smart cities

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Review

Contextualizing the Smart City in Africa: Balancing Human-Centered and Techno-Centric Perspectives for Smart Urban Performance

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Abstract: The continuous growth of urban populations and the complexities of their current management in Africa have driven local governments to explore new technologies to optimize their urban and territorial performance. These governments and related stakeholders' resort to the term "smart city" to orient the current urban planning policies and practices to be more efficient and adequate. Nevertheless, the issue that remains is how to contextualize this global term that has not yet been fully adopted by African cities that have claimed to be "Smart". This contextualization becomes more complex in this critical context, where the city has not yet reached an ideal performance. Therefore, to reach this prospective African smart city, a critical review of how it would be both human-centered and techno-centered is imperative. This paper would review accordingly the above argument and set key performance indicator-based methodology on how to evaluate the smartness of a city in the African context.

Keywords: Smart City; sustainable; urban; approach; ICT; Africa; assessment; key performance indicators

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1. Introduction

Over the last few decades, urban populations have grown at a breakneck pace around the world. More than 55 percent of the world's population now lives in cities, and this rate is expected to rise to 70 percent in the next 30 years, with an additional 25 billion people expected to relocate to cities by 2050 [1]. The exponential expansion of the global population has reached an unprecedented level. This, coupled with the rapid urbanization process, leads to a variety of socio-technical, organizational, and economic factors that create numerous challenges. These challenges pose a threat to both the environmental integrity and economic resilience of cities [2]. As a result, most governments are purposefully concerned about implementing "smart" concepts to enhance the utilization and control of both material and immaterial resources and properties.

In this context, the concept of a "Smart City" is introduced, encompassing the intelligent and strategic use of new technological advances in communication and information (ICT to establish a sustainable urban environment and improve the Quality of Life (QoL). Smart cities have become increasingly prominent in modern societies due to their diverse range of applications [3,4]. In this context, it is essential to provide relevant references to substantiate the significance of smart cities. To set the stage for our research direction, we can draw upon published opinions, statements, and reflections in the literature.

In the realm of infrastructure, smart building management systems have been developed to effectively regulate temperature and lighting, leveraging digital technologies to optimize energy consumption [5]. This energy-efficient approach aligns with the broader goal of creating sustainable urban environments as noted in studies by experts [5–7].

Moreover, the healthcare sector has witnessed significant advancements within smart cities. Innovations in healthcare diagnostics have paved the way for improved medical services [8]. Published opinions from healthcare professionals emphasize the transformative impact of smart city technologies on patient care and health outcomes [9]. Along with these advancements, smart cities leverage cutting-edge technologies to enable intelligent edge processing and network connectivity. The integration of these technologies has been explored in recent research by [10], who highlight the potential for enhancing communication networks and data processing within urban environments [3,11].

Education has not been left behind in the smart city revolution, with modern technologies being used to facilitate education systems and provide interactive and personalized learning experiences for students. This is evidenced by a large number of publications that highlight the benefits of digital education [12,13].

Efficient governance is an essential component of urban innovation, with the inclusion of digital technologies to facilitate administrative procedures [4,14]. Insights from governmental experts, such as [15–18], underscore the role of digital governance in promoting transparency and citizen engagement.

Lastly, the security issue is tackled by the deployment of smart security measures [19]. These measures aim to minimize security risks and protect valuable assets, sensitive data, and individuals [20,21]. This ensures a safe and secure environment for smart city inhabitants.

In addition to these positive aspects, the implementation of smart security measures is crucial for minimizing security risks and safeguarding valuable assets, sensitive data, and individuals. A comprehensive approach to security is vital, as outlined in the report of COO and co-founder, VivaCity, from Open Access Government news [22] and cybersecurity experts [23–27]. By connecting these threads of research and expert opinions, we can gain a more coherent understanding of the multifaceted applications and significance of Smart Cities in contemporary society. This approach ensures that our research direction is well grounded and informed by the broader discourse on smart city applications and their impact [28–30].

One of the reasons for the popularity of this paradigm, according to [31], is that the Smart City (SC) idea is accompanied by the promise of enhanced competitiveness and economic prosperity. This vision has captivated municipal authorities worldwide, transcending geographical boundaries and encompassing regions that may experience significant urbanization. As a consequence of its increasing popularity, the concept of the Smart City has arisen as a prevalent topic of scientific scrutiny and analysis. It has become a model for smart urban development and sustainable socio-economic progress around the world [32,33]. Similar to other frequently employed notions, a smart city lacks a single definition because it is an interdisciplinary concept, leading to ongoing debates [34].

The authors classify Smart City definitions into two different concepts [35]. The first relies on technology areas that make cities more efficient and functional, such as Big Data and Internet of Things (IoT).

The second strategy focuses on citizens and emphasizes soft aspects like commitment and participation, education, culture, public policy, social innovation, and governance. In this context, several examples from around the world demonstrate that certain cities are described as smart, but the definition ascribed to this term varies. Since the Smart City idea has developed out of observational practice, a systemic theoretical review of this phenomenon is lacking. Before delving into the specifics of a Smart City as an invention, we must first grasp its fundamental conceptual features. In fact, understanding the significance of a Smart City is the first step. A brief examination of the extant literature reveals that the term of Smart City is quite debatable [36–38]. Indeed, the emergence of comparable concepts like digital cities, learning cities, virtual cities, and augmented cities has introduced a certain level of ambiguity to the conceptual term. Hence, academic, industrial, and governmental sectors have all contributed to the gradual development of the Smart City paradigm (Table 1).

Table 1. Smart City definitions from the literature: recapitulation and consensus findings.

Definition Number	Smart City Definition	Key References for Definitions	Consensus Finding
1	"A smart city is an urban area that utilizes digital technology to improve performance, well-being, and efficiency while reducing costs and resource consumption."	[39,40]	Smart cities exploit digital technology to improve performance and quality of life and to minimize the consumption of resources.
2	"A smart city is distinguished by the use of information and communication technologies (ICT) to improve quality, well-being and reduce its resource utilization."	[41–43]	ICT play a central role in smart city initiatives, with the aim of enhancing quality of life and resource efficiency.
3	"In a smart city, digital technologies are utilized to advance infrastructure, services, and the quality of life for its residents."	[44,45]	Digital technologies in smart cities enhance infrastructure and services for residents, leading to improved quality of life.
4	"A smart city is one that promotes sustainability, efficiency, and innovation by the use of ICT."	[15,46]	Using ICT, smart cities prioritize efficiency, environmental responsibility, and innovation.
5	"Data and technology serve a purpose in smart cities to optimize urban operations and resources, thereby improving the living conditions of its inhabitants."	[47,48]	Data and technology optimization in smart cities leads to improved urban operations and living conditions for residents.
6	The term "smart city" denotes an advanced urban environment where residents integrate informational and urban features with emerging technologies to foster sustainable, environmentally conscious, competitive businesses, and superior living standards.	[49]	Integration of information and technology for sustainability and improved living standards.
7	Smart Cities are the result of cutting-edge, knowledge-based techniques targeted at improving urban centers' competitiveness, support, and environmental, cultural, and socio-economic functioning. These smart cities are built with an evolving combination of human, technological, and social capital, with entrepreneurship assets.	[50]	Knowledge-driven strategies for enhanced urban competitiveness and socio-economic functioning.
8	The notion of the "smart city" is perceived as a unique intellectual capacity that encompasses multiple aspects of technical, social, and innovative economic advancement. This concept is shaped by the interplay of these factors. The term "interconnected" signifies the expansion of the broadband economy, while "green" denotes urban infrastructure that fosters environmental conservation and carbon gas emissions. On the other side, the collaboration of "creative and knowledge-based cities" seeks for enhancement of the city's capacity for innovation through the development of creative and knowledge-based human capital. The term "intelligent or smart" highlights the capacity to generate valuable information from real-time urban data processed through sensor technologies.	[51]	Intellectual capacity integrating social, technical, and economic factors for innovation and environmental conservation.

Table 1. *Cont.*

Definition Number	Smart City Definition	Key References for Definitions	Consensus Finding
9	The advancement of the smart city paradigm has been shaped by the collaborative efforts of three pivotal sectors: academia, industry, and government. Within the context of the smart city idea, the city is perceived as a system comprising multiple interconnected subsystems. The system's overall capacity to exhibit intelligent and cohesive behavior relies on the effective coordination of these subsystems. Broadly speaking, a smart city encompasses a multidimensional framework with diverse objectives.	[52]	Collaborative efforts of academia, industry, and government for an interconnected and multidimensional smart city framework.
10	The expression "smart city" corresponds to a city that makes use of ICT, technology, and innovation developments to address urban concerns, such as enhancing livability, fostering economic development, creating a sustainable, safe environment, and facilitating the implementation of efficient urban management strategies.	[53]	Utilization of ICT, technology, and innovation for addressing urban concerns and efficient urban management.
11	A smart city is an organized, networked, and intelligent area. It frequently possesses several intelligent characteristics, including economics, governance, environment, people, and mobility. This concept consists of a governance dimension and a technology dimension, with the latter serving as the foundation. Everything about modern technology, gadgets, etc., falls under the technological category. The technological component serves as a basis for the management component, consisting of novel strategies and unconventional approaches that are put into practice using digital technologies and other technological advances.	[54]	Organized, networked, and intelligent area with characteristics in economics, governance, environment, people, and mobility.
12	To establish a smart city with high production and value creation, we need people with advanced degrees and innovative planning techniques. By promoting ongoing information generation, sharing, evaluation, renewal, and updating, this city strives for knowledge-based development. This can be accomplished by fostering a constant connection between the city's residents and, concurrently, between them and residents of other cities. These contacts are supported by both the knowledge-sharing culture of the population and the well-designed technological networks and infrastructures of the city.	[55–57]	Knowledge-based development through ongoing information generation, sharing, and innovative planning.

This table now includes a "Consensus Finding" column that summarizes the shared themes or key concepts found in these definitions.

2. Smart City-Related Concept and Dimensions

Faced with environmental, economic, and social challenges, our cities must evolve into smart, resilient, inclusive, and sustainable future cities.

2.1. Smart as a Concept

The conceptual framework underpinning the notion of "smart" within the context of sustainable cities is intricately woven into the fabric of three pivotal developments. The first pertains to the pervasive adoption of sustainability principles, which has been increasingly

acknowledged as fundamental to urban development [58]. The second catalyst is the rise in urbanization rates, a phenomenon widely observed and documented in the works of urban scholars such as [59,60]. The third catalyst, pivotal in this paradigm shift, is the rapid advancements in ICTs [40]. The intricate interplay of these three forces has ushered in a transformative era for urban landscapes, giving rise to the emergence of sustainable cities.

The concept of smart, sustainable cities hinges on the deliberate integration of innovative and extensive ICT applications in the pursuit of sustainable urban planning. This notion finds resonance in the work of [40], which posits that the effective use of ICT is an integral part of achieving sustainability goals in urban settings. The strategic integration of ICT is argued to enhance efficiency, resource management, and overall urban functionality [47]. However, it is crucial to critically examine and reflect upon these assertions.

Among the myriad ICT applications in urban settings, the Internet of Things (IoT) and its concomitant utilization of big data emerge as particularly prominent examples. The IoT facilitates real-time data collection and communication among interconnected devices, offering unprecedented insights into urban dynamics [61]. Additionally, the utilization of Big Data in tandem with IoT technologies enable data-driven decision-making processes, fostering a more informed and adaptive approach to sustainable urban planning [62].

However, to ensure the robustness of these claims, it is imperative to engage in a rigorous scholarly inquiry. This involves verifying the empirical evidence supporting the positive impacts of sustainability principles [7,63], questioning assumptions about the uniform benefits of rapid urbanization [64], and critically reflecting on the potential challenges and unintended consequences associated with extensive ICT integration in urban planning [65]. By triangulating these concepts with a diverse array of references, this discourse endeavors to contribute to a nuanced and well-substantiated comprehension of the intricate linkage between urbanization and sustainability, ICT, and the realization of smart, sustainable cities.

2.2. Smart City Dimensions

Within this part, we present one of this paper's key sections: a conceptualization of the Smart City dimensions.

To establish a collective set of multidimensional aspects, we need to look at Smart City concepts in depth [49,52]. The three aspects of technology, economy and society, and governance are illustrated in the following (Table 2).

Table 2. Dimensions and consensus concepts in Smart Cities.

Dimensional Aspect	Sub-Concepts	Core Findings	Common Consensus among Scholars	Sources
Technology and Data	Data Generation, Sources, Analytics, Infrastructure	– Smart cities rely on connected environments for data generation. – Data are sourced from IoT devices, social media, and public records. – Advanced analytics processes extract insights and inform decision-making. – A robust digital infrastructure, including high-speed internet and wireless networks, is vital for seamless communication and data exchange.	Scholars commonly agree on the significance of connected environments, diverse data sources, and advanced analytics for informed decision-making in smart cities.	[66]
Economy/ Society	Economic Goals, Techno-centric Approach, Social Involvement, Private Sector Collaboration	– Economic goals include enhancing quality of life and optimizing resource utilization. – A techno-centric approach fosters competitiveness, sustainable development, and economic growth. – The social dimension involves citizens in a passive consumer role; the private sector collaborates for innovative solutions.	Scholars widely concur on economic goals, the techno-centric approach, and the changing role of citizens and the private sector in the social dimension of smart cities.	[66]

Table 2. *Cont.*

Dimensional Aspect	Sub-Concepts	Core Findings	Common Consensus among Scholars	Sources
Governance	Technological Aids, Data-Driven Decision-Making, Active Government Support	– Governance involves a preference for technological aids in city management. – Decisions are increasingly data-driven, relying on smart devices, IoT infrastructures, and big data. – Active government support fosters technological innovations.	Scholars commonly acknowledge the reliance on technological aids, data-driven decision-making, and government support for technological innovations in the governance of smart cities.	[66]

This table (Table 2) provides a highlight of the sub-key concepts associated with each dimensional aspect of smart cities, supported by core findings across the dimensions of smart cities emphasized by common consensus among scholars. This tabular presentation format is intended to provide an in-depth comprehension of the smart city literature's consensus, and to present the information in a concise and relevant manner.

3. Key Features of Smart City Development

In the dynamic landscape of Smart City development, the conceptualization of "smart people" (Table 3) takes center stage, an idea substantiated by [40]. Their research highlights the indispensable role of citizens equipped with proficient ICT skills and a substantial educational background, positing that these demographics form the basis of significant social and human capital. This assertion prompts critical reflection on the societal implications of smart city initiatives, raising questions about inclusivity, accessibility, and potential inequalities among citizens.

Table 3. Key characteristics associated with the development of a smart city [67].

Feature	Smart City Development's Content
Smart people	In a "smart city", citizens possess proficient ICT skills alongside a substantial level of education. Such a city is recognized for its significant social and human capital.
Smart infrastructure	A "smart city" is characterized by its infrastructure, which is built upon intelligent systems, IoT, and other cutting-edge Industry 4.0 technologies.
Smart living	In a "smart city", every citizen assumes a more participatory role within the community, actively involving themselves in the utilization of public and private services and efficiently evaluating their appropriateness. By considering aspects such as cultural amenities, health conditions, personal security, housing standards, and other factors, a "smart city" strives to offer a high quality of life.
Smart economy	In a "smart city", the economy is built upon the foundation of ICTs and various Industry 4.0 technologies. This encompasses not only ICT-related sectors but also encompasses "smart" enterprises that integrate ICT and new technologies into their manufacturing processes and business models.
Smart mobility	A "smart city" is a city that leverages contemporary transportation technology, logistics, and innovative transport systems to enhance urban mobility and improve the overall quality of life.
Smart management	The concept of a "smart city" denotes a city that incorporates intelligent management and administration practices, employing novel approaches to citizen engagement and communication, such as "e-management" and "e-democracy".
Smart environment	A "smart city" is one that has a safe, "green", and long-term environment, with modern technology incorporated into natural settings that are free of environmental and health risks.

The complex nature of "smart infrastructure" is illuminated through the lens of [68]. Their work explores the incorporation of smart systems and Industry 4.0 technologies, raising crucial considerations about the integration challenges, cybersecurity concerns, and societal implications of heavy reliance on sophisticated infrastructure.

The concept of "smart living" intersects with the work of [69], who explore the participatory role of citizens in assessing their quality of life as part of smart cities. This prompts a critical examination of the balance between technological integration and human-centered urban planning, raising questions about privacy, autonomy, and the potential for technological solutions to enhance rather than replace human experiences.

The authors of Ref. [15] contribute to the discourse by highlighting the fundamental role of ICT in shaping the "smart economy". Their research calls for a critical examination of the economic implications, particularly regarding potential disruption, job displacement, and the equitable distribution of economic benefits in the context of smart city transformations.

The expansion of "smart mobility", as explored by [70], invites critical thinking about the societal implications of modern transportation technology. Considerations about accessibility, the potential for increased surveillance, and the societal tradeoffs associated with prioritizing efficiency in urban mobility emerge.

The authors of Ref. [71] delve into the complexities of "smart management" and introduce novel approaches to citizen engagement and communication. This sparks critical discussions about democratic implications, potential biases in decision-making algorithms, and the overarching question of who holds power and influence in the Smart City governance model. The vision of a "smart environment" intricately interwoven with modern technology, as discussed by [47], requires critical reflection on the environmental sustainability of Smart City initiatives. Considerations arise regarding the environmental footprint of technology integration, potential unintended consequences, and the long-term environmental viability of Smart City developments.

These critical reflections, grounded in scientific research, underscore the nuanced and complex nature of Smart City development. They encourage thoughtful consideration of the broader societal, economic, and environmental implications and urge stakeholders to navigate these transformations with a keen awareness of the potential challenges and opportunities embedded in the smart city paradigm.

4. Smart City Approaches in Literature Studies

4.1. Conceptualizing the Smart City's Approach

This paper aims to categorize present approaches to understanding the Smart City concept and to organize relevant theoretical insights. A comprehensive and descriptive research methodology was used to accomplish this purpose.

To achieve our objective, we undertook a thorough literature analysis, focusing on the exploration of concerns associated with Smart Cities (SC). During this process, we extensively reviewed the works of researchers from academic and expert backgrounds to identify multiple definitions of the term. To broaden our understanding, we conducted thorough searches for the terms "smart cities" and "smart city" in collections such as Web of Science (WoS), Scopus, and Google Scholar. The authors of the definitions and the works that were selected for inclusion were chosen based on a personal appraisal of their particular significance. This evaluation considered the works' citation numbers, the authors' recognition for their work in the field of Smart Cities, as well as how innovative and original the chosen works are. To eliminate redundancy in Table 1, which collects the definitions and terminologies of Smart City, there are also rejected references where a high degree of similitude was found with the definitions of Smart City previously established by other authors.

Finally, the literature of more than 95 articles was reviewed to find the most relevant definitions of Smart City provided by the contributors. Hence, based on a compilation of 30 distinct definitions, the rationale behind Smart City rhetoric was explored. The additional definitions identified (typically representing current research on Smart City) enlarged the descriptions of approaches for understanding the Smart City and thereby broadened the representation of perspectives and viewpoints on it. This definition-based discussion refers to the conceptual framework of Smart City and not to real-life cases.

Therefore, additional contextual research is required as will be explained in the next section of this document. A qualitative content study of the gathered definitions allowed for the separation of keywords and the recognition of the key attributes of the Smart City notion. In the accompanying Table 4, the selected keywords and studied definitions are listed. The identified keywords in the two approaches could be divided into three divisions in accordance with their technological, economic/social, and governance dimensions, allowing for the differentiation of four dimensions of the Smart City paradigm. The introduced method helped to discern the two approaches to deduce existing research and analysis on assimilating the Smart City paradigm (Figure 1). Based on the aforementioned qualitative definition analysis, two approaches to conceptualizing the smart city were noted (Table 4).

Table 4. Smart city definition classified by approach. Source: created by the author.

	Definition	Author/Year	Keywords
Techno-centric Approach	In its core, a Smart City denotes an urban setting that leverages ICTs and relevant technological progress to optimize the efficient execution of standard municipal functions and improve the quality of services delivered to urban residents.	[72]	urban space; ICT; technological innovations; improving performance of city functions; enhancing the QoS provided to citizens
	Smart Cities are all about integrating ICT into every element of human life, smart devices, sensor networks, and real-time data collection.	[73]	sensor networks, intelligent devices, gathering real-time data, integration of ICT
	Being a Smart City entails employing resources and technology intelligently and with coordination, with the aim to create an inclusive, livable, and sustainable urban environment.	[74]	intelligent use of resources and technologies; inclusive; livable sustainable urban areas
	A Smart City (SC) is demarcated as the application of computing technologies aimed at enhancing the intelligence, connectivity, and efficiency of critical infrastructure and services inherent to urban environments. This encompasses a spectrum of domains, including but not limited to city administration, education, healthcare, real estate, public safety, and utilities.	[75]	smart technologies ; intelligent connectivity; infrastructure; services
	Smart and sustainable cities are usually based on the realization of various ICT implementations of ubiquitous computing, particularly the IoT, wherein connected objects work together via various distributed computing systems to offer data and services to urban organizations and residents, enabling seamless collaboration.	[76]	ICT implementations; IoT, distributed computing systems; urban organizations; urban residents
	The concept of a Smart City embraces advanced principles that seek to manage cities and urban areas in a contemporary manner, leveraging the technical tools offered by the latest innovations, such as information technology. It aims to align with ecological standards, while simultaneously prioritizing resource preservation and achieving intended outcomes.	[77]	cutting-edge concept; modern management; use of technical tools; the standards of ecology
	Smart sustainable cities integrate ICT to manage resources more intelligently. This reduces costs and energy use, improves the provision of services and the standard of living, and causes less of an ecological impact, all which support innovation and a green economy.	[78–80]	ICT; smart sustainable cities, reducing costs and energy use, provision of services; ecological impact; green economy

Table 4. *Cont.*

	Definition	Author/Year	Keywords
Techno-centric Approach	A smart city is a city where new digital technologies are used to coordinate and combine ICT with conventional infrastructure.	[15]	conventional infrastructure; coordinating and combining ICT; digital technologies
	The author indicates that by an "instrumented, interconnected, and intelligent city", we mean a city that is managed by ICT. Smart technologies have the potential to improve the intelligence, interconnection, and efficiency of a city's essential infrastructure and services, including city management, health services, education, public safety, residential and commercial properties, transportation, and amenities [75].	[32]	instrumented and interconnected city; city management; transportation and amenities; efficiency of the city's infrastructure
	With the growing impact of urbanization, governments, corporations, and communities are increasingly turning to technology to tackle associated challenges. This has led to the emergence of "smarter" cities that prioritize connectivity among seven vital components: municipal governance, educational systems, healthcare services, public safety initiatives, real estate management, transportation networks, and utility provisions. To achieve this, a smart city utilizes software systems, server, and network infrastructures, as well as consumer devices collectively known as Smart Computing and Information Technology, ensuring the seamless integration and efficient management of these crucial aspects.	[75]	Smart Computing technologies; services; Rapid Urbanization; city infrastructure; Smart City Planning; City Management
Human- and social-centric approach	A smart city is a community that actively and sustainably supports the general well-being of all its members while maintaining a high stability level to become a consistently a better place for living, working, and playing.	[81]	community, general well-being; high stability level; living, working, and playing place
	Socially conscious smart cities must engage with citizens and social capital, rather than simply trusting that software can alter and enhance cities entirely on its own. The impactful feature of information technology is not its ability to inherently build smart societies, but rather its accessibility to be used socially in ways that embolden and promote public awareness, as well as engage the public in a participatory democracy relating to the urban environment in which they live.	[41]	individuals; human resources; socially harnessed information technology; people's empowerment; education; people's engagement in political discourse
	A city achieves smart status when social and human capital investments, along with traditional and new (ICT) communication infrastructures, contribute to sustained economic growth and a high standard of living.	[82,83]	human capital; social investments; development of modern infrastructure; sustainable economic development; high standard of living
	The smart city is an integrated approach wherein citizens and social capital interact extensively by means of technology-based solutions. Based on a multi-stakeholder, municipality-based collaboration, the smart city concept aspires to effectively accomplish sustainable and resilient development along with an improved standard of living.	[5]	integrated approach; technology-driven solutions; resilient and sustainable development; high standard of living; collaborative efforts of multiple stakeholders

Table 4. *Cont.*

	Definition	Author/Year	Keywords
Human- and social-centric approach	Smart city is a complex combination of social, infrastructural, human, and business assets that is fused, managed, and integrated into city fabrics through advanced technologies, in order to tackle social, economic, and environmental challenges, integrating multi-actor, multi-sector, and multi-layer perceptions.	[84]	complex combination of assets; multi-layer perceptions; city fabrics; advanced technologies; social, economic, and ecological environmental challenges
	Fundamentally, the smart city vision is an individualistic or human-centric approach, with the goal of delivering a high-tech, secure, and sustainable future. It relies on strong governance among its government entities and other formal and informal organizations at the organizational level. It also emphasizes the development and dissemination of knowledge management procedures, the development of national missions, goals, and targets, and the establishment of financial models for national progress.	[85]	individualistic or human-oriented approach; sustainable future; knowledge management procedures; financial models
	A smart city is a well-organized and functional city that attends to the needs of its residents, manages public spaces, and coordinates processes, establishing optimal conditions for enhancing the quality of life for its inhabitants, and fulfilling the objectives of relevant stakeholders.	[86]	effective process organization; efficient management of public space; maximizing growth potential; optimizing conditions to enhance citizens' quality of life; aligning with stakeholders' objectives; fostering a well-structured city
	A smart city is a place that uses ICT-based solutions in collaboration with several governmental stakeholders to tackle social challenges.	[87]	ICT-based solutions; public challenges; multi-stakeholder collaboration; civic foundation
	A smart city is defined by its excellence across six key domains: smart government, smart economics, smart transport, smart buildings, smart people, and smart environment. It is a community that thrives on a well-balanced blend of resources and the proactive initiatives of self-sufficient, informed, and independent residents.	[88]	future-oriented; abilities and behaviors of self-determining, independent, and conscious citizens
	Suitable and dependable governing structures, along with open-minded and innovative individuals, are anticipated to provide the necessary support for smart cities. By collaborating effectively, they can enhance local productivity, which serves as a fundamental requirement for driving accelerated economic growth.	[33]	physical infrastructure; human capital; social capital; urban performance; urban architecture, planning, and governance

This section focuses on the different approaches to understanding the concept of smart cities based on a literature review. Its objective is not to assess the various perspectives of smart cities, but to describe and illustrate them using specific definitions.

The table lists two approaches to the concept of Smart Cities (SCs): techno-centric and human social centric. The techno-centric approach views Smart Cities as urban spaces where advanced technologies, such as sensors and real-time data networks, have become an integral part of every dimension of human life, permeating various aspects and activities to optimize resource use and service delivery. In contrast, the human social approach sees SCs as more than just the use of modern technologies for improved efficiency and cost savings. Instead, it highlights the importance of cross-sector collaboration, investing in social capital, and implementing participatory governance to foster sustainable economic growth and enhance the well-being of city residents (Figure 1). The Smart City concept spans across diverse dimensions, incorporating human, infrastructural, social, and entrepreneurial

capital. It strategically utilizes emerging technologies to effectively address prevailing challenges in the social, economic, and environmental spheres.

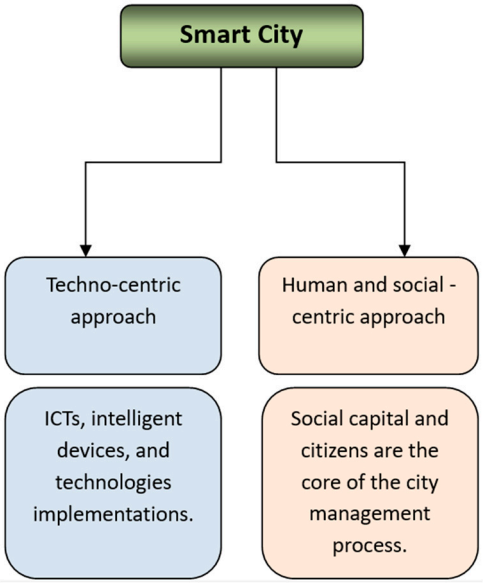

Figure 1. Approaches for understanding the smart city concept. Source: created by the author.

In the literature first discussed, the notion of smart cities and their technocratic approach underscore the utilization of ICTs [78] to improve urban management and efficiency. The goal of SCs, according to authors adhering to this approach, is to integrate smart devices, real-time data networks, and sensors [73] into every facet of human existence to maximize the efficient utilization of resources [78], optimize the provision of services, and enhance well-being and living standards [76,89]; in addition, the authors of Ref. [90] propose a multidimensional framework for understanding smart cities that integrates development drivers (such as technology, governance, social inclusion, and sustainability) with desired outcomes (such as livability, workability, sustainability, resilience, innovation, and equity). The authors argue that this framework can help policymakers and practitioners make informed decisions about the development and execution of smart city initiatives by identifying the relationships between development drivers and desired outcomes.

In Ref. [73], an extreme illustration is given of the technology-centric Smart City paradigm, Smart City transitions, in which sensors, digital devices, and shared data networks are incorporated with various elements of human existence. In this sense, incorporating the most cutting-edge technological solutions into the city space may appear to be a goal in and of itself; however, as Ref. [78] points out, Smart Cities utilize information and communication technologies (ICTs) to enhance their intelligence and resource utilization efficiency. Therefore, this approach leads to cost and energy reductions, enhanced service provision, and an overall improved quality of life. According to [76], as well as [90–93], the effective implementation of information and communication technology (ICT) has become the key to optimal governance and an essential requirement for achieving urban intelligence [92]. In Ref. [75], the authors have the perception that a city achieves smart status when ICT technologies enhance the knowledge, efficiency, and connectivity of critical infrastructure and service components, including governance, healthcare, educational institutions, safety and security, property, logistics, and community services.

On this point, modern cities, which are brimming with intelligent sensors, have the capability to autonomously optimize resource utilization, control traffic and street lights, along with maintaining surveillance on safety conditions, promptly notify emergency services of accidents, and even provide information regarding necessary road and building maintenance [76,94]. According to [74], a city is smart when it intelligently leverages all available technologies and resources in a coordinated manner, in order to establish

interconnected and environmentally sustainable urban hubs that are beneficial for its residents. A Smart City should be maintained based on the obtained input data and processed by these "smart" systems and devices, according to [95,96].

In Ref. [77], the authors emphasize the significance of technology in the creation of Smart Cities. The authors use the term "SC" to refer to a creative idea that takes advantage of the technological resources available today. Its purpose is to help modern city management adhere to ecological and resource conservation principles. According to [15], a Smart City is not only planned and coordinated utilizing newer technologies, but ICTs and classical infrastructure are also converging in a Smart City.

Thus, given the fact of the techno-centric approach, the definition of smart, sustainable cities is based on incorporating the innovation and widespread use of Information and Communication Technology (ICT) in the transition to sustainable urban planning. The Internet of Things (IoT) and associated big data applications are one of the most prominent ICT applications in urban environments. This literature includes other various scholars such as, [15,74–77,92–94], who highlight the importance of technology in creating SCs that are coordinated, integrated, and sustainable. The use of ICTs is not only about making infrastructure and service components more intelligent and efficient, but also merging them with traditional infrastructure. The Smart City concept is not solely dependent on the use of modern technologies [68], but it revolves around fostering collaboration across sectors and investing in the development of social capital. According to [9], the paradigm of a Smart City involves the establishment and utilization of interrelationships and linkages between human and social capital, alongside information and communication technologies (ICTs), with the aim of generating sustainable economic growth and improving the quality of life. The management of natural resources is based on participatory governance. The Smart City strategy aims to focus on a multifaceted strategy that considers all city actors rather than just the use of ICT. In Ref. [97], the Smart City is depicted as a hub that can harmonize competitiveness and sustainable development through the integration of diverse developmental dimensions and infrastructure investments. It represents a multi-dimensional amalgamation of human, infrastructural, social, and entrepreneurial capital, which is seamlessly blended, coordinated, and integrated into the urban fabric using innovative technologies. This approach aims to address social, economic, and environmental challenges, from a multi-actor, multi-sector, and multi-level perspective [84]. Technological advancements in the digital realm support community-led urban development and participation-based governance [98].

4.2. The Smart City in Africa: A New and Fast-Growing Research Area

To respond to the challenges posed by these exponential population growths, African cities have already created technopoles and are currently implementing initiatives borrowing from the smart cities concept. In terms of growth, the top ten fastest growing cities in the world—as well as their projected growth by 2025—are all African (Figure 2), a sign of how swiftly the continent's population is expanding. As urbanization is a recent and very rapid phenomenon in Africa, cities are not yet equipped with complex and high-tech systems, as some cities in Europe, America, and Asia can be. Despite their difficulties linked to a very strong demographic explosion, significant inequalities, healthcare, and education systems that are still underperforming, and sometimes unstable political contexts, African cities are gradually beginning to take innovative initiatives.

African metropolises, being comparatively younger and more adaptable than cities in developed nations, face fewer limitations imposed by existing infrastructure. This affords them numerous opportunities to undertake projects with substantial technological potential, including the direct adoption of mobile and fiber optics and the implementation of Smart Grids for efficient energy management. These localized initiatives signify progress towards the establishment of smart cities in Africa, leading to the gradual emergence of the smart city phenomenon on the African continent.

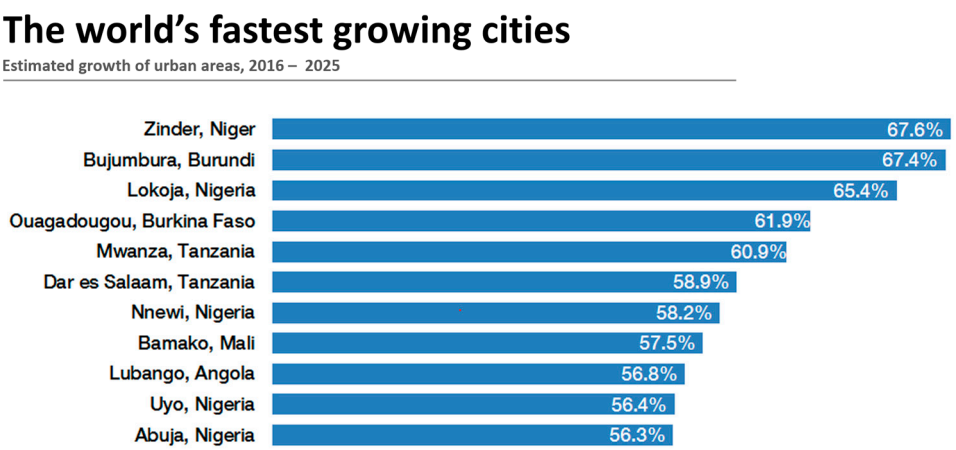

Figure 2. World's fastest growing cities: estimated growth of urban areas 2016–2025. Source: UN World Urbanization Prospects 2014 Revision by the UN's Department of Economic and Social Affairs.

The concrete applications of smart cities in Africa are currently concentrated in about ten of the fifty-four countries of the continent. Even if North African cities (Cairo, Tunis, Algiers, and Casablanca) are heading the list, many regional megacities such as Accra, Lagos, Abidjan, or Nairobi are also very successful in terms of economic attractiveness for investors and growth for their middle class. New cities such as Johannesburg and Kigali are also showing amazing speed and maturity thanks to the emergence of a dynamic and connected middle class.

Due to the distinctive geography, history, and culture of each city in Africa, a uniform smart city model is not applicable. Instead, diverse projects are being established in various metropolises, and each year, multinational corporations, recognizing the continent's potential for growth, actively participate in ambitious initiatives alongside African cities.

Prior to the global economic crisis in 2009, several African countries had initiated efforts in building Smart Cities, with consideration for the challenges involved, such as Konza Technopolis in Kenya, Cité du Fleuve in the Democratic Republic of Congo, Eko Atlantic City in Nigeria, and the Lanseria Smart City project in South Africa [99].

Rwanda leads the way in developing smart city infrastructure in Africa. Modernization in Kigali is part of the government's strategy to improve access to public services [100]. The Irembo platform allows citizens to do tasks online. Rwanda works with the private sector to develop smart cities. They partnered with Nokia to enhance social sustainability. The Vision City project in Kigali aims to create a technologically advanced neighborhood equipped with streetlamps powered by solar energy and offering complimentary Wi-Fi in the central town square [101].

The Nigerian Smart City Initiative launched in 2017 aimed to boost ICT innovation in Nigeria and demonstrate how it could be integrated with physical infrastructure to improve service delivery. Similarly, Addis Ababa, Ethiopia, addressed its parking shortage by implementing smart parking, which uses Chinese technology to park cars in a steel-structure building using an automated elevator, and IBM sent a Smarter Cities Challenge team to Accra, Ghana, to explore ways to leverage technology for economic and social development [102].

The challenges faced by Morocco in establishing new cities and dealing with rural exodus are rooted in the adoption of a "Smart City" approach. This is highlighted by Morocco being the first country in North Africa to embrace 3G technology. The Casablanca Smart City initiative has played a major role in transforming Casablanca into Africa's premier financial hub, with a focus on software development, e-commerce, and ICT companies [103]. According to the Smart City Index Report 2023, published by the International Institute for Management Development, Rabat ranks among the top five smart cities in Africa [104]. This ranking is based on factors such as integrating artificial intelligence in telemedicine,

electric mobility, the digital economy, and the ecological transition. These developments demonstrate the country's rapid progress.

While officials and city stakeholders propose building new smart cities as a solution to abandoning old towns, it is important to acknowledge that Africa has limited Smart City developments due to the high costs and complexities associated with infrastructure and socio-environmental factors. Nevertheless, with careful planning and investment, it is possible to overcome these challenges and create sustainable smart cities that meet the needs of the urban population. Therefore, implementing Smart City initiatives in existing towns and cities is a more feasible and confident strategy to accommodate the increasing urban mass.

4.3. The Smart City Approach in an African Context

An African "Smart City" approach involves using technology and data to improve the quality of life for residents, increase efficiency and sustainability, and promote economic development. There are several key elements to an African smart city approach, including (Figure 3):

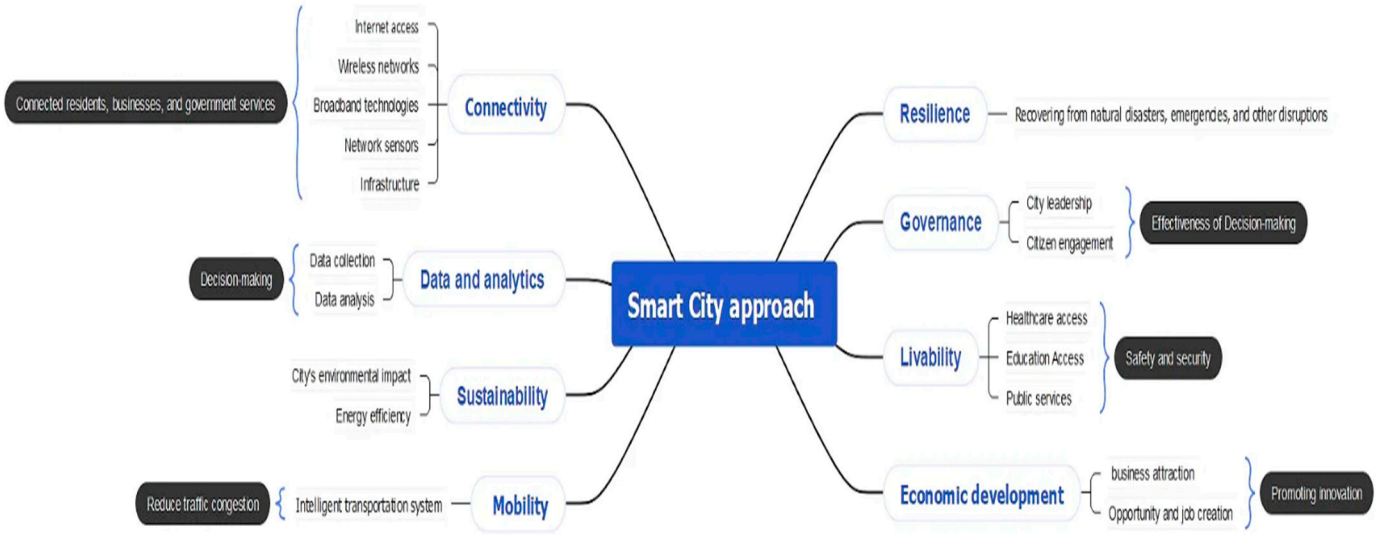

Figure 3. Smart City approach flowchart. Source: created by the author.

Connectivity: building and maintaining high-speed internet and wireless networks to connect residents, businesses, and government services.

Data and analytics: collecting and analyzing data to inform decision-making and improve city services.

Sustainability: using technology and data to reduce the city's environmental impact and promote energy efficiency.

Mobility: improving transportation options and reducing congestion with smart transportation systems.

Livability: using technology and data to improve access to healthcare, education, and other public services.

Economic development: using technology and data to attract and retain businesses, create jobs, and promote innovation.

Governance: using technology and data to improve the effectiveness of city leadership and decision-making processes, as well as citizen engagement and participation.

Safety and security: using technology and data to improve safety and security for residents and visitors.

Resilience: using technology and data to prepare for, withstand, and recover from natural disasters, emergencies, and other disruptions.

A smart city approach typically involves collaboration between the city government, private sector companies, and citizens. It also involves a holistic approach where all the aspects of the city are considered like environment, social, economic, technological, and governance. It also requires a clear vision and long-term strategic plan for the development of the city.

There is no generic solution to the development of smart cities in Africa, as each city presents a specific array of challenges and opportunities. However, there are some general principles that can be followed to ensure that smart city initiatives are successful in Africa:

Engage with stakeholders: it is important to involve a wide range of stakeholders in the development of smart city initiatives, including government officials, business leaders, and community organizations. This will help to ensure that the initiatives are aligned with the needs and priorities of the community.

Focus on improving the delivery of public services: smart city initiatives can help to improve the delivery of public services, such as healthcare, education, and transportation, which can have a significant impact on the lives of residents.

Promote economic development: smart city initiatives can help to drive economic development and job creation in the city, by attracting new businesses and promoting innovation.

Foster innovation and the use of technology: smart city initiatives should involve the use of innovative technologies and approaches to address local challenges and opportunities.

Ensure sustainability: smart city initiatives should be designed to be financially sustainable over the long term and should aim to reduce the environmental impact of the city.

Promote social equity: smart city initiatives should aim to promote equal access to services and opportunities for all members of the community, regardless of their socio-economic status or background.

5. Developing and Assessing Afro-Smart City Methodology

Afro-Smart Cities refer to urban centers in Africa that are designed to incorporate technology and innovation to enhance the quality of life for citizens. Before approaching Afro-Smart Cities, it is essential to have a clear understanding of the local context (Figure 4) and learn about the cultural, social, economic, and political factors that impact the city. This will help to identify the unique challenges and opportunities that need to be addressed.

This schema (Figure 4) illustrates the interconnected steps involved in approaching Afro-Smart Cities. Understanding the local context leads to the identification of key stakeholders and priority areas [105]. Leveraging technology and innovation, along with involving citizens, contributes to the development and implementation of sustainable and inclusive Afro-Smart Cities. The final step emphasizes the importance of fostering partnerships and collaborative networks to achieve the desired outcomes.

To effectively implement a smart city approach in Africa, it is important to prioritize financing the infrastructure that supports the informal economy and manages population growth in highly dynamic urban areas. Furthermore, it is necessary to consider the geopolitical situation and stability of the region to determine the feasibility and scalability of implementing the Afro-Smart City approach. Rational investment in human capital resources can also boost the readiness of a smart African city in terms of skill development. Because without the right skills and capacities, it would be almost impossible to fully realize the outputs of implementing a successful African smart city strategy.

There are several ways to assess Afro-Smart Cities strategies and initiatives performance; this includes first defining what we mean by "Afro-Smart City", as this can vary widely. As a result, it is essential to have a comprehensive understanding of the local context and what we are looking for, which will help to ensure that we are assessing the right things and that we are comparing apples to apples. Secondly, it is necessary to conduct a comprehensive review of existing smart cities initiatives in Africa by looking for examples of successful projects and identifying common themes or best practices. Subsequent to this step, the focus shifts to creating a set of criteria or metrics to assess the performance of smart city initiatives. These should be in line with the smart city objectives and might

include factors such as sustainable economic development, environmental impact, and social inclusion, as well as gathered insights and perspectives on the effectiveness of the initiatives from key stakeholders including government officials, business leaders, and community organizations through interviews, focus groups, or surveys. The information gathered can be used then to assess the advantages and disadvantages of the current initiatives and make recommendations for improvement [106]. The recommendations can be followed by a comparison against similar initiatives in other cities, both inside and outside the country. This can provide valuable insights and best practices that can be adopted to improve the initiatives being assessed.

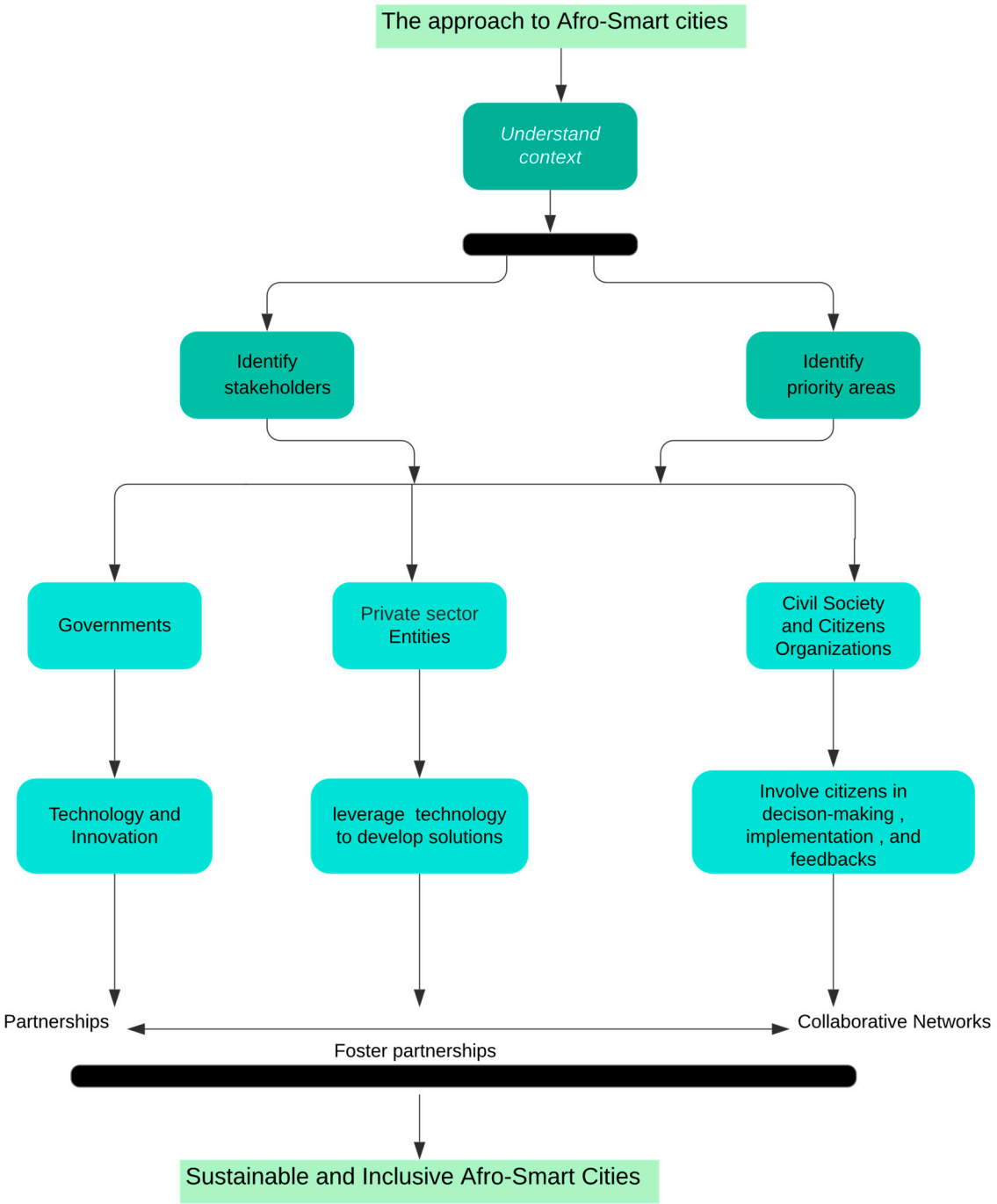

Figure 4. Schema representing the approach to Afro-Smart Cities. Source: created by the author.

It should be noted that the continuous monitoring and evaluating of the progress of the initiatives over time [11] will allow us to identify any problems early on and adjust as needed. As a final point, it is necessary to generate a report on the results, by summarizing the findings and results of the assessment, and to make recommendations for improvement [107]. This report should be easily accessible and understandable to all stakeholders, including the public. One of the most common methods for assessing Smart Sustainable City (SSC) Performance is the Key Performance Indicators (KPIs) [108]; these are a set of metrics that are used to measure the performance of an Afro-Smart City. These metrics can be utilized to evaluate various aspects of a city's performance, such as energy efficiency and consumption, transportation and mobility, air quality, digital infrastructure, quality of life and citizen engagement and participation [109,110]. These KPIs can help evaluate the effectiveness of ICT interventions in driving smart and sustainable development in cities [108,111]. It is important to adapt and customize these indicators based on specific African city contexts and goals.

The figure below (Figure 5) represents a matrix of KPIs for assessing the role of ICT in rendering African cities more sustainable and smarter [112].

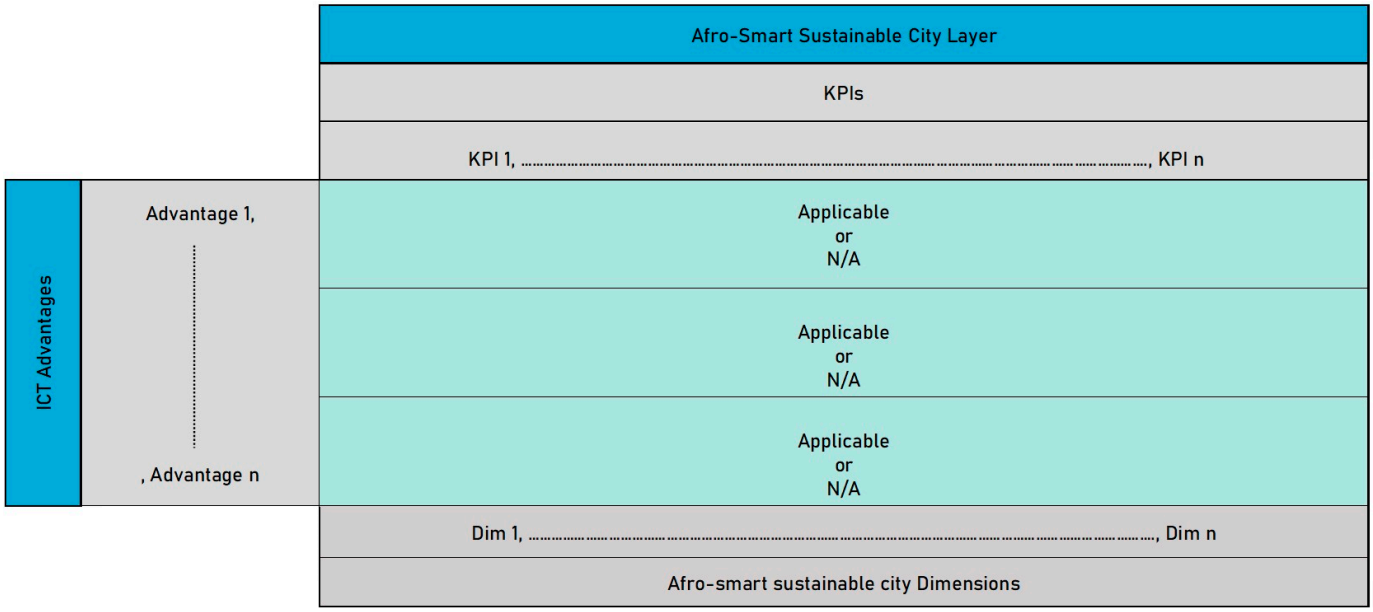

Figure 5. Matrix with the KPIs for Afro-Smart Sustainable Cities (ASSC). Source: created by the author.

This matrix provides an overview of the main KPIs for assessing Afro-Smart and Sustainable Cities in relation to the contributions of ICT-based solutions.

The methodology used for the formulation of the Key Performance Indicators matrix was derived from an in-depth examination of various collections of smart city index systems, the Smart Sustainable Cities standard, and the ICT development index (IDI), particularly those offered by the Global City Indicators Facility, UN-Habitat, the International Telecommunication Union (ITU), The United Nations Economic Commission for Europe (UNECE), and the International Organization for Standardization (ISO) [112]. Additionally, the indicators of European ranking of medium-sized cities (ERMC) were also taken into consideration during this process. This matrix, which serves as the foundation for the evaluation of Smart City initiatives in Africa, is primarily based on the technological advancements that these initiatives bring forth, subsequently generating additional value. The evaluation of this additional value is then conducted using key performance indicators. Moreover, the advantages of ICT are classified according to the different dimensions of an Afro-Smart Sustainable City. For each dimension, there are one or more key performance indicators that have been defined to assess these advantages qualitatively or quantitatively.

This inclusive matrix representation plays a crucial role in facilitating the integration of all dimensions of sustainability, as visually depicted in Figure 5.

Depending on the specific requirements and priorities, the matrix can be adjusted and enlarged as illustrated in the figure.

6. Discussions

The proposed methodology focuses primarily on defining the ICT-related Key Performance Indicators matrix for Afro-Smart Sustainable Cities, with limited consideration given to the other KPIs of cities. However, in terms of adaptability and interoperability, the KPI matrix can be adapted to identify the impact of ICT on the KPIs of other sectors, such as energy and agriculture. This allows for comparisons between African cities with similar characteristics.

A significant challenge in the African context is the limited involvement of citizens in the design of key performance indicators (KPIs), which may reduce the possibility of integrating a highly human-centered element in the design and evaluation phases. It is recommended that community-driven indicators, such as satisfaction with advanced technology services, accessibility of services, quality of service, and community inclusion, be included to ensure that smart city projects in Africa achieve urban performance.

The proposed methodology for developing and evaluating smart city initiatives will help different urban administrators and policymakers in Africa, each in his or her field, understand how ICT-based initiatives' performance can be reached and measured. It aims to involve them as active co-producers of the ICT impact assessment approach. This will guarantee that the resulting KPIs are adapted to the Afro-Smart City projects and that the urban contexts in which they are implemented are relevant to the stakeholders concerned.

Various methods exist for engaging with city planners and stakeholders. Academia and local governments frequently have job positions responsible for overseeing specific datasets related to buildings, ICT, energy, and mobility. However, locating the appropriate individuals and initiating them to share data can be challenging, particularly if they are not directly involved in Smart City projects. Acquiring data from private sector partners is even more complex. While larger corporations are subject to more comprehensive data collection and reporting processes, tech startups and small businesses may not be able to manage or deliver data for their Smart City projects or applications.

7. Conclusions and Way Forward

This research paper discusses two distinct approaches to the concept of a Smart City (SC): The techno-centric approach and the social- and human-oriented one. Distinct components for developing urban "Smartness" are suggested by each of the two approaches, and each one gives a distinct interpretation of the Smart City notion. This conception establishing urban intelligence is exactly the most divisive issue in the Smart City review. The suggested approaches arrange the existing definitions of the Smart City concept and highlight the need for further research and empirical analysis to understand and evaluate the implementation of Smart City initiatives. The two distinguished approaches are as follows:

1. Techno-centric Approach: This approach considers modern technologies as the driving force behind urban development. It focuses on utilizing technological advancements to improve city functioning and enhance the quality of life for residents.
2. Human and social-centric approach: The human- and social-oriented approach views a Smart City as a multifaceted development involving all stakeholders in the city and their active engagement in the processes of decision-making. It emphasizes the inclusion of various social and humanistic factors in the development of smart cities as well as the implementation of good governance principles in Smart City initiatives by prioritizing the engagement, participation, and well-being of the citizens.

Despite their differences, all approaches aim to improve urban residents' quality of life and improve city functionality. This is accomplished by several activities encompassing

three dimensions of a Smart City: technology, economy/society, and governance. The paper also acknowledges that the definition-based discussion refers to the conceptual framework of Smart City and not to real-life cases and that the study conducted includes the use of only three databases (Scopus, Web of Science, and Google Scholar) and the exclusion of other sources, which might have provided additional insights and definitions. Therefore, additional future research that could expand the categories and include more examples and subcategories is required.

Furthermore, we suggest that the presented conceptualizations can serve as an initial basis for future studies into developing a complete Smart Urban Planning Model. By combining methods and techniques from each approach, a comprehensive framework for managing smart cities can be developed. In this sense, our research study corroborates that contextual research in Africa was required, which was presented and described in Section 4 . In this section, several key elements to an African smart city approach were defined considering that the Smart City in Africa is a new and fast-growing research area aiming to respond to the challenges posed by these exponential population growths.

The notion of the Afro-Smart City has gained worldwide recognition, but it often lacks a standardized assessment methodology. A thorough review of the literature has unveiled a research gap in the African Smart City paradigm concerning the need for integrated approaches to evaluate Smart Sustainable Cities. This research paper aims to fill the gap by developing a Key Performance Indicators (KPIs) Matrix to assess the performance of an Afro-Smart City. The KPI Matrix has been proposed in terms of evaluating the contributions of adaptive ICT-based solutions in making African cities smarter and more sustainable.

The Key Performance Indicator (KPI) matrix may be useful for city planners and policymakers to understand the progress of African Smart Sustainable Cities initiatives and evaluate the impact of information and communication technology (ICT).

The paper concludes by proposing that the KPI matrix could be used as criteria for creating Afro-Smart City assessment. Instead of comparing African Smart Cities in a fragmented manner, a ranking based on a shared approach to the Smart City concept implementation could provide more meaningful and insightful comparisons between cities. Such rankings could shed light on which cities perform better in specific dimensions or approaches based on the developed KPIs. The identified Assessing Afro-Smart City methodology can serve as a basis for developing a holistic African Smart City framework assessment model applied to a city case study, and it can also be used as criteria for creating Afro-Smart City rankings, providing meaningful comparisons between African cities.

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References

1. Bhushan, B.; Khamparia, A.; Sagayam, K.M.; Sharma, S.K.; Ahad, M.A.; Debnath, N.C. Blockchain for smart cities: A review of architectures, integration trends and future research directions. *Sustain. Cities Soc.* **2020**, *61*, 102360. [CrossRef]
2. Gaur, L.; Agarwal, V.; Chatterjee, P. *Intelligent Decision Support Systems for Smart City Applications*; Scrivener Publishing LLC: Beverly, MA, USA, 2023.
3. Attaran, H.; Kheibari, N.; Bahrepour, D. Toward integrated smart city: A new model for implementation and design challenges. *GeoJournal* **2022**, *87*, 511–526. [CrossRef]
4. Myeong, S.; Park, J.; Lee, M. Research Models and Methodologies on the Smart City: A Systematic Literature Review. *Sustainability* **2022**, *14*, 1687. [CrossRef]
5. Pieroni, A.; Scarpato, N.; Di Nunzio, L.; Fallucchi, F.; Raso, M. Smarter City: Smart energy grid based on Blockchain technology. *Int. J. Adv. Sci. Eng. Inf. Technol.* **2018**, *8*, 298–306. [CrossRef]

6. Orecchini, F.; Santiangeli, A.; Zuccari, F.; Pieroni, A.; Suppa, T. Blockchain Technology in Smart City: A New Opportunity for Smart Environment and Smart Mobility. In *Advances in Intelligent Systems and Computing*; Springer: Cham, Switzerland, 2019.
7. Wu, M.; Yan, B.; Huang, Y.; Sarker, M.N.I. Big Data-Driven Urban Management: Potential for Urban Sustainability. *Land* **2022**, *11*, 680. [CrossRef]
8. Marvi, L.T.; Behzadfar, M.; Shemirani, S.M.M. International Journal of Human Capital in Urban Management Defining the social-sustainable framework for smart cities. *Int. J. Hum. Cap. Urban Manag.* **2023**, *8*, 95–110. [CrossRef]
9. Lai, C.S.; Jia, Y.; Dong, Z.; Wang, D.; Tao, Y.; Lai, Q.H.; Wong, R.T.K.; Zobaa, A.F.; Wu, R.; Lai, L.L. A Review of Technical Standards for Smart Cities. *Clean Technol.* **2020**, *2*, 290–310. [CrossRef]
10. Schiavo, F.T.; Magalhães, C.F.d. Smart Sustainable Cities: The Essentials for Managers' and Leaders' Initiatives within the Complex Context of Differing Definitions and Assessments. *Smart Cities* **2022**, *5*, 994–1024. [CrossRef]
11. Paskaleva, K.; Evans, J.; Watson, K. Co-producing smart cities: A Quadruple Helix approach to assessment. *Eur. Urban Reg. Stud.* **2021**, *28*, 395–412. [CrossRef]
12. Singh, T.; Solanki, A.; Sharma, S.K.; Nayyar, A.; Paul, A. A Decade Review on Smart Cities: Paradigms, Challenges and Opportunities. *IEEE Access* **2022**, *10*, 68319–68364. [CrossRef]
13. Shtebunaev, S.; Gullino, S.; Larkham, P.J. Planning the Smart City with Young People: Teenagers' Perceptions, Values and Visions of Smartness. *Urban Plan.* **2023**, *8*, 57–69. [CrossRef]
14. Myeong, S.; Jung, Y.; Lee, E. A Study on Determinant Factors in Smart City Development: An Analytic Hierarchy Process Analysis. *Sustainability* **2018**, *10*, 2606. [CrossRef]
15. Batty, M.; Axhausen, K.W.; Giannotti, F.; Pozdnoukhov, A.; Bazzani, A.; Wachowicz, M.; Ouzounis, G.; Portugali, Y. Smart cities of the future. *Eur. Phys. J. Spec. Top.* **2012**, *214*, 481–518. [CrossRef]
16. Allam, Z.; Newman, P. Redefining the smart city: Culture, metabolism and governance. *Smart Cities* **2018**, *1*, 4–25. [CrossRef]
17. Slavova, M.; Okwechime, E. African Smart Cities Strategies for Agenda 2063. *Afr. J. Manag.* **2016**, *2*, 210–229. [CrossRef]
18. Allam, Z.; Dhunny, Z.A. On big data, artificial intelligence and smart cities. *Cities* **2019**, *89*, 80–91. [CrossRef]
19. Ismagilova, E.; Hughes, L.; Rana, N.P.; Dwivedi, Y.K. Security, Privacy and Risks within Smart Cities: Literature Review and Development of a Smart City Interaction Framework. *Inf. Syst. Front.* **2020**, *24*, 393–414. [CrossRef]
20. Lazaroiu, C.; Roscia, M. Smart Resilient City and IoT Towards Sustainability of Africa. In Proceedings of the 2018 7th International Conference on Renewable Energy Research and Applications (ICRERA), Paris, France, 14–17 October 2018; pp. 1292–1298.
21. Zhan, J.; Dong, S.; Hu, W. IoE-supported smart logistics network communication with optimization and security. *Sustain. Energy Technol. Assess.* **2022**, *52*, 102052. [CrossRef]
22. Mildon, P. The importance of data privacy in smart cities. *Open Access Government*. February 2023. Available online: https://www.openaccessgovernment.org/importance-data-privacy-smart-cities/152918/ (accessed on 1 December 2023).
23. Fabrègue, B.F.G.; Bogoni, A. Privacy and Security Concerns in the Smart City. *Smart Cities* **2023**, *6*, 586–613. [CrossRef]
24. Kuang, Z.; Chen, C. Research on smart city data encryption and communication efficiency improvement under federated learning framework. *Egypt. Inform. J.* **2023**, *24*, 217–227. [CrossRef]
25. Ma, C. Smart city and cyber-security; technologies used, leading challenges and future recommendations. *Energy Rep.* **2021**, *7*, 7999–8012. [CrossRef]
26. Sookhak, M.; Tang, H.; He, Y.; Yu, F.R. Security and Privacy of Smart Cities: A Survey, Research Issues and Challenges. *IEEE Commun. Surv. Tutor.* **2019**, *21*, 1718–1743. [CrossRef]
27. Romani, G.F.; Pinochet, L.H.C.; Pardim, V.I.; de Souza, C.A. Security as a key factor for the smart city, citizens' trust, and the use of technologies. *Rev. Adm. Publica* **2023**, *57*, e2022-0145. [CrossRef]
28. Rejeb, A.; Rejeb, K.; Abdollahi, A.; Keogh, J.G.; Zailani, S.; Iranmanesh, M. Smart city research: A bibliometric and main path analysis. *J. Data Inf. Manag.* **2022**, *4*, 343–370. [CrossRef]
29. Lau, B.P.L.; Marakkalage, S.H.; Zhou, Y.; Hassan, N.U.; Yuen, C.; Zhang, M.; Tan, U.X. A survey of data fusion in smart city applications. *Inf. Fusion* **2019**, *52*, 357–374. [CrossRef]
30. Barro, P.; Degila, J.; Zennaro, M.; Wamba, S. Towards Smart and Sustainable Future Cities Based on Internet of Things for Developing Countries: What Approach for Africa? *EAI Endorsed Trans. Internet Things* **2018**, *4*, 155481. [CrossRef]
31. Campbell, T. *Beyond Smart Cities: How Cities Network, Learn and Innovate*; Routledge: London, UK, 2013.
32. Harrison, C.; Eckman, B.; Hamilton, R.; Hartswick, P.; Kalagnanam, J.; Paraszczak, J.; Williams, P. Foundations for Smarter Cities. *IBM J. Res. Dev.* **2010**, *54*, 1–16. [CrossRef]
33. Kourtit, K.; Nijkamp, P.; Arribas, D. Smart cities in perspective—A comparative European study by means of self-organizing maps. *Innov. Eur. J. Soc. Sci. Res.* **2012**, *25*, 229–246. [CrossRef]
34. Leitheiser, S.; Follmann, A. The social innovation–(re)politicisation nexus: Unlocking the political in actually existing smart city campaigns? The case of SmartCity Cologne, Germany. *Urban Stud.* **2020**, *57*, 894–915. [CrossRef]
35. Guo, Y.M.; Huang, Z.L.; Guo, J.; Li, H.; Guo, X.R.; Nkeli, M.J. Bibliometric analysis on smart cities research. *Sustainability* **2019**, *11*, 3606. [CrossRef]
36. Ziosi, M.; Hewitt, B.; Juneja, P.; Taddeo, M.; Floridi, L. Smart cities: Reviewing the debate about their ethical implications. *AI Soc.* **2022**. [CrossRef]
37. Visvizi, A.; Lytras, M.D. Smart cities research and debate: What is in there? In *Smart Cities: Issues and Challenges Mapping Political, Social and Economic Risks and Threats*; Elsevier: Amsterdam, The Netherlands, 2019; pp. 1–14.

38. Han, H.; Hawken, S. Introduction: Innovation and identity in next-generation smart cities. *City Cult. Soc.* **2018**, *12*, 1–4. [CrossRef]
39. Giffinger, R.; Fertner, C.; Kramar, H.; Meijers, E. City-ranking of European medium-sized cities. *Cent. Reg. Sci. Vienna UT* **2007**, *9*, 1–12.
40. Caragliu, A.; Del Bo, C.; Nijkamp, P. Smart Cities in Europe. *J. Urban Technol.* **2011**, *18*, 65–82. [CrossRef]
41. Hollands, R.G. Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City* **2008**, *12*, 303–320. [CrossRef]
42. Mora, L.; Deakin, M. *Untangling Smart Cities: From Utopian Dreams to Innovation Systems for a Technology-Enabled Urban Sustainability*; Elsevier: Amsterdam, The Netherlands, 2019.
43. Anthopoulos, L.G. Understanding the Smart City Domain: A Literature Review. In *Public Administration and Information Technology*; Springer: Berlin/Heidelberg, Germany, 2015; pp. 9–21.
44. Gracias, J.S.; Parnell, G.S.; Specking, E.; Pohl, E.A.; Buchanan, R. Smart Cities—A Structured Literature Review. *Smart Cities* **2023**, *6*, 1719–1743. [CrossRef]
45. Angelidou, M. Smart cities: A conjuncture of four forces. *Cities* **2015**, *47*, 95–106. [CrossRef]
46. 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]
47. Nam, T.; Pardo, T.A. Conceptualizing smart city with dimensions of technology, people, and institutions. In Proceedings of the ACM International Conference Proceeding Series, College Park, MD, USA, 12–15 June 2011; pp. 282–291.
48. Komninos, N.; Pallot, M.; Schaffers, H. Special Issue on Smart Cities and the Future Internet in Europe. *J. Knowl. Econ.* **2013**, *4*, 119–134. [CrossRef]
49. Duan, W.; Nasiri, R.; Karamizadeh, S. Smart city concepts and dimensions. In Proceedings of the ACM International Conference Proceeding Series, Shanghai, China, 20–23 December 2019; Association for Computing Machinery: New York, NY, USA, 2019; pp. 488–492.
50. Esfandiari, M.; Mousakhani, M. Designing a knowledge management model to observing urban information in smart cities. *Strateg. Manag. Stud. Natl. Def. Stud.* **2022**, *12*, 31–60.
51. Giffinger, R.; Gudrun, H. Smart cities ranking: An effective instrument for the positioning of the cities? *ACE Archit. City Environ.* **2010**, *4*, 7–26. [CrossRef]
52. Pourahmad, A.; Ziari, K.; Hataminejad, H.; Parsa, S. Explanation of Concept and Features of a Smart City. *Bagh-e Nazar* **2018**, *15*, 5–26.
53. Hamamurad, Q.H.; Mat Jusoh, N.; Ujang, U. Concept and Evaluating of Smart City. *J. Adv. Geospat. Sci. Technol.* **2022**, *1*, 92–111.
54. Andreev, D. The "Smart City" concept and its implementation prospects. *E3S Web Conf.* **2023**, *389*, 06014. [CrossRef]
55. Carrillo, F.J. *Knowledge Cities: Approaches, Experiences, and Perspectives*; Routledge: London, UK, 2006; pp. 1–290. [CrossRef]
56. Ergazakis, K.; Metaxiotis, K.; Psarras, J. An emerging pattern of successful knowledge cities' main features. In *Knowledge Cities: Approaches, Experiences, and Perspectives*; Taylor and Francis Inc.: Abingdon, UK, 2006; pp. 3–15.
57. Nordin, R. Creating Knowledge-Based Clusters through Urban Development: A Study of Cyberjaya. Master's Thesis, Rheinische Friedrich-Wilhelms-Universität Bonn, Bonn, Germany, 2012.
58. Smith, A.; Stirling, A.; Berkhout, F. The Governance Of Sustainable Socio-Technical Transitions. *Res. Policy* **2005**, *34*, 1491–1510. [CrossRef]
59. Sassen, S. *Brutality and Complexity in the Global Economy*; Harvard University Press: Cambridge, MA, USA, 2014.
60. Flores, R. Rebel Cities: From the Right to the City to the Urban Revolution. *Community Dev. J.* **2013**, *48*, 339–341. [CrossRef]
61. Zanella, A.; Bui, N.; Castellani, A.; Vangelista, L.; Zorzi, M. Internet of things for smart cities. *IEEE Internet Things J.* **2014**, *1*, 22–32. [CrossRef]
62. Chourabi, H.; Nam, T.; Walker, S.; Gil-Garcia, J.R.; Mellouli, S.; Nahon, K.; Pardo, T.A.; Scholl, H.J. Understanding smart cities: An integrative framework. In Proceedings of the Annual Hawaii International Conference on System Sciences, Maui, HI, USA, 4–7 January 2012; IEEE Computer Society: Washington, DC, USA, 2012; pp. 2289–2297.
63. Khan, M.A.; Siddiqui, M.S.; Rahmani, M.K.I.; Husain, S. Investigation of Big Data Analytics for Sustainable Smart City Development: An Emerging Country. *IEEE Access* **2022**, *10*, 16028–16036. [CrossRef]
64. Angel, S.; Parent, J.; Civco, D.; Blei, A.; Potere, D. The Dimensions of Global Urban Expansion: Estimates and Projections for All Countries, 2000–2050. *Prog. Plan.* **2011**, *75*, 53–107. [CrossRef]
65. Kitchin, R. Thinking critically about and researching algorithms. *Inf. Commun. Soc.* **2017**, *20*, 14–29. [CrossRef]
66. Baraniewicz-Kotasińska, S. Smart city. Four approaches to the concept of understanding. *Urban Res. Pract.* **2020**. [CrossRef]
67. Safiullin, A.; Krasnyuk, L.; Kapelyuk, Z. Integration of Industry 4.0 technologies for "smart cities" development. In *IOP Conference Series: Materials Science and Engineering, Saint-Petersburg, Russia, 21–22 November 2018*; Institute of Physics Publishing: Bristol, UK, 2019.
68. Albino, V.; Berardi, U.; Dangelico, R.M. Smart cities: Definitions, dimensions, performance, and initiatives. *J. Urban Technol.* **2015**, *22*, 3–21. [CrossRef]
69. Deakin, M.; Alwaer, H. From intelligent to smart cities. *Intell. Build. Int.* **2011**, *3*, 140–152. [CrossRef]
70. Pandiyan, P.; Saravanan, S.; Usha, K.; Kannadasan, R.; Alsharif, M.H.; Kim, M.-K. Technological advancements toward smart energy management in smart cities. *Energy Rep.* **2023**, *10*, 648–677. [CrossRef]

71. Linders, D. From E-Government to We-Government: Defining a Typology for Citizen Coproduction in the Age of Social Media. *Gov. Inf. Q.* **2012**, *29*, 446–454. [CrossRef]
72. 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]
73. Cretu, L.G. Smart Cities Design using Event-driven Paradigm and Semantic Web. *Inform. Econ.* **2012**, *16*, 57–67.
74. Barrionuevo, J.M.; Berrone, P.; Ricart Costa, J.E. Smart Cities, Sustainable Progress: Opportunities for Urban Development. *IESE Insight* **2012**, *14*, 50–57. [CrossRef]
75. Washburn, D.; Sindhu, U. Helping CIOs Understand "Smart City" Initiatives. *Growth* **2009**, *17*, 1–17.
76. Bibri, S.E. The IoT for smart sustainable cities of the future: An analytical framework for sensor-based big data applications for environmental sustainability. *Sustain. Cities Soc.* **2018**, *38*, 230–253. [CrossRef]
77. Sikora- Fernandez, D.; Stawasz, D. The Concept of Smart City in the Theory and Practice of Urban Development Management. *Rom. J. Reg. Sci.* **2016**, *10*, 86–99.
78. Cohen, B. The top 10 smart cities on the planet. *Fast Co.* **2012**, *11*, 181.
79. 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]
80. Colombo, M.; Hurle, S.; Portmann, E.; Schafer, E. A Framework for a Crowdsourced Creation of Smart City Wheels. In Proceedings of the 2020 7th International Conference on eDemocracy and eGovernment, ICEDEG 2020, Buenos Aires, Argentina, 22–24 April 2020; Institute of Electrical and Electronics Engineers Inc.: New York, NY, USA, 2020; pp. 305–308.
81. Lara, A.P.; Da Costa, E.M.; Furlani, T.Z.; Yigitcanlar, T. Smartness that matters: Towards a comprehensive and human-centred characterisation of smart cities. *J. Open Innov. Technol. Mark. Complex.* **2016**, *2*, 1–13. [CrossRef]
82. Bibri, S.E.; Krogstie, J. Generating a Vision for Smart Sustainable Cities of the Future: A Scholarly Backcasting Approach. *Eur. J. Futures Res.* **2019**, *7*. [CrossRef]
83. Caragliu, A.; Del Bo, C.F. Smart innovative cities: The impact of Smart City policies on urban innovation. *Technol. Forecast. Soc. Chang.* **2019**, *142*, 373–383. [CrossRef]
84. Wilhelm, R.; Ruhlandt, S. The governance of smart cities: A systematic literature review. *Cities* **2018**, *81*, 1–23. [CrossRef]
85. Garg, S.; Mittal, S.K.; Sharma, S. ScienceDirect Role of E-Trainings in Building Smart Cities Role of E-Trainings in Building Smart Cities. *Procedia Comput. Sci.* **2017**, *111*, 24–30. [CrossRef]
86. Maciej Błaszak, M.B.; Artur Fojud, A.F. Trzy wymiary użytecznego miasta. *Człowiek I Społeczeństwo* **2016**, 219–231. [CrossRef]
87. Manville, C.; Europe, R.; Millard, J.; Technological Institute, D.; Liebe, A.; Massink, R. Directorate General for Internal Policies Policy Department A: Economic and Scientific Policy. In *Mapping Smart Cities in the EU Study*; European Parliamentary Research Service: Brussels, Belgium, 2014.
88. Giffinger, R. *Smart Cities Ranking of European Medium-Sized Cities*; Centre of Regional Science: Vienna, Austria, 2007.
89. Bibri, S.E.; Krogstie, J. The emerging data–driven Smart City and its innovative applied solutions for sustainability: The cases of London and Barcelona. *Energy Inform.* **2020**, *3*, 5. [CrossRef]
90. Yigitcanlar, T.; Kamruzzaman, M.; Buys, L.; Ioppolo, G.; Sabatini-Marques, J.; da Costa, E.M.; Yun, J.H.J. Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework. *Cities* **2018**, *81*, 145–160. [CrossRef]
91. Yigitcanlar, T.; Cugurullo, F. The sustainability of artificial intelligence: An urbanistic viewpoint from the lens of smart and sustainable cities. *Sustainability* **2020**, *12*, 8548. [CrossRef]
92. Gomez, C.; Chessa, S.; Fleury, A.; Roussos, G.; Preuveneers, D. Internet of Things for enabling smart environments: A technology-centric perspective. *J. Ambient Intell. Smart Environ.* **2019**, *11*, 23–43. [CrossRef]
93. Voordijk, H.; Dorrestijn, S. Smart city technologies and figures of technical mediation. *Urban Res. Pract.* **2021**, *14*, 1–26. [CrossRef]
94. O'Dwyer, E.; Pan, I.; Acha, S.; Shah, N. Smart energy systems for sustainable smart cities: Current developments, trends and future directions. *Appl. Energy* **2019**, *237*, 581–597. [CrossRef]
95. Serrano, W. Digital systems in smart city and infrastructure: Digital as a service. *Smart Cities* **2018**, *1*, 134–154. [CrossRef]
96. Bibri, S.E.; Alexandre, A.; Sharifi, A.; Krogstie, J. Environmentally sustainable smart cities and their converging AI, IoT, and big data technologies and solutions: An integrated approach to an extensive literature review. *Energy Inform.* **2023**, *6*, 9. [CrossRef]
97. Kumar, H.; Singh, M.K.; Gupta, M.P.; Madaan, J. Moving towards smart cities: Solutions that lead to the Smart City Transformation Framework. *Technol. Forecast. Soc. Chang.* **2020**, *153*, 119281. [CrossRef]
98. Sugandha; Freestone, R.; Favaro, P. The social sustainability of smart cities: A conceptual framework. *City Cult. Soc.* **2022**, *29*, 100460. [CrossRef]
99. Mgwebi, S. Africa, Be Smart about New Cities. Available online: https://itweb.africa/content/5yONP7ErJPWMXWrb (accessed on 20 December 2023).
100. Rwanda Information Society Authority—RISA: Africa Smart Cities Investment Summit Kicked Off with the Launch of Smart City Hub. Available online: https://www.risa.gov.rw/news-detail/africa-smart-cities-investment-summit-kicked-off-with-the-launch-of-smart-city-hub (accessed on 23 December 2023).
101. Echendu, A.J.; Okafor, P.C.C. Smart city technology: A potential solution to Africa's growing population and rapid urbanization? *Dev. Stud. Res.* **2021**, *8*, 82–93. [CrossRef]

102. Bernard Binagwaho Smart City: Towards More Sustainable Cities in Africa ?—Tactis. Available online: https://www.tactis.fr/smart-city-towards-more-sustainable-cities-in-africa/?lang=en (accessed on 23 December 2023).
103. Mbassi, J.P.E. Smart Cities—The African story. *New Mag. UCLG-Afr.* **2016**, *5*.
104. IMD Smart City Index Report 2023. Available online: https://imd.cld.bz/IMD-Smart-City-Index-Report-2023/109/ (accessed on 23 December 2023).
105. Aurigi, A.; Odendaal, N. From "Smart in the Box" to "Smart in the City": Rethinking the Socially Sustainable Smart City in Context. *J. Urban Technol.* **2021**, *28*, 55–70. [CrossRef]
106. Sharifi, A. A typology of smart city assessment tools and indicator sets. *Sustain. Cities Soc.* **2020**, *53*, 101936. [CrossRef]
107. Neumann, H.-M.; Iglár, B.; Huovila, A.; Airaksinen, M. Recommendations for a smart city index. *CITYkeys-Smart City Perform. Meas. Framew.* **2016**. [CrossRef]
108. Caird, S.P.; Hallett, S.H. Towards evaluation design for smart city development. *J. Urban Des.* **2019**, *24*, 188–209. [CrossRef]
109. Airaksinen, M.; Huovila, A. *CITYkeys Indicators for Smart City Projects and Smart Cities*; The European Commission: Helsinki, Finland, 2017. [CrossRef]
110. Ericsson Ltd. *Networked Society City Index 2014*; Ericsson Ltd.: Stockholm, Sweden, 2012.
111. Shirazi, M.R.; Keivani, R. The triad of social sustainability: Defining and measuring social sustainability of urban neighbourhoods. *Urban Res. Pract.* **2019**, *12*, 448–471. [CrossRef]
112. International Telecommunication Union. *ITU-T FG-SSC Telecommunication Standardization Sector of ITU, Key Performance Indicators Definitions for Smart Sustainable Cities*; Focus Group Technical Report; ITU-T: Geneva, Switzerland, 2015.