2018; pp. 39–131. [CrossRef]
73. Belli, L.; Cilfone, A.; Davoli, L.; Ferrari, G.; Adorni, P.; Di Nocera, F.; Dall'olio, A.; Pellegrini, C.; Mordacci, M.; Bertolotti, E. IoT-Enabled Smart Sustainable Cities: Challenges and Approaches. *Smart Cities* **2020**, *3*, 1039–1071. [CrossRef]
74. Elshater, A.; Abusaada, H.; Alwaer, H. *Smart Liveable Cities: Plans or Forms?* Institution of Civil Engineers-Urban Design and Planning: London, UK, 2022; Volume 175, pp. 98–102.
75. 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]

76. Khorrami, Z.; Mirzaee, M.; Mehdi, M.; Davarani, F.; Khanjani, N. Measuring Liveability in Iranian Cities Using the Global Liveable City Index (GLCI). *Health Scope* **2021**, *10*, e112409. [CrossRef]
77. Wong, A.T.L. Sustainable development (urban transport and mobility)—"Sharpening the saw" in shaping liveable cities towards quality of life experiences. In Proceedings of the IOP Conference Series: Materials Science and Engineering, Selangor, Malaysia, 29–31 October 2018; Volume 512, p. 012044. [CrossRef]
78. Khomenko, S.; Nieuwenhuijsen, M.; Ambròs, A.; Wegener, S.; Mueller, N. Is a liveable city a healthy city? Health impacts of urban and transport planning in Vienna, Austria. *Environ. Res.* **2020**, *183*, 109238. [CrossRef]
79. McArthur, J.; Robin, E. Victims of their own (definition of) success: Urban discourse and expert knowledge production in the Liveable City. *Urban Stud.* **2019**, *56*, 1711–1728. [CrossRef]
80. Yigitcanlar, T.; Han, H.; Kamruzzaman, M.; Ioppolo, G.; Sabatini-Marques, J. The making of smart cities: Are Songdo, Masdar, Amsterdam, San Francisco and Brisbane the best we could build? *Land Use Policy* **2019**, *88*, 104187. [CrossRef]
81. Martin, C.J.; Evans, J.; Karvonen, A. Smart and sustainable? Five tensions in the visions and practices of the smart-sustainable city in Europe and North America. *Technol. Forecast. Soc. Chang.* **2018**, *133*, 269–278. [CrossRef]
82. Kallidaikurichi, S.; Yuen, B. *Developing Living Cities: From Analysis to Action*; World Scientific: Singapore, 2010; pp. 1–299. [CrossRef]
83. Chen, Z. Evaluating Sustainable Liveable City via Multi-MCDM and Hopfield Neural Network. *Math. Probl. Eng.* **2020**, *2020*, 4189527. [CrossRef]
84. Parvez, M.; Hazelton, J.; James, G. Greenhouse gas emissions disclosure by cities: The expectation gap. *Sustain. Account. Manag. Policy J.* **2019**, *10*, 685–709. [CrossRef]
85. Li, W.; Yang, M.; Long, R.; He, Z.; Zhang, L.; Chen, F. Assessment of greenhouse gasses and air pollutant emissions embodied in cross-province electricity trade in China. *Resour. Conserv. Recycl.* **2021**, *171*, 105623. [CrossRef]
86. Shubin, R. How blue–green infrastructure can create liveable cities and address climate change. *Dense Green Build. Typol. Res. Policy Pract. Perspect.* **2019**, *2019*, 55–63. [CrossRef]
87. Mora, L.; Deakin, M.; Aina, Y.A.; Appio, F.P. Smart City Development: ICT Innovation for Urban Sustainability. In *Encyclopedia of the UN Sustainable Development Goals: Sustainable Cities and Communities*; Springer: Cham, Switzerland, 2019; pp. 1–17. [CrossRef]