Review and Analysis of Smart City Evaluation Frameworks

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ABSTRACT

Over the past 10 years, there has been a surge in the study and implementation of smart city (SC) technology. A detailed analysis of the literature evaluations that have already been published on SCs reveals a deficiency of studies that categorize the literature into distinct themes and determine the most and least popular topics based on the number of peer-reviewed research papers that fall under each theme. In an attempt to close this gap, a descriptive literature evaluation of peer-reviewed papers on SCs has been carried out for this work. Over the past 10 years, there has been a surge in the study and implementation of smart city (SC) technology. Based on the number of peer-reviewed research articles that fall under each subject, a detailed analysis of the literature evaluations that have already been published on SCs reveals a lack of studies that classify the literature into different themes and identify the most and least popular topics. The investigation shows that although various frameworks provide insightful information, there is sometimes a lack of standardization, which complicates comparisons. Furthermore, the majority of frameworks fall short in addressing issues of social justice and public involvement in the assessment process. The study emphasizes the requirement for a single framework that guarantees inclusivity and integrates a variety of criteria.

Keywords: Smart city, Assessment, Index, Challenges, Economic.

1. INTRODUCTION

The term "smart city" was first used in 1990 to refer to the integration of advanced information and communication technology (ICT) into urban planning **(Bibri and Krogstie, 2017)**. Demands from decision-makers and the development of smart cities have linked the concept of smart cities to a variety of other concepts, such as digital cities, intelligence, pervasiveness, knowledge, and information **(Gupta et al., 2019).** Smart cities aim to improve the effectiveness, efficiency, accountability, and transparency of public-government relations by incorporating ICT technologies **(Gupta et al., 2019)**. Although the goal of almost

all smart city programs is to build communities that are sustainable, efficient, and pleasurable for their residents, there are many different definitions of what makes a smart city, therefore there are differences in the frameworks used to design these communities. While there are differences in national and urban characteristics that make it impossible to use the same framework for establishing smart cities everywhere, there should be a shared set of standards and evaluation criteria for smart city efforts. This facilitates information exchange and learning across different municipalities and helps to concentrate the development of smart cities. Smart city assessment is a relatively young field with a lot of development potential. Therefore, it is crucial to review and analyze the frameworks for smart cities that are currently in place as well as create consistency **(Sharifi, 2019)**. Instruments for efficiently evaluating the growth of smart cities are crucial, and they are advantageous to all the numerous stakeholders **(Moura and Almeida, 2020).** Both academics and those who employ smart city assessments are looking for better assessment frameworks **(Lacson et al., 2023).** Future planning and development of smart cities will be greatly influenced by the establishment of widely accepted, thorough rules and basic concepts for assessing smart cities. The current trend of economic globalization is being reflected in the increasing advancement of smart city development toward common future objectives. These overarching guidelines can provide general guidance and enhancement, but they will not have an immediate impact on the national laws governing the creation of smart cities. The following are the fundamental components that form the basis of the Smart City Concept: Different groups and scholars have different ideas about what makes up a smart city according to their own perspectives. In this paragraph, we search for various cores from previous research on the constituents of smart cities. 151 papers have been calculated. We determine that the average frequency is six. The framework will include components that have been mentioned in earlier research studies more than six times. The element clusters are administration, utilities, transportation, technology, people, environment, economy, and society. Municipal government or administration is the first acknowledged component. According to Washburn and Sindhu **(Washburn et al., 2009)**. A city's management is made simpler. In today's service-based economy, an efficient local government that assists businesses and provides services to its residents is essential. Furthermore, the ability of smart government services to effectively inform residents about municipal situations and reach them is what makes them indispensable. To do this, it is crucial to administer municipal services like healthcare and education utilizing technology for cooperation and communication. It also offers transportation on the side of green Structures, along with reliable infrastructure. Additionally, we implement the Social Standard as the second component **(Washburn et al., 2009).**

Societal norms elevate opportunities, reduce expenses, bolster educational endeavors, and improve overall well-being. Collectively, these factors suggest that the widespread integration of technology in education will enhance the learning process as a whole and enhance both accessibility and participation. The deployment of personal computers (PCs) and Internet connectivity would provide access to educational resources for individuals living in remote locations or those who are unable to attend classes on a full-time basis. Similarly, the utilization of digital learning resources and collaborative technology has the potential to enhance the quality of education in a more straightforward and cost-effective manner. **(Barrionuevo et al., 2012)** argue that several elements are necessary to improve a city's social environment, including thorough research, an inclusive immigration policy, community development, elder and health care, and public health safety. The third element comprises utilities and infrastructure. It is advisable to reduce waste by giving the minimum

amount of energy or water necessary. An intelligent utility infrastructure is essential for enhancing the efficiency of existing systems and providing innovative methods for generating and distributing water, gas, and electricity. Furthermore, in light of limited resources, it is crucial to employ many cutting-edge methods for the distribution, administration, and preservation of energy. **(Shen et al., 2018)** argued that in order to advance urban, cultural, and social development, it is necessary to enhance economic and political effectiveness by utilizing interconnected infrastructure. Furthermore, these networksPresent-day assessment models frequently overemphasize economic advantages and technological prowess at the expense of other crucial aspects. For example, long-term sustainability, citizen engagement, social equality, and the interoperability of disparate systems are often overlooked by frameworks. Furthermore, there is inadequate adaptation to regional socioeconomic situations and a deficiency of robust approaches for evaluating ethical issues and privacy implications. These omissions make it difficult to fully assess the entire impact of smart cities and lead to a partial comprehension of their effectiveness.

To define the scope of the study and direct the review process, we formulated the research questions at the outset of our literature assessment. An extensive evaluation was conducted to have a more comprehensive comprehension of the current state of smart cities. The study encompassed an analysis of definitions, funding allocation, applications, quantitative methodologies, metrics, advantages, downsides, and implementation difficulties. Additionally, the study explored the strategies employed by cities to address these issues. By performing a detailed examination and analysis of the current smart city evaluation frameworks, this study seeks to close these gaps. We methodically investigate how various frameworks tackle the following neglected issues or do not handle them: Social Equity: Assessing how frameworks handle social inequities and taking into account how smart city projects will affect different demographic groups **(Ajmal et al., 2022)**.

Citizen Engagement: Examining how well incorporating citizen input and participation into assessment procedures shapes the results of smart city initiatives. Economic Impact and Cost-Benefit Analysis: Determining how models evaluate smart city programs' financial sustainability and economic advantages.

The primary focus of our inquiry is around the following question:
1. What is the precise definition of smart cities?
2. What are the obstacles or difficulties?
3. Which indexes measure smart cities?
4. Intelligent Index Evaluation.

2. METHODS OF SURVYING

In light of the study's goal, is to choose pertinent research articles for a systematic literature review and to gather data from those articles. The procedure had many parts, including protocol creation, research paper filtration using keywords, titles, and abstracts, and data extraction from the filtered publications. This paper analyzes and assesses current smart city assessment frameworks using a systematic review methodology. Our objectives are to identify gaps in the existing literature and conduct a thorough assessment of how these frameworks address different aspects of smart city efforts. IEEE Xplore, Scopus, Web of Science, Google Scholar, and JSTOR are just a few of the scholarly databases we thoroughly searched. Our search strategy involved combining terms like "smart city assessment," "smart city evaluation frameworks," "urban smart technologies," and "smart city performance metrics."

The inclusion criteria for the frameworks were as follows: they had to encompass several aspects of smart cities, be published in peer-reviewed journals or recognized conferences, and explicitly offer a methodology for evaluating smart city initiatives. Frameworks were disqualified if they were unpublished or not subjected to peer review, if they were exclusively theoretical and lacked elements of a practical evaluation, or if they were centered around a single technology without considering broader evaluation criteria. The Procedure for Screening and Selection is as follow : Screening: Based on the inclusion and exclusion criteria, the titles and abstracts of the discovered publications were examined to ascertain their relevancy. Review of the Entire Text: Selected papers were reviewed in their entirety to ensure that they were relevant and to extract relevant assessment frameworks. Expert Consultation: To confirm the inclusion of frameworks and guarantee thorough coverage, we conferred with specialists in the field of smart cities.

3. REVIEW OF SMART CITIES

3.1 Smart Cities Definition

The emergence of the concept of a "smart city" may be traced back to the New Urbanism movement in the United States throughout the 1980s. The emergence of information technology led to the introduction of the phrase "smart city" in the media during the 1990s. **(Bibri and Krogstie, 2017)**.

The study of smart city definitions has employed text analysis tagging techniques, a commonly utilized tool in social science research. The important phrases in the definitions have been categorized and examined according to the primary issues that have been identified. The definitions have been organized and evaluated based on their efficacy in addressing the concerns, as per the existing literature. To present the preliminary results in a manual manner, the key terms in the definitions have been organized using Excel tables **(Fernandez-Anez, 2016)**.

When developing a comprehensive smart city concept, it is important to take into account all aspects, limitations, extent, and terminology. A smart city comprises land, people, technology, and government. The boundaries of a city's size can vary, ranging from a tiny urban area within a single city to a larger region, a network of cities, and finally including national and global scales. These domains require clearly defined and quantifiable objectives: well-being, public involvement, intelligent intellectual capital development, and environmental sustainability. Now, it is feasible to attempt to construct the subsequent all-encompassing explanation of a smart city: A smart city is a clearly defined geographical region where advanced technologies, such as information and communication technology (ICT), logistics, and energy production, collaborate to enhance the well-being, participation, and inclusion of citizens, as well as improve environmental quality and promote intelligent development. It is governed by a specific group of individuals who establish policies and regulations for the city's government and growth **(Dameri, 2013)**.

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Smart Cities are not a strictly defined concept **(Solanas et al., 2014)** but are a term commonly used to refer to the convergence of technology and city **(De Lima et al., 2020)** Although the term "smart cities" is sometimes used interchangeably with other, more specific terms such as "information cities" or "virtual cities," smart cities include all of these as well as the most important—and often ignored—aspect: The inhabitants **(Albino et al., 2015).** Smart cities are composed of intricate and sophisticated networks of pervasive digital devices that link residents, authorities, and data-transmitting items in real-time. The four primary components of smart city ideas are often sustainability, quality of life, urbanization, and intelligence, with certain subcategories of these having stronger relationships than others **(De Lima et al., 2020).**

Given this, cities all over the world must become "smart," or, to put it another way, must come up with clever and creative solutions to deal with these impending problems **(Monzon, 2015).** The concept and intent of a "smart city," however, have generated debate in academia and a range of suggestions about this subject. (**Albino, 2015)** provide a thorough summary of the research on the definition of a smart city **(Albino et al., 2015)**. The definitions for different authors are shown in **Table 1.**

Table 1. Smart City Definitions.

Definition	Reference
Enhancing the overall intellectual capacity of the city by integrating its physical, IT, social, and commercial infrastructure to their maximum potential.	**(Wenge et al., 2014)**
A city that is smart is an integrated technology system that uses advanced data processing to optimize municipal governance, enhance citizen contentment, stimulate economic development, and foster environmental sustainability.	**(Yin et al., 2015)**

A city is deemed intelligent when it strategically focuses resources towards enhancing social and human capital, as well as upgrading both traditional and modern transportation and communication facilities. This promotes a superior standard of living, sustainable economic expansion, and responsible exploitation of natural resources, all accomplished through inclusive and participatory governance.	**(Caragliu et al., 2015)**
Smart cities are urban areas that employ information and communication technologies to enhance the well-being of its residents and promote sustainable development.	**(Capdevila, 2015)**
A city that is smart is a cutting-edge concept designed to tackle the issues brought about by fast urbanization and population expansion, with the objective of helping both governments and the general populace. Smart cities are urban initiatives focused on improving the efficiency, sustainability, and livability of metropolitan environments.	**(Joshi et al., 2015)**
A city that is smart is a hypothetical model of a city that utilizes technology to efficiently address complex issues, leading to economic advancement, environmental sustainability, and enhanced quality of life.	**(Meijer et al., 2016)**
Smarter cites are urban areas that employ information and communication technologies to efficiently address specific challenges and improve the overall social, economic, and environmental sustainability of the region	**(Mora, 2016)**
Smart cities are characterized by their use of sensors to detect and monitor the environment, and by their networked devices that transmit this information to the Internet, Our environment's information is made widely available and easily accessible to individuals through the internet. Users have the ability to access information at any given moment and from any location, even while traveling. Individuals that possess a gregarious nature have the ability to disseminate knowledge across their social network. Sharable refers to the ability to share not only data but also physical items that can be used when they are available for free. Visible/augmented means that the physical environment is modified to incorporate information that is not only accessible through mobile devices but also shown in physical locations like street signs.	**(Cassandras, 2016)**
Smart cities consist of interconnected components that constantly exchange data, aiming to enhance the quality of life for residents within their nation.	**(Baig et al., 2017)**
A smart city employs networking and computing technologies, data security measures, and privacy protections to enhance the overall quality of life for its residents. This includes improving utilities, healthcare, transportation, entertainment, and government functions through innovative applications and efficient data collection, processing, and dissemination technologies.	**(Gharaibeh et al., 2017)**
A smart town is an urban environment that utilizes information and communication technology (ICT) and other pertinent technologies to enhance the efficiency of everyday city functions and the standard of services provided to citizens.	**(Silva et al., 2018)**
A city that is smart is a cutting-edge metropolitan area that employs information and communication technology (ICT), human capital, and social capital to promote sustainable socio-economic growth and guarantee a high quality of life.	**(Tascikaraoglu, 2018)**
Cities that are smart utilize technology for communication and information to enhance the quality of life for its residents, boost the	**(Ismagilova et al., 2019)**

regional economy, optimize transportation and traffic management, and facilitate engagement with the government.	
Smart towns and cities utilize advanced contemporary information and communication technology (ICT) to create a sustainable urban environment and enhance the quality of life for citizens. A smart city is a complex system that uses technology-based solutions and innovations to successfully solve public concerns, accomplish sustainable development, and maintain a high quality of life by leveraging and interacting with natural and economic resources.	**(Xie et al., 2019)**
An assemblage of interconnected tools of different sizes, linked through various networks, that continuously provide data on individuals and the surroundings. This data aids in making informed decisions regarding the social and physical layout of the city.	**(Akpinar, 2019)**
The city leverages collaborative leadership tactics, interdisciplinary approaches, and modern technologies to improve the well-being of its citizens, businesses, and visitors, while also relying on data for decision-making. These endeavors are focused on guaranteeing a viable and enduring future without inflicting damage on people or the ecological system. A city that greatly improves its methods of connecting with people and tackling challenges such as climate change, rapid population growth, and political and economic instability.	**(ISO, 2019)**
These can be utilized when they are free; visual/enhanced; where the physical environment is adapted and knowledge becomes clear not only on mobile devices but also in physical locations such as street signs.	**(Alsamhi et al., 2019)**
Based on Digital City, smart cities realize automatic, real-time operations and complete awareness of urban activities by means of sensor and intelligent technologies.	**(Wang et al., 2019)**
Smart and sustainable cities are anticipated to play a vital role in attaining global resource efficiency and sustainability.	**(Angelakoglou, 2019)**
The city that optimizes its limited resources and makes the best use of all the connected information currently available to better understand and control its operations	**(Khan et al., 2020)**
The objective of smart cities is to efficiently handle the growing urbanization, and energy usage, maintain an eco-friendly environment, enhance the living and economic conditions of inhabitants, and improve their competence in current technology for communication and information (ICT).	**(Ullah et al., 2020)**
The following presents a proposed description of a smart city: Considered to be able to learn from experience (E) in respect to a given task (T), a performance metric (P), and resource optimization (O), a smart city is One may argue that the task is being enhanced by experience (E) if the performance of the city on the task (T), judged by the performance measure (P), increases with regard to resource optimization (O). IBM defines a smarter city as one that efficiently makes use of all the connected information at hand to improve its knowledge and operation management as well as to maximize the utilization of limited resources. The third is The Manchester Digital Development agency defines a "smart city" as "smart citizens" with access to all the required knowledge to make wise decisions about their travel plans, employment, and way of life.	**(Singh et al., 2020)**

A city that is smart is the mix of modern information and communication technologies (ICT) with a sustainable living environment. A smart city is an urban self-contained enclave where the quality of living for its citizens is given most priority.	**(Haque et al., 2020)**
The smart city is a complex cyber-socio-technical system where technological systems, cyber artifacts, and people interact to achieve a goal associated with improving the quality of urban life.	**(De Nicola, 2021)**
A sustainable city that is smart is a forward-thinking urban area that prioritizes the economic, social, and environmental needs of both present and future generations by utilizing ICTs (information and communication technologies) and other methods to optimize urban operations and services, promote competitiveness, and enhance quality of life.	**(Singh et al., 2022)**
Smart city design makes use of technology for communication and information to improve inhabitants' quality of life as well as government administration.	**(Attaran et al., 2022)**
Smart cities are those that use a broad adoption of ICT and other technological tools to improve the wellbeing of residents while balancing advances in the economy, environment, and society.	**(Dashkevych, 2022)**
By employing a methodical approach to gathering and examining meticulously planned and regulated data, the smart city can proficiently recognize its issues and implement strategies to tackle their fundamental origins.	**(INCOSE, 2023)**
A city with smart technology is a geographical area that utilizes digital technologies to optimize the efficiency of traditional networks and services, resulting in advantages for its residents and enterprises.	**(European Commission, 2023)**

3.2 Advantages and Challenges of Smart Cities

Even if the concept of a "smart city" is widely accepted and is being implemented in the actual world with some realism, in order to advance further, it is now necessary to solve certain obstacles. This section provides a brief summary of the challenges and promising future directions for the use of smart cities. The challenges were discovered through a comprehensive review of the literature on recent advances in smart city research. Similarly, the opportunities were found via prior research and real-world application experience with smart city projects **(Antasari and Putri, 2022**).

There are challenges to the actual use of smart cities at every stage of the process: design, implementation, and operation. High design and operating costs, heterogeneous device types, large-scale data collection and processing, information security, and sustainability are a few of the primary challenges. Minimal operational expenditures are highly needed to guarantee the sustainability of service provision without adding to the financial burden on governments. However, sustaining cost-effectiveness throughout a smart city remains a challenging task **(Silva et al., 2018).**

problems into eight groups and list the difficulties within each group along with a number of possible solutions.

- Managers and organizations encounter various challenges such as project size, management attitudes and behaviors, user diversity, misalignment between projects and organizational goals, conflicting goals, resistance to change, turf and conflict, and other issues.

- The challenges include technological obstacles such as a lack of IT skills and persons with integration abilities, as well as organizational barriers such as a lack of collaboration between sectors and coordination between departments. Additionally, there may be issues related to unclear vision in IT management, politics, and cultural problems.
- The government should prioritize cooperation, communication, data sharing, accountability, transparency, leadership, championing, participation, partnership, and integration of services and apps **(Bluman and Cole, 2012).**
- Policy context: The integration of ICT with political and institutional factors poses challenges due to the divergent goals of each.
- Individuals and societies: addressing digital disparities; guardians of knowledge and community; participation and cooperation; communication; education; quality of life;
- Economy: This category encompasses several aspects related to economic competitiveness, such as innovation, entrepreneurship, productivity, and other relevant elements.
- Damaged infrastructure: this encompasses IT infrastructure (obstacles to internal systems; absence of interoperability; accessible and compatible software systems and applications); security and privacy (risks from viruses, worms, and Trojan horses; privacy and personal data); and operational expenses.
- The natural environment, which includes all the difficulties related to the long-term adoption of ICT.

(Van den Bergh and Viaene, 2015) look at a few challenges cities face in their quest to become SC. Six challenges were identified following in-depth interviews: (1) The city administration's place in the ecosystem, (2) the assignment of an expert team to supervise the SC's expansion, (3) the establishment of an internal coordination mechanism (as there was no official framework for discussing SC projects), (4) the management of the relationship between IT and business, (5) the need for a positive and driven workforce in a SC, and (6) the transition from the experimental phase, where SC projects stall, to a real implementation **(Bergh et al., 2015)**.

Pierce and Andersson examine municipal decision-making from a theoretical standpoint as well as via their personal interviews in their suggested taxonomy of SC challenges. The following were among the non-technical barriers that were identified: The first five are financial, followed by collaboration, governance, finance, awareness, and five technology concerns (interoperability, privacy, etc.). the smart cities challenges are :

- Cooperation: this involves making a pathetic attempt to work with other parties.
- Financial: This covers problems like not having a business strategy, having to pay a large sum of money up front, not having enough money for SC initiatives, and having difficulty profiting from SC investments.
- Leadership: challenges brought about by antiquated rules and conventions that hinder SC initiatives.
- Consciousness: this category covers issues brought on by a lack of knowledge and comprehension of technologies connected to SC.
- Cooperation: involves challenges with SC integration.
- Personal information: includes the difficulty of handling big data while preserving citizens' privacy.
- Iraq is among the Arab countries that seeks for non-conventional solutions to many of the problems and challenges that have gotten worse over the last several decades due to wars and economic crises, which have an impact on the entire city. Finding solutions, the

research indicates, requires an awareness of the fundamental problems that underlie the previously mentioned problems, such as those pertaining to government, the environment, the economy, and society **(ElMooty, 2017; Thabit, 2019; Alsayed, 2020; Mohsin, 2020; Mohammed, 2020; Altaie, 2024).** The problems of develoing smart cities :

- The reduction in security resulting from armed conflicts and war, especially during the 2003 war in terms of both crime and terrorist attacks.
- An increase in the population paired with a severe lack of housing and a decline in the public's desire for these units. This is made worse by the subsequent increase in the proportion of unofficial housing and the dispersion of slums, or informal settlements, throughout the cities, especially in Baghdad. Being the capital, the city attracts a lot of displaced people
- Frequent usage of gasoline-powered generators and the pollutants emitted by internal combustion engine automobiles on city streets are the main causes of environmental pollution. In addition to several other factors, the city's various ways of acquiring
- The regular occurrence of desertification resulting from excessive grazing, inadequate irrigation methods, and the conversion of agricultural land into residential areas as a result of a lack of environmental consciousness among the general public and the government.
- Inadequate utilization of primary resources due to a heavy reliance on imports, especially in the construction and reconstruction sectors.
- The economy's fragile status.
- The absence of planning plans for the next year or years, as well as an integrated planning system that can address housing difficulties. They have not been followed as there is an emergency in the country.
- The decline of Iraq's educational system, particularly during the 2003 War, as a result of institutional corruption, inadequate facilities, and rising rates of student absences and dropouts due to financial hardships. Every one of these is represented in the educational framework.
- The manner that political upheaval, economic sanctions, wars, and financial and administrative corruption have all contributed to the steady degradation of Iraq's health system over the last forty years. The result has been a sharp drop in healthcare quality.
- How urban form has been altered by conflict and catastrophe, especially in Baghdad, and how elite intellectuals and architects have failed to see this collectively.

3.3 Smart City Indexes

Although there are several smart city indices now in use, they vary in terms of their topics, degree of measurement, and coverage area. **(Kaur and Garg, 2019; Patrão et al., 2020).** In the form of a typology, indices can be further categorized into certain groupings based on their primary foci **(Kaur and Garg, 2019).** Even if we accept that systematic reviews, particularly the search strategy, should be ensured using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist **(Page et al., 2021)**. ISO 37122:2019 was developed based on ISO 37120:2018. ISO 37120:2018 deals with indicators for smart cities, and ISO 37123:2019 deals with indicators for resilient cities **(ISO 37120, 2014)**. At the moment, a number of international city indicator standards are pertinent to the assessment and documentation of smart and sustainable cities.

The first certification system based on ISO 37120 was developed by the World Council on City Data (WCCD) and the Global Cities Registry to provide specified standards for smart city evaluations. The responsibility for creating the standards to construct resilient, sustainable, and intelligent cities rests with WCCD; these standards must conform to ISO 37120 **(Picioroagă et al., 2018).** The World Council on City Data (WCCD) and the Global Cities Registry created the first certification system based on ISO 37120 to give defined criteria for smart city assessments. In order to build smart, sustainable, and resilient cities, WCCD is in charge of developing the standards, which must adhere to ISO 37120 **(Aragão et al., 2023)**. Number of indicators of ISO 3712x series as shown in **Table 2.** Based on the survey from the previous studies, the indicators are shown in **Fig. 1.** An organized summary of the numerous indicators used in the various smart city assessment frameworks can be found in the Smart City Indicators Table. These metrics or criteria serve as indications for evaluating the performance and efficacy of smart city projects.

Table 2. Smart city indicators.

| Author	Index main
(ISO 37120:2014)	Budget Environment and climate change; energy; education Budget Management: Governance Health: residential situation, population, and social circumstances Recreation: Safety Solid waste; sports and cultural events Telecom Vehicles Urban and local food security and agriculture Urban designing Water from wastewater
(Myeong et al., 2018)	Economy Human Resources Environment Innovation Citizens (people)
(Bhattacharya et al., 2020)	Environmental Index Economic Index Social Index Culture And Life Style
(Syalianda and Kusumastuti, 2021)	Economy Human Resources Governance Mobility Environmental Living
(De Lima et al., 2022)	Economic Mobility Environmental Living Governance
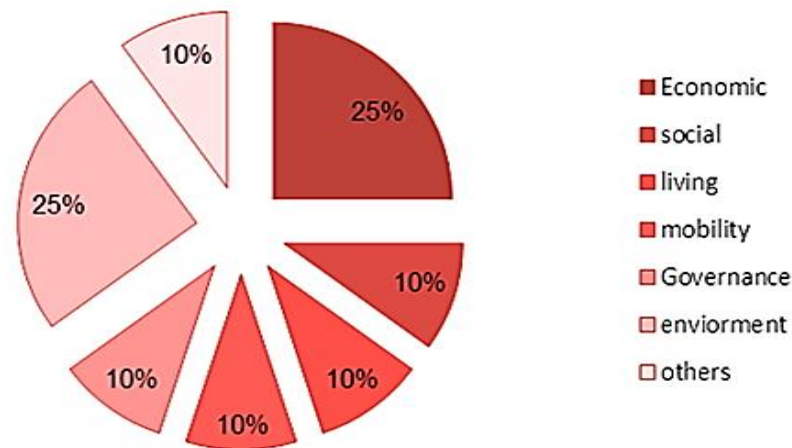
Figure 1. Smart city indicators **(Bhattacharya et al., 2020).**

3.4 Assessment Methods of Smart Cities

Programs for evaluating smart cities have been established for nearly 10 years, although little is known about their typology. Studies that are currently available in the literature usually only cover a limited subset of assessment techniques without taking into account their typology. These studies often provide an overview of the schemes and their assessment techniques, or they concentrate primarily on the variety and type of indicators used for assessment. Journal 4 pre-proof Caird has provided broad overviews of a few ideas **(Albino et al. 2015; Caird et al., 2016; Wu et al., 2016)** provided a summary of a few (mostly Chinese) intelligent city assessment techniques. Information on key strategies for selecting indicators and gathering and utilizing data is included in their paper. With a focus on evaluation methodology, (**Anthopoulos et al., 2016)** investigated several benchmarking techniques and discovered that the wide definition of smartness creates a lot of difficulties **(Anthopoulos et al., 2019; Altaie, 2024)**.

Like assessment tools developed for other purposes **(Sharifi and Murayama, 2015; Sharifi and Yamagata, 2016)**, Indicators are crucial components that make up smart city assessment (SCA) tools. Choosing a group of pertinent indicators is frequently the first stage in creating an evaluation tool. The following techniques can be used alone or in combination to choose indicators: stakeholder consultation, expert survey, and literature study. Selected indicators are frequently categorized into themes and sub-themes based on how similar they are **(Sharifi and Murayama, 2015; Sharifi and Yamagata, 2016)**. Scorecards, like those included in the SCC and WWC tools, are used to evaluate performance in relation to the indicators. These scorecards can also take the shape of checklists, questionnaires, or other types of scoresheets. External auditors (i.e., third-party assessment, as in the SCIeI tool), tool developers (e.g., EDCi and LRSC tools), or tool users (i.e., self-evaluation, as in the CSC tool) can all conduct performance assessments. Numerous tools (such as the SCIeI and CKPI tools) combine the scores of numerous indicators to create an aggregate index that can be used to show overall performance. Given that several kinds of variables can be employed.

Thirty-four assessment plans met the requirements. It should be noted that the objectives of these programs and the measures they use to assess their efficacy are very different from one another. Some schemes, like the Boyd-Cohen index, only include a small number of ICT-related variables and do not adhere to this pattern, whilst other schemes, like GPCI, mainly rely on ICT-enabled indicators. Ultimately, though, all of the selected schemes seek to

evaluate how well cities are performing in terms of enhancing their sustainability and quality of life as well as maintaining their competitiveness in an increasingly interconnected network of cities.

Information and communication technologies (ICT) are used by smart cities to enhance resource management, service delivery, and urban living standards. It is imperative to assess these cities using all-encompassing frameworks in order to gauge their efficiency, sustainability, and conformity to both technological and social objectives. The paper's assessment frameworks may center on evaluating the various domains that contribute to the definition of a smart city. Typically, these domains consist of:

Governance: The efficiency and openness of the decision-making procedures. Technology: The adoption and integration of IoT, AI, and other tech advances. Sustainability: Waste management, energy efficiency, and environmental impact. Mobility: Smart traffic management and public transportation are components of the transportation infrastructure.

Economy: The city's capacity for innovation and its rate of economic growth. Quality of life: The general well-being, safety, health, and education of the populace. Reducing digital gaps through equal access to technology and services is known as social inclusion. The study probably explores a number of frameworks, possibly created by governmental, international, or academic groups. Several well-known frameworks are as follows:

The sustainable community development standard ISO 37120 includes quality of life and city service metrics. Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance are the six main axes that the European Smart Cities Model focuses on.

CityKeys: An EU-funded initiative that created a set of metrics especially for initiatives involving smart cities. The IESE Cities in Motion Index is a tool used to rank cities worldwide according to important aspects of smart cities, including environment, human capital, mobility, and social cohesion. Since each of these frameworks is based on a unique set of priorities, indicators, and measurement techniques, evaluations of what qualifies can differ. Thirty-four assessment plans met the requirements. It should be noted that the objectives of these programs and the measures they use to assess their efficacy are very different from one another. Some schemes, such as the Boyd-Cohen index, only include a small number of ICT-related variables and do not adhere to this pattern, whilst other schemes, such as the GPCI, mainly rely on ICT-enabled indicators. Ultimately, though, all of the selected schemes seek to evaluate how well cities are performing in terms of enhancing their sustainability and quality of life as well as maintaining their competitiveness in an increasingly interconnected network of cities. Furthermore, it's critical to remember that although efforts have been made

4. CONCLUSIONS

In the past several years, a large variety of techniques have been developed to assess the success of smart city programs and projects. This study reviewed previous research to have a better knowledge of the advantages and disadvantages of such studies for their contents, structures, and SCA methods. The analytical technique that was described may be used by target groups interested in SCA to evaluate the efficacy of the tool or tools. There are several applications for the results of these evaluations. The analytical framework may be used, for instance, by developers or local government organizations to choose the technologies that

best meet their needs. Researchers and tool developers may also utilize the framework to evaluate the material. In conclusion, there is still much space for improvement even if the creation and use of smart city assessment frameworks has advanced significantly. By filling in the gaps that have been found and adding inclusive, transparent, and comprehensive practices, these frameworks will be better able to direct the creation of smart cities. Stakeholders may better negotiate the intricacies of smart city efforts and help create more intelligent, sustainable, and equitable urban settings by implementing the guidelines and improving evaluation techniques. A wide range of approaches and standards are employed to evaluate urban smartness, as shown by the examination and analysis of smart city assessment frameworks. Several important conclusions were revealed by our study:

The many methods used by the frameworks under evaluation to assess smart cities are indicative of the complex character of urban smartness. Technological integration, sustainability, economic effect, and citizen participation are common dimensions. Some frameworks are restricted by specific target areas or lack methodological clarity, while others excel in offering thorough assessments and strong methodology. While frameworks with a tighter focus could offer deeper insights into particular features, frameworks that include a wider range of criteria typically offer more holistic evaluations.

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Credit Authorship Contribution Statement

Enass Mohammed: Writing - original draft, review and editing, research and data collection. Meervat R. Altaie: Supervision, review and editing, validation, project management.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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مراجعة وتحليل أطر تقييم المدن الذكية

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الخلاصة

على مدى السـنوات العشـر الماضـية، كان هناك زيادة في دراسـة وتنفيذ تكنولوجيا المدينة الذكية. يكشـف التحليل التفصـيلي لتقييمات الأدبيات التي نُشـرت بالفعل حول المدن الذكية عن نقص الدراسـات التي تصـنف الأدبيات إلى موضـوعات مميزة وتحدد الموضـوعات الأكثر والأقل شعبية بناءً على عدد أوراق البحث التي تمت مراجعتها من قبل الأقران والتي تتدرج تحت كل موضـوع. في محاولة لسد هذه الفجوة، تم إجراء تقييم وصـفي للأدبيات التي تمت مراجعتها من قبل الأقران حول المدن الذكية لهذا العمل. على مدى السنوات العشر الماضية، كان هناك زيادة في دراسة وتنفيذ تكنولوجيا المدينة الذكية. بناءً على عدد المقالات البحثية التي تمت مراجعتها من قبل الأقران والتي تتدرج تحت كل موضـوع، يكشـف التحليل التفصـيلي لتقييمات الأدبيات التي نُشـرت بالفعل حول المدن الذكية عن نقص الدراسـات التي تصـنف الأدبيات إلى موضـوعات مختلفة وتحدد الموضـوعات الأكثر والأقل شـعبية. يُظهر التحقيق أنه على الرغم من أن الأطر المختلفة توفر معلومات ثاقبة، إلا أن هناك أحيانًا نقصًـا في التوحيد القياسـي، مما يعقد المقارنات. علاوة على ذلك، فإن أغلب الأطر تفشـل في معالجة قضـايا العدالة الاجتماعية والمشـاركة العامة في عملية التقييم. وتؤكد الدراسـة على ضـرورة وجود إطار عمل واحد يضـمن الشـمول ويدمج مجموعة متنوعة من المعايير.

الكلمات المفتاحية: المدن الذكية، تقييم، مؤشرات، التحديات، الاقتصادية.