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Harmonizing Urban Futures: Integrating Smart and Sustainable City Principles

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Abstract:- In an era marked by rapid urbanization and evolving urban challenges, understanding the intricate relationship between sustainable and smart city principles is paramount for shaping resilient and future-ready cities. This study delves into the integration of sustainable and smart city principles, aiming to illuminate their interconnectedness in contemporary urban contexts. By analyzing the latest academic understanding of this integration, the research contributes to the development of comprehensive frameworks guiding urban development strategies. Through bibliometric analysis using VOSviewer, key factors such as air quality, intelligent transportation systems, internet connectivity, urban growth, solar energy, and learning processes emerge as central to understanding the interplay between smart and sustainable cities. This analysis informs efforts towards integrated urban development and resilience. The study hypothesizes that smart city principles build upon sustainable city foundations, as evidenced by interrelated indicators across urban domains. Recognizing the significance of this integration, urban planners and policymakers can craft strategies that prioritize sustainability, innovation, and inclusivity, thus shaping resilient and future-ready cities. By elucidating the symbiotic relationship between smart and sustainable city concepts, this research offers insights crucial for addressing contemporary urban challenges and fostering sustainable urban development globally.

Keywords:- *Sustainable Cities; Smart Cities; Vosviewer; Sustainability.*

I. INTRODUCTION

Cities in the twenty-first century have made tremendous progress in improving quality of life and meeting current social and human demands (do Livramento Gonçalves et al., 2021; Lima et al., 2020; Suartika & Cuthbert, 2020). This advancement has been driven by two main approaches: sustainable cities and smart cities. Sustainable cities prioritize the preservation and efficient use of natural resources and energy while adhering to health and environmental norms (Almihat, Kahn, Aboalez, & Almaktoof, 2022; Bottero, Caprioli, Cotella, & Santangelo, 2019; Todeschi, Mutani, Baima, Nigra, & Robiglio, 2020). They are designed with an eye toward environmental impacts, with citizens actively working to reduce the city's consumption of energy, water, and food, as well as minimizing waste, emissions, and pollutants.(Hariram, Mekha, Suganthan, & Sudhakar, 2023; Satterthwaite, 2021; Sikandar, Ali, & Hassan, 2024). The objective is to address the needs of the present population without compromising the ability of future generations to meet their own needs (Kalfas, Kalogiannidis, Chatzitheodoridis, & Toska, 2023; Marvila, de Azevedo, de Matos, Monteiro, & Vieira, 2021; Vardopoulos et al., 2023; Villa-Arrieta & Sumper, 2019). On the other hand, smart cities focus on leveraging Information and Communication Technology (ICT) to enhance urban living and fulfill their goals (Bouramdane, 2023; Mishra & Singh, 2023; Rachmawati, Sari, Sukawan, Widhyastana, & Ghiffari, 2021). They combine human capital, social capital, and infrastructure with ICT to address public urban challenges, promote sustainable development, and improve overall quality of life. However, contemporary urban planning and design, especially in strategic urban expansion, now aim to integrate these methods, creating synergies that maximize the opportunities in urban planning (Apanavičienė & Shahrabani, 2023; Belli et al., 2020; Brzeziński & Wyrwicka, 2022; Fialová, Bamwesigye, Łukaszkiewicz, & Fortuna-Antoszkiewicz, 2021; Gracias, Parnell, Specking, Pohl, & Buchanan, 2023; Ramirez Lopez & Grijalba Castro, 2020).

The primary emphasis of smart cities lies in fostering environmental sustainability through smart energy, smart environments, and smart mobility (Apanavičienė & Shahrabani, 2023; Mavlutova et al., 2023; Ramírez-Moreno et al., 2021). Additionally, the aim is to enhance the livability of cities through smart health, education, and smart living and working (Abdelkarim, Ahmad, Ferwati, & Naji, 2023; Brzeziński & Wyrwicka, 2022; Chang & Smith, 2023). However, this focus on sustainability and quality of life has sparked concerns about insufficient attention being given to certain aspects. Inclusivity is a particularly significant concern, as it is closely associated with citizens' acceptance of Internet-based services within a broader context of security-related issues (Costa, Duran-Faundez, Andrade, Rocha-Junior, & Just Peixoto, 2018; Mechant, De Marez, Claeys, Criel, & Verdegem, 2011). There is a clear necessity to establish a sustainable model for managing the rapid urbanization and population growth expected in cities (Cosentino, Amato, & Murgante, 2018; De Roo & Miller, 2019; Z. Yang, 2019). This led the International Telecommunication Union (ITU) to introduce the term "Smart Sustainable Cities" as a means to address resource concerns and combine the characteristics of eco-cities with those of smart cities (Kasznar et al., 2021; Lai et al., 2020; Paes et al., 2023; Pozdniakova, 2017). The ITU-T Focus Group on Smart Sustainable Cities developed this concept by analysing numerous definitions, ultimately agreeing upon the following definition during their fifth meeting in June 2014 in Genoa, Italy: A smart, sustainable city is an innovative city that utilizes information and communications technologies (ICT) and other means to enhance the quality of life, improve the efficiency of urban operations and services, promote competitiveness, and ensure the fulfilment of economic, social, and environmental needs for present and future generations (Dashkevych & Portnov, 2022; Kim & Yang, 2021). The comprehensive official definition of the sustainable smart city, established primarily by the ITU, aims to capture the general characteristics of these cities and develop fundamental indicators for them. This aids in establishing the necessary infrastructure for information and communications technology, as well as creating measurement systems and policies for sustainable smart cities. Silvia Guzman, Head of the ITU-T Specialized Group on Smart Sustainable Cities, emphasizes that decision-makers face challenges in adapting infrastructure creation, service provision, citizen engagement, and system connectivity to the demands of rapid urbanization. The goal is to transform cities into more sustainable and resilient living environments, with information and communication technology playing a central role in this transformation (Fernández-Güell, Collado-Lara, Guzmán-Arana, & Fernández-Anez, 2016). Each smart, sustainable city must define a vision that aligns with its local community, determining its identity, long-term political priorities, and development strategy (Bibri, 2021; Schiavo & Magalhães, 2022). It is crucial to establish strong connections between stakeholders in smart, sustainable cities who will assist in the implementation process (Alamoudi, Abidoye, & Lam, 2022; Viale Pereira & Schuch de Azambuja, 2021). Additionally, assessing the current level of ICT usage in the city and identifying existing government mechanisms are essential for efficient and effective management of sustainable smart city solutions (Fang & Shan, 2022; Sharifi, Khavarian-Garmsir, & Kummitha, 2021).

Ralf Fücks (Fücks, 2015) explores the concept of smart growth as a dual approach to achieving economic and environmental sustainability. He posits that smart growth extends beyond mere economic expansion, encompassing innovations that reduce environmental impacts while enhancing quality of life. Fücks (2015) highlights the critical role of advanced technologies, including digitalization and renewable energy, in the development of sustainable urban environments. These technologies are essential for optimizing resource use and minimizing waste, thereby aligning urban growth with ecological sustainability.

This review article aims to establish a comprehensive framework that elucidates the integration of sustainable and smart city principles in contemporary urban landscapes. Through an extensive analysis of Scopus-indexed literature and bibliometric analysis using VOSviewer, this study seeks to explore the interrelationships between these two models. The objective is to provide a clear understanding of how smart city principles depend on the foundations of sustainable cities, shedding light on the latest academic insights and contributing to the development of a novel smart sustainable city model that addresses the challenges of 21st-century urbanization.

II. MATERIAL AND METHODS

A. Systematic Literature Review Methodology

In this study, a comprehensive methodology was employed to systematically gather and analyze relevant scholarly literature pertaining to the intersection of smart and sustainable cities. The primary source of literature was the Scopus database, chosen for its extensive coverage of academic publications across various disciplines. Specifically, publications between the years 2022 and 2024 were considered, ensuring a focus on recent advancements and developments in the field. To maintain consistency and facilitate analysis, only documents published in the English language were included, recognizing English as the predominant language of scholarly communication.

Within the specified timeframe and language criteria, a diverse range of publication types were considered, including articles, reviews, and conference papers. This inclusive approach aimed to capture a broad spectrum of research outputs and perspectives relevant to the study topic. Furthermore, the scope was restricted to the engineering field, acknowledging the multidisciplinary nature of smart and sustainable cities and the significant contributions from engineering disciplines.

To ensure the quality and accessibility of the selected literature, publications marked as "final" were prioritized, indicating that they had undergone peer review and met the standards for publication in scholarly journals. Additionally, only open-access publications were included, aligning with principles of transparency and open science to facilitate widespread dissemination and access to research findings. In the end 475 studies were taken.

Following the compilation of the literature corpus, VOSviewer, which is a sophisticated bibliometric analysis tool, was employed to conduct a comprehensive analysis of citation networks and co-authorship networks within the collected literature (Guo et al., 2019; Janik, Ryszko, & Szafraniec, 2021; Kirby, 2023). VOSviewer enables the visualization and exploration of bibliographic data, allowing researchers to identify key themes, influential authors, and emerging trends within a given field (Jia & Mustafa, 2022; Kemeç & Altınay, 2023). By leveraging the capabilities of VOSviewer, this study aimed to uncover patterns, relationships, and insights that contribute to a deeper understanding of the complex dynamics surrounding smart and sustainable cities. The methodology adopted in this study was designed to be rigorous, transparent, and inclusive, leveraging established scholarly databases and cutting-edge analysis tools to provide a comprehensive overview of the literature landscape in the field of smart and sustainable cities.

III. RESULTS AND DISCUSSION

A. Results

The recent understanding of the integrated relationship between smart cities and sustainable cities primarily revolves around several key factors: air quality, intelligent transportation systems (ITS), internet connectivity, urban growth, solar energy, learning processes, and others. These factors serve as the fundamental pillars bridging the concepts of smart cities and sustainable cities (Campisi, Severino, Al-Rashid, & Pau, 2021). Air quality management is paramount for both types of cities, with smart technologies enabling real-time monitoring and intervention to mitigate pollution, while sustainable cities prioritize eco-friendly transportation and energy-efficient practices (Almusaed, Yitmen, & Almssad, 2023; Bouramdane, 2023; Hassebo & Tealab, 2023). Intelligent transportation systems play a crucial role in enhancing mobility while minimizing environmental impacts, with smart cities leveraging technologies such as traffic management systems and real-time transit information, complementing sustainable city initiatives promoting public transit and cycling (Oliveira, Nery, Costa, Silva, & Lima, 2021; Poon, 2021; Waqar, Alshehri, Alanazi, Alotaibi, & Almujibah, 2023). Internet connectivity is essential for smart systems and citizen engagement, fostering communication and access to information, aligning with sustainable cities' focus on digital technologies for community participation and environmental conservation (Caputo, Magliocca, Canestrino, & Rescigno, 2023; Kabalci, Kabalci, Padmanaban, Holm-Nielsen, & Blaabjerg, 2019). Managing urban growth responsibly is a shared objective, with smart growth principles advocating for compact, mixed-use development and sustainable cities emphasizing infill development and green building practices (Y. Yang, Dong, Zhou, & Liu, 2024). Solar energy adoption is pivotal for sustainability, with smart cities integrating solar panels and renewable energy systems, while sustainable cities incentivize solar power use through policies and investments (Etukudoh et al., 2024; Liu, Skandalos, Braslina, Kapsalis, & Karamanis, 2023; Mishra & Singh, 2023; Wyrwicka, Więcek-Janka, & Brzeziński, 2023). Learning processes are crucial for innovation and sustainability, with smart cities fostering a culture of innovation and digital literacy, and sustainable cities promoting education and awareness about environmental conservation and sustainable living practices (Morales, Segalás, & Masseck, 2023; Sá, Serpa, & Ferreira, 2022). By addressing these factors, both smart and sustainable cities aim to create livable, resilient, and environmentally friendly urban environments that enhance residents' well-being and contribute to a sustainable future. After analyzing keywords in the bibliometric analysis using VOSviewer, it becomes evident that these factors are central to understanding the interconnectedness between smart and sustainable cities, guiding efforts towards integrated urban development and resilience.

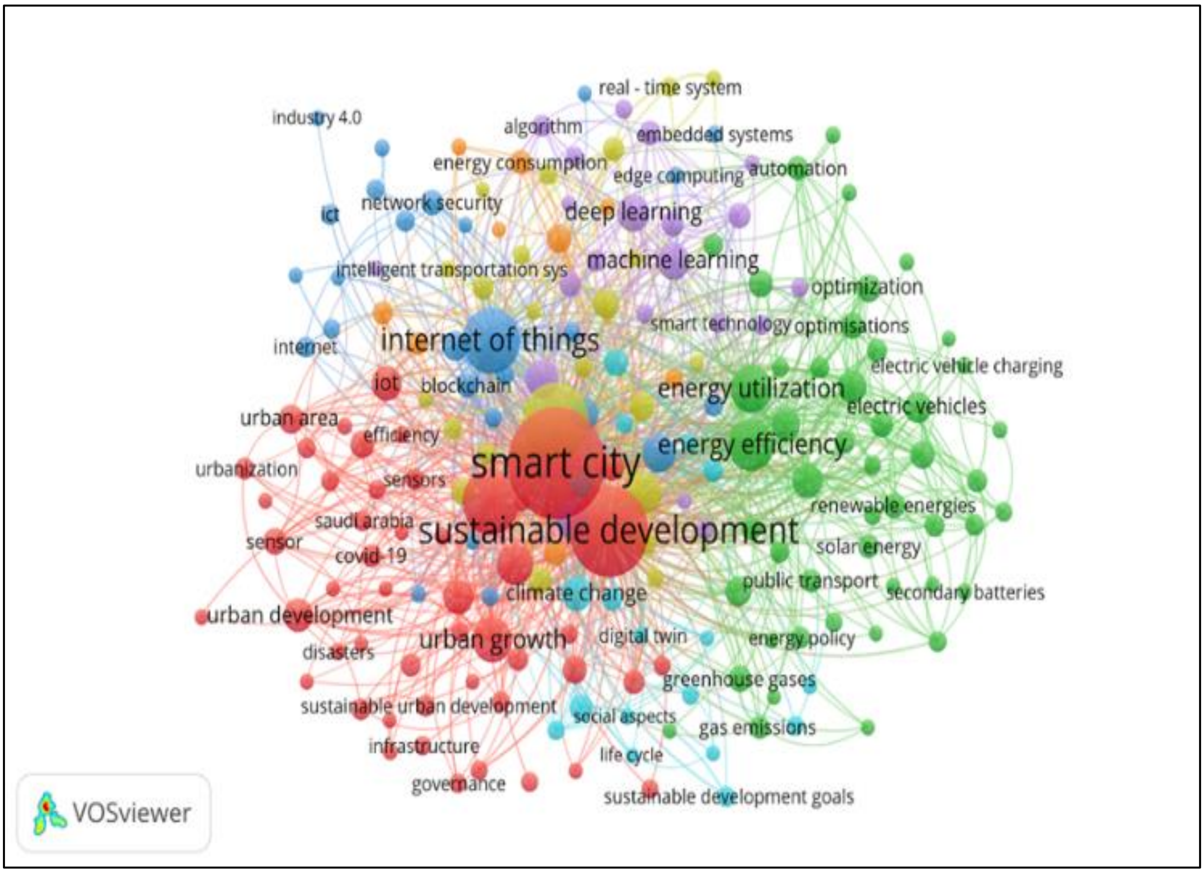

Fig. 1. Bibliometric Analysis Using VOSviewe

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The relationship between smart cities and sustainable cities is fundamental to understanding the complex dynamics shaping urban development in the 21st century. Smart cities leverage cutting-edge technologies and data-driven approaches to optimize urban services, infrastructure, and governance, ultimately enhancing the quality of life for residents. In contrast, sustainable cities prioritize environmental conservation, social equity, and economic viability to ensure long-term prosperity and well-being. A key aspect of this relationship lies in the integration of various domains that serve as connecting factors between smart and sustainable models. These domains encompass a wide range of urban aspects and provide a platform for integration and interconnection, enabling the development of intelligent urban solutions that address pressing challenges and promote holistic urban development. One critical domain is smart governance, which focuses on promoting participatory democratic processes, ensuring transparency, and facilitating access to information for citizens. By fostering citizen engagement and collaboration across multiple levels and departments, smart governance enhances the effectiveness and responsiveness of government services, leading to more inclusive and equitable urban development outcomes. Another vital domain is smart mobility, which seeks to develop efficient and sustainable transportation systems that reduce congestion, emissions, and reliance on private vehicles. Through the implementation of intelligent traffic management systems, promotion of public transportation, cycling, and walking, and integration of smart technologies for parking management and navigation, smart mobility initiatives contribute to enhanced accessibility, connectivity, and environmental sustainability within cities. The smart environment domain plays a crucial role in promoting sustainable practices and preserving natural resources. This includes implementing sustainable waste management practices, promoting energy-efficient infrastructure and buildings, enhancing green spaces and urban biodiversity, and monitoring and managing air and water quality using smart sensors. By prioritizing environmental stewardship and conservation, smart environment initiatives contribute to the resilience and sustainability of urban ecosystems. In the realm of smart economy, the focus is on fostering innovation, entrepreneurship, and economic diversification through digital technology. This includes promoting digital connectivity and broadband access, supporting local businesses and startups, and encouraging the development of a knowledge-based economy that drives sustainable growth and prosperity. The smart living domain centers on enhancing the quality of life for residents through the deployment of smart technologies and services. This involves providing efficient and reliable utility services such as water and electricity, implementing smart home automation systems for energy conservation, promoting digital inclusion, and ensuring equal access to digital services for all segments of society. By prioritizing human-centric design and accessibility, smart living initiatives contribute to the well-being and satisfaction of urban residents.

Lastly, the smart people domain emphasizes investing in human capital development and digital skills training to empower individuals and communities to thrive in the digital age. By promoting lifelong learning, digital literacy, and social inclusion, smart people initiatives ensure that all residents have the opportunity to participate in and benefit from the digital transformation of cities. By integrating these domains and common indicators, cities can develop comprehensive strategies and action plans to advance both smart and sustainable development goals. This integrated approach not only enhances the quality of life for residents but also promotes environmental sustainability, economic prosperity, and social equity within urban areas. Through ongoing research, collaboration, and knowledge sharing, cities can continue to evolve and innovate, paving the way for a more resilient, inclusive, and sustainable urban future.

The objectives of smart cities can be broadly categorized into three main areas: sustainability, quality of life, and efficiency. Sustainability focuses on promoting flexible, sustainable development and environmentally friendly growth, emphasizing holistic solutions that consider energy and material flows. Quality of life aims to enhance human well-being, ensure the survival of human life, and provide opportunities for entertainment and enjoyment, thereby improving the overall living conditions for city residents. Efficiency emphasizes achieving effectiveness through measures such as privatization, which allows cities to unlock their full potential by realizing cost savings, synergies, efficient management, and overall improvements in city operations.

Urban city planners recognize the value of an integrated approach, treating cities as interconnected networks rather than a collection of isolated sectors. This approach seeks to improve the quality of life for residents by combining technological and social innovation. Information and communications technology play a crucial role in enhancing the performance of sectors such as transportation, energy, urban safety, and waste management. Sustainable smart cities can be evaluated using indicators related to these sectors.

Based on previous models and frameworks of smart cities, six integrated sectors can be identified as key areas of focus for smart city initiatives (Fernandez-Anez, Fernández-Güell, & Giffinger, 2018).

B. Discussion

- *Systematic Literature Review Methodology*

The concepts of sustainable cities have resulted in numerous urban design strategies, which may be divided into two major strategies:

Strategy 1: This method focuses on the urban form of the city and attempts to ensure sustainability (Al-Thani, Amato, Koç, & Al-Ghamdi, 2019; Bednarska-Olejniczak, Olejniczak, & Svobodová, 2019; Handayanto, Tripathi, Kim, & Guha, 2017). It is referred to as the "Compact City" plan (Palusci & Cecere, 2022; Shawly, 2022). This plan is realized through a separate urban style known as New Urbanism, or New Traditional Design (Andrés López, 2023; Shawly, 2022).

As part of a dynamic and safe urban environment, Barnett (2012) emphasized in her dissertations the need of comprehending the city via its social and economic activities as well as the social usage density of public places. Urban density, in her opinion, is an illustration of a qualitative social science approach. The main characteristics that characterize standardization were emphasized through the use of the descriptive approach (Barnett, 2012; Vidal-Domper, Herrero-Olarte, Hoyos-Bucheli, & Benages-Albert, 2024).

Many theories and conceptions about urban sustainability originate from a close investigation of prior models of contemporary urban architecture, sometimes known as "non-urban cities," and post-World War II planning models (Biranvand, 2019; Kamei, Mastrucci, & van Ruijven, 2021; Zhao, Zhao, Yan, Zhu, & Guan, 2021). These approaches tend to scatter the urban fabric and contribute to the separation of urban functions, resulting in complicated and difficult management of urban environments (Galacho-Jiménez & Reyes-Corredera, 2024).

In the contemporary period, cities have lost their social core, and urban space has become limited to its physical and service-oriented structure (Ročak, Hospers, & Reverda, 2016). This can be traced to conceptual methods that have widely addressed urban structures while concentrating on urban settings.

From this perspective, the "Compact City Model" seeks to promote the integration and consolidation of urban spaces inside a city in order to achieve social, economic, and environmental sustainability (Allam, Bibri, Chabaud, & Moreno, 2022; Bibri, Krogstie, & Kärrholm, 2020; Conticelli, 2020). The city adopted the concept of "The Pedestrian Pocket" which was formulated by Calthorpe (1993) in his book "The Next American Metropolis" (Calthorpe, 1993).

In his book "Cities for a Small Planet," Rogers (2008)argues that the city is the physical framework of social and urban life, with urban environments serving as content for its people's social activities. He sees the sustainable city as a vehicle for sustainability, trying to strike a balance between energy consumption and social convergence by decreasing services and minimizing automobile mobility while encouraging pedestrian movement. The idea also aims to provide inclusive connectedness between urban places, establish them as urban hubs for all citizens, and foster a sustainable local urban community with low environmental effects by stressing inclusive public transit and improving pedestrian circulation (Rogers, 2008).

Strategy 2: The second strategy is to establish sustainable cities through environmentally sensitive and ecologically appropriate construction design (Newton & Rogers, 2020; Zielinska-Dabkowska, 2022). In the last two decades of the twentieth century, there has been a tendency toward correcting the difficulties produced by prior architecture by adopting more ecological designs that are compatible with the environment (Bungau, Bungau, Prada, & Prada, 2022; Fernando, Navaratnam, Rajeev, & Sanjayan, 2023; Monsù Scolaro & De Medici, 2021). However, these efforts have fallen short since they have focused solely on the performance of individual buildings, but the true problem is in the urban environment (Ding, 2008).

Uncontrolled urban development is dangerous and damaging, and it must be monitored in cities (Capolongo et al., 2018; Esfandeh, Danehkar, Salmanmahiny, Sadeghi, & Marcu, 2021). Urban growth should occur inside the boundaries of existing cities rather than on new sites outside the city, which degrades the surrounding green area (Vinoth Kumar, Pathan, & Bhanderi, 2007; Yasin, Yusoff, Abdullah, & Noor, 2020).

Several urban design ideas for sustainable cities have arisen, with the environment serving as a focus point for achievement and the most important of them is green urbanism (Bibri, 2020; Huang & Wey, 2019). Green urbanization is a proposed urban planning paradigm that focuses on sustainable practices and aims to produce environmentally friendly communities with low emissions and waste (Bansal, Shrivastava, & Singh; Kwilinski, Lyulyov, & Pimonenko, 2023). It has gained popularity since the 1990s in response to the need for urban development that emphasizes energy efficiency and reimagines existing city sectors to meet the demands of the post-industrial age. This notion aims to promote social and environmental well-being in urban areas while also supporting sustainable and eco-friendly urban planning and development practices (Chen, Chen, Lyulyov, & Pimonenko, 2023; Rayan, Gruehn, & Khayyam, 2022).

The green urbanization movement includes two major trends:

- Green Development & Green Infrastructure
- Low Impact Development (LID)

Both trends share a common goal of promoting green urbanization. The concept of green urbanization strives to shift existing cities from being energy consumers to energy producers (Lehmann, 2008). On the other hand, the theory of ecological cities focuses on establishing a harmonious relationship between the urban environment and nature. In the twenty-first century, numerous urban development projects have endeavored to achieve these principles. These projects and cities have made efforts to reduce reliance on petroleum-based fuels and transition towards renewable energy sources. One notable example is the city of Freiburg in Germany, the BEDZED project in the UK, and the EVA-Lanxmeer project in Netherlands.

To achieve green urbanization, a city must implement a comprehensive set of 15 principles. These include considering the climate and context of the area, ensuring efficient transport and well-designed public spaces, and promoting density and retrofitting to make better use of existing structures. Green buildings and districts are essential, as is effective water management and the adoption of a zero-waste concept. The use of local materials and the integration of

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renewable energy sources are crucial for sustainability. Additionally, enhancing landscape, gardens, and biodiversity contributes to the city's environmental health. Livability, health, and mixed-use development should be prioritized, alongside support for local food production. Preserving cultural heritage, fostering governance and leadership, and investing in education and research are also key elements. Finally, special strategies must be tailored for developing cities to address their unique challenges.

One of these principles is related to the topic of energy, which involves transforming city sectors into local energy-generation stations using various natural sources. This includes integrating renewable energy technologies into individual buildings, such as incorporating photovoltaic systems into the structure and implementing Micro Combined Heat and Power (Micro CHP) and Solar Air Conditioning Systems (Kolokotsa, 2017). As a result, several cities have embraced the concept of Green Infrastructure, which has become an essential part of urban planning strategies for achieving urban sustainability. For example, Tokyo has introduced a strategy to be a sustainable city (Okata & Murayama, 2011), while London has presented the London Green Grid Framework to enhance green spaces in the city (Oh, 2022). Therefore, establishing a network of green and blue areas as planning elements in eco-city projects has become a necessary part of the new model of eco-cities that we are about to create or plan for the twenty-first century. Green environmental infrastructures consist of a series of green spaces of various types, public and private, open for different uses that can be exploited to produce biomass or to produce renewable energy, in addition to their role in softening and purifying the atmosphere, lowering the temperature, and encouraging movement without the use of vehicles, which reduces fuel consumption and pollution from vehicle movement, as it can be distributed (hub) or regions (connected) depending on the planning or design philosophy and the nature of the project (Ma, Li, & Xu, 2021). Therefore, two types of environmental structures emerged:
-A: Blue Infrastructure (water bodies and the rivers and lakes that penetrate or surround the city).
-B: Green Infrastructure (green areas and public and private parks that penetrate or surround the city).

Since 2009, these two terms have emerged that significantly influence urban planning and design. These terms revolve around water treatment and management, as well as the deliberate planning of green spaces. These aspects play a crucial role in mitigating the environmental impact on the climate, reducing temperatures, and positively influencing the well-being of citizens (Ghofrani, Sposito, & Faggian, 2017). Additionally, these areas can serve as connectors or distribution zones within the city while also establishing clear boundaries for achieving the ordered and distinct characteristics that architect Rogers emphasized as fundamental principles for eco-cities (Furberg, Ban, & Mörtberg, 2020).

➢ *The Theory of Smart City*

The concept of smart cities has undergone several stages, representing key trends for cities. There are three main trends for the concept of smart cities:

- The first trend is based on adopting digital amenities in the city through Information and Communication Technology (ICT) as a tool to enhance the city, making urban services and transportation more efficient and effective (Apanavičienė & Shahrabani, 2023; Belli et al., 2020; Tcholtchev & Schieferdecker, 2021). The aim is to improve the quality and performance of these services, reduce costs and resource consumption, and engage citizens more effectively (Fang & Shan, 2022). The primary goal of smart cities in this trend is to enhance the quality of life as a fundamental condition for human existence, as measured by indicators such as the Human Life Index, Human Well-Being Index, and Human Enjoyment Index.

Smart cities incorporate various concepts such as digital city, electronic communities, flexible city, information city, knowledge-based city, networked city, and ubiquitous city (Albino, Berardi, & Dangelico, 2012; Repette, Sabatini-Marques, Yigitcanlar, Sell, & Costa, 2021). These concepts aim to utilize information technology efficiently to enhance urban services and promote a better quality of life (Al-Maqashi, Al-Maqashi, Abdullah, Al-Rumaim, & Almansob, 2024; Gohar & Nencioni, 2021; Murroni et al., 2023). The goal is to create a well-connected and technologically advanced urban environment as in Fig. 2.

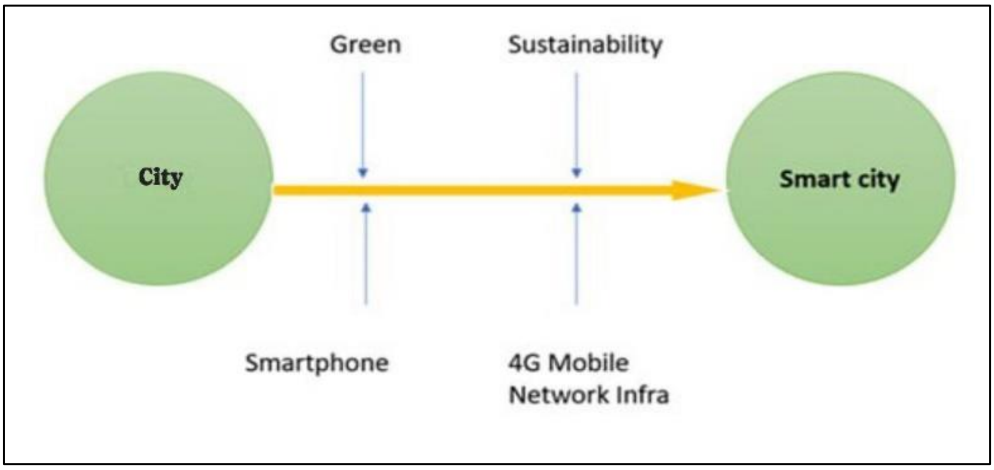

Fig. 2. Turn a City into Smart City

- The second trend, known as smart growth, focuses on controlling city development in an intelligent manner through a set of principles for land use and development (Geyer Jr, 2024; Talen & Knaap, 2003). The goal is to enhance quality of life, preserve the natural environment, and achieve cost savings (Kolbadi, Mohammadi, & Namvar, 2015). Smart growth principles have evolved over time, placing emphasis on financial and environmental sustainability, as well as social responsibility (Mohammed, Alshuwaikhat, & Adenle, 2016). The manifestations of this trend emerged when the United States Environmental Protection Agency (EPA) identified a set of general principles for smart growth in 1996 (Bagheri & Shaykh-Baygloo, 2021).

➢ *The Principles of Smart Growth Include*:

- Adopting mixed land uses: encouraging the integration of different types of land uses, such as residential, commercial, and recreational, within a compact area.
- Taking advantage of compact building design: Promoting the development of compact, walkable neighborhoods with a mix of housing, businesses, and amenities.
- Creating a range of residential opportunities and options: Providing diverse housing options to accommodate different income levels, family sizes, and lifestyles.
- Designing residential neighborhoods that promote pedestrian movement: creating neighborhoods that prioritize walkability, connectivity, and accessibility, reducing the dependence on automobiles.
- Encouraging placemaking and creating attractive communities: Fostering the development of vibrant, attractive, and unique communities that instill a sense of place and identity.
- Preserving open spaces, agricultural lands, natural beauty, and environmental areas: protecting and conserving valuable natural resources, green spaces, and agricultural lands.
- Directing growth to existing communities: Promoting development and revitalization in existing urban areas to make use of existing infrastructure and resources.
- Providing a variety of transportation options: supporting and enhancing multiple modes of transportation, including walking, cycling, public transit, and car-sharing, to reduce reliance on single-occupancy vehicles.
- Making development decisions predictable, fair, and cost-effective: Creating transparent and efficient processes for development approvals and regulations that are fair to all stakeholders (Landis, 2022).
- Encouraging community cooperation and stakeholder involvement in development decisions: Promoting collaboration and engagement among community members, organizations, and government entities to ensure that development decisions reflect the needs and aspirations of the community (Bagheri & Shaykh-Baygloo, 2021).

Smart growth intersects with various urban concepts, including new urbanism, growth management, new community design, sustainable development, urban land preservation, sprawl prevention, placemaking, best practices development, conservative development, and sustainable transportation (Parolek, Parolek, & Crawford, 2008). These principles and concepts collectively aim to create more sustainable, livable, and vibrant communities (Tretter, 2013). The Principles of Intelligent Urbanism (PIU) are a set of ten principles that guide the development of city plans and urban design in an integrated manner. The primary objective of this trend is to achieve smart integration among the various concerns of urban planning (El Din, Shalaby, Farouh, & Elariane, 2013). These principles of Intelligent Urbanism (PIU) were identified by the International Congresses of Modern Architecture (CIAM) (Bugadze, 2018). The ten basic principles of Intelligent Urbanism encompass a holistic approach to city planning. The first principle is achieving a balance with nature, ensuring that urban development respects and integrates with the natural environment. The second principle emphasizes a balance with tradition, preserving cultural heritage and local identity. The third principle, conviviality, focuses on creating spaces that cater to various social needs, including places for individuals, friendships, households, neighborhoods, communities, and the public domain. Efficiency is the fourth principle, advocating for resourceful and sustainable use of urban infrastructure. The fifth principle highlights the importance of maintaining a human scale in design, ensuring that urban spaces are accessible and comfortable for people. The sixth principle, the Opportunity Matrix, seeks to create a dynamic environment that offers diverse opportunities for all citizens. Balanced movement is the seventh principle, emphasizing the need for efficient and equitable transportation systems. Institutional integrity is the ninth principle, stressing the importance of strong governance and reliable institutions in urban development. Lastly, the tenth principle underscores the necessity of a clear and forward-thinking vision to guide sustainable urban growth.(Benninger, 2002).

➢ *The Correlation Between Smart and Sustainable Cities*

Developing cities in the Third World still face numerous challenges such as poverty, unemployment, health problems, traffic congestion, non-car mobility, pollution and crimes (Awuah & Abdulai, 2022; Pojani & Stead, 2015; Tan & Taeihagh, 2020).

These challenges necessitate integrated solutions across various sectors and fields that should align with the advancements in communication and information technologies, which have become defining features of urbanization worldwide. Information technology, particularly the Internet, has revolutionized urban planning by urging traditional planners to consider not only physical aspects but also the utilization of information technology to enhance the city's economy, environment, mobility, and governance (Nassereddine & Khang, 2024; Townsend, 2013). The concept of "growing cities" has been replaced by the notion of creating smart cities through smart urbanization, which strives to achieve smart growth.

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When exploring the correlation between the principles of smart urbanization, smart growth for smart cities, and green urbanization for sustainable city models, one can observe their overlapping and complementary nature. This interconnectedness is effectively illustrated in Figure 3, which presents a representative model of collaborative urban systems. Figure 3 offers a simplified depiction of the urban information model, where each level in the diagram represents a collection of layers encompassing diverse yet interconnected types of information within a two-dimensional space. This layered approach emphasizes the need for holistic and integrated urban planning that aligns with the complex and multi-faceted nature of modern cities, particularly in the context of smart and sustainable development.

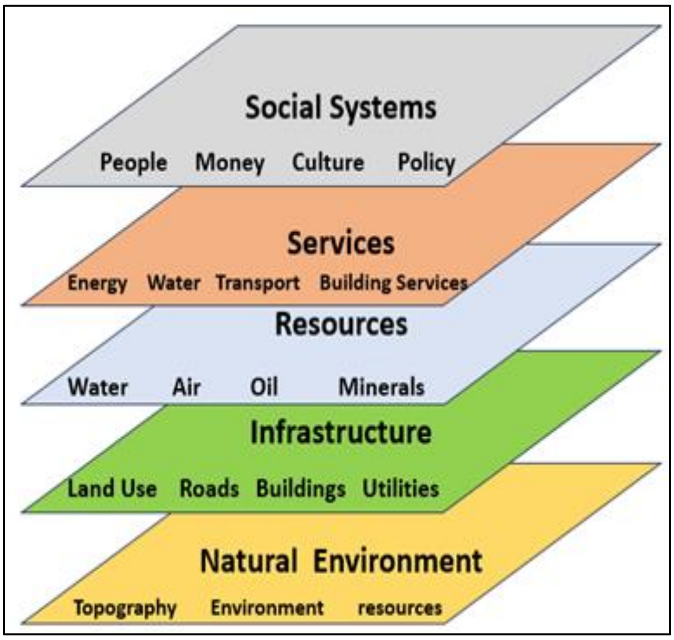

Fig. 3. A Model of Collaborative Urban Systems, Depicting the Urban Information Model with Layers of Interconnected Data in a Two-Dimensional Space. This Illustrates the Integration Needed for Smart and Sustainable City Development.

These principles are shared across different urban systems, sectors, and fields, as illustrated by the following points: Mixed land uses, compact design, and placemaking (smart growth principles 1, 4) overlap with integrating green infrastructure into the urban fabric, a key aspect of green urbanization. This strengthens live-work connections and provides amenities to support walkable, bike-friendly neighborhoods. Offering a range of housing and preserving lands (principles 2, 6) corresponds to green urbanization's aim of responsible urban expansion that considers environmental protection alongside housing supply, with compact growth retaining natural buffers. The emphasis on connected, multi-modal transit systems (principle 8) reduce reliance on private vehicles and emissions, aligning with green urbanization's climate goals as well as smart urbanization's prioritization of walkability and shared mobility solutions. Directing growth inward through infill and density (principles 3, 7) limits sprawl's energy/resource impacts, linking to green urbanization's sustainable development approach within existing boundaries to contain the urban footprint. Lastly, participatory planning processes and cooperation across sectors (principles 9, 10) are essential for implementing smart strategies, green technologies, and innovations through an integrated systems approach embraced by all three frameworks.

According to many contemporary theorists, smart cities are characterized by their utilization of information and communications technology (ICT) to enhance residents' quality of life while promoting sustainable development (Singh & Singla, 2021).

IV. CONCLUSION

The research strongly supports integrating the sustainable cities model, with its social, economic, and environmental foundations, into the smart cities model. This integration, driven by the goal of enhancing quality of life, achieving smart growth, and fostering urbanization, relies heavily on information and communication technology (ICT) as a key enabler. Through bibliometric analysis using VOSviewer and an extensive review of Scopus-indexed literature, key factors such as air quality, intelligent transportation systems, and urban growth emerge as central to understanding the interconnectedness between smart and sustainable cities. These findings align with previous research, confirming the hypothesis that integrating these models within urban sectors is crucial. This integration has led to the development of a novel smart sustainable city model, characterized by collaborative and interconnected urban systems. The pervasive presence of ICT allows cities to implement these models, driving urban development in innovative ways that differ from past efforts. The significance of integrating urban sectors is crucial for creating future urban models that unlock new opportunities and effectively address the challenges of the coming decades. The smart sustainable city model not only facilitates efficient resource use and enhances urban service management but also emphasizes social equity and inclusivity. By fostering citizen engagement, promoting equal opportunities, and encouraging participatory decision-making, this model ensures that the benefits of urban development are accessible to all. Additionally, the interplay between the smart and sustainable aspects of cities fuels economic growth and innovation, creating opportunities for job creation, economic diversification, and prosperity. Furthermore, integrating smart and sustainable models transcends geographical boundaries, allowing cities worldwide to learn from each other's experiences and foster global cooperation. This interconnectedness enables cities to tackle common challenges such as climate change and resource scarcity, collectively working towards a more sustainable and resilient future.

In conclusion, the integration of smart and sustainable city models, supported by insights from bibliometric analysis and Scopus-indexed literature, presents a transformative approach to urban development. By leveraging advanced technologies, embracing sustainability principles, and fostering collaboration and inclusivity, cities can navigate the complexities of the modern world, unlocking a future characterized by sustainable development, enhanced quality of life, and technological advancement.

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