JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

STUDY OF SELECTED SMART CITY INDICATOR IN THE CONTEXT OF KOSHI PROVINCE IN NEPAL

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Abstract

The smart city is gaining popularity since it can solve the problems of city such as road traffic, pollution, energy utilization and waste management. The traditional urban strategies such as knowledge cities are being incorporated into smart city ideas. Many cities have financed heavily for smart city initiatives and projects in the digital age to address urbanization and climate change. Numerous efforts have been made to evaluate these programmes and projects. Population growth increases the demand for energy, environment and other vital natural resources and poses major challenges for the global community. Data exchange between physical entities, citizens and interested parties coordinates and improves smart cities. This study examines 34 smart city assessment tools to determine their pros and as well cons and their potential impact on the smart city movement. The tools are evaluated based on criteria such as scope, stakeholder involvement, context sensitivity, strategic orientation, uncertainty management, linkages, flexibility, feasibility, presentation, communication and action plans. The results indicate that the selected instruments only partially to meet these requirements. This study examines smart city assessment tools and their effectiveness in assessing urban smartness. The distribution of smartness indicators across different themes, comprehensive indicators and fair reporting and communication are discussed. It analyses which assessment systems can deal with the multidimensionality of smart cities and the value of human-centred and data-driven metrics. It also examines the needs of end users and how dedicated reporting, different communication methods and effective visualisation can improve stakeholder engagement and smart city projects. It is concluded that a comprehensive and impartial approach to smart city evaluation and reporting is needed to achieve the many goals of the stakeholders involved in smart city development.

Keywords: *Smart City, urban problems, digital city, ecological city, smart city initiatives, population growth, environmental challenges, data sharing, stakeholder engagement, energy demand, environmental challenges, stakeholder engagement, strategic alignment.*

1. INTRODUCTION

The size of cities worldwide has grown steadily over the last 50 years. By 2050, about 70% population will stay in cities [1]. Cities can offer both health risks and opportunities. Opportunities arise from the fact that cities are centers of population density, business establishment, and concentration of educational institutions. Diseases, because the cost of living is quite high and cities have more traffic, pollution and waste than other places. The responsibility for coordinating sustainable urban development, which includes job creation, environmental preservation and the provision of optimal living conditions for city dwellers, is a daunting task that municipalities and public administration must face. In addition, cities strive to gain a competitive benefit by attracting and retaining a well- cultured and skilled workforce for innovative and high-performing enterprises. In addition, they seek to attract substantial touristic influxes, which are influenced by perceived quality of life to maximize their efforts to create public value. Smart City is taken as a popular urban strategy that applies technology to enhance the environmental quality and provide better services to the population while increasing the quality of life in city areas [2]. Smart cities, smart strategies and smart initiatives are the subject of numerous scientific studies covering an extremely wide range of topics, including air quality, waste treatment, and renewable energy production, energy efficiency of buildings, open data and e-government in smart cities. However, limited research has so far addressed more complex aspects, such as the interactions between these topics, which also differ from each other, the potential benefits they can generate, their impact on citizens' quality of life, their effectiveness in solving urban problems and the performance of smart projects. This study aims to address these questions through a comprehensive analysis focusing on smart mobility is one most important areas of interest for smart cities. One of the most important prerequisites for the functioning of a metropolis is mobility [3]. However, there are a number of serious disadvantages and problems related to transportation that have a negative impact on the life quality in urban areas: environment pollution, road traffic, long commutes that have a negative impact on day to day work-life balance, heavy costs related to public transport services, etc. As it has the potential to significantly improve the quality of life for virtually all municipal stakeholders, smart mobility is one of the most promising topics in the field of smart cities.

1.1 Smart City

The concept of the Smart City, while relatively new, originates from more established urban strategies that originated from various academic disciplines and were ultimately incorporated into the Smart City blueprint. The subjects were classified into three divisions following an exhaustive literature review and analysis of the labels and definitions ascribed to cities [4].

1. **Digital city:** It is related to the usage of ICT to facilitate the formation of a bound, ubiquitous, interrelated network of organizations and citizens that assists them in joining online services and exchanging data and information; this is made possible by public policies including e-democracy as well e-government [5].

2. **Green city:** It is concerned with an environment and ecological vision of city space that is sustainable development-based. Preserving or establishing public green spaces such as parks and gardens, in addition to reducing pollution waste and energy consumption, are all components of green city policies [6].
3. **Knowledge city:** It relates to policies that seek to enforce and value data, information, and knowledge produced and available in the city, particularly by its social and cultural associations as well technological parks, companies, and innovative districts [7].

"A smart city is one that operates in a progressive manner with regard to its economy, inhabitants, governance, transportation, environment, and way of life." It is constructed through the intelligent fusion of the actions of autonomous, self-reliant, and informed citizens [8].Technology and information and communication technology, which are constituents of the Digital City, are evidently essential, albeit not the ultimate objective but the means to achieve it, since the ultimate goals are to enhance the quality of life for the populace and effectively manage natural resources Green City while involving the public through participatory city governance Smart City. Hence, as per the authors' assertions, a municipality can be considered intelligent to the extent that it actively pursues the integration of smart living quality of life, smart mobility transport and ICT, smart environment preservation of natural resources, smart governance participation, and smart people social and human capital [9].Energy supply and global warming are highly correlated and governments are implementing policy measures to reduce greenhouse gas emissions [10-11].The transport sector is the primary contributor to the 75% of global greenhouse gas emissions that are produced by cities. Smart cities provide robust services for improving liability, overall efficiency, and sustainability; therefore, their development could be a crucial factor in mitigating the negative impacts of cities[13].The notion of smart cities has experienced significant global growth in recent years, prompting numerous nations to consider policy adjustments that would facilitate the implementation of smart city initiatives [14].Although this is a multifaceted undertaking that necessitates a comprehensive and synchronised approach accompanied by suitable policies and strategies, the advantages that smart cities impart to businesses and residents surpass the associated challenges [15].In smart cities, for instance, it is anticipated that energy losses can be reduced while citizens have access to affordable energy and environmental performance is enhanced through the implementation of energy-efficient technologies, the modernization of electricity systems, and the utilization of clean renewable energy resources [16-17].Smart cities possess the capacity to provide forthcoming generations with elevated standards of living. In actuality, a smart city is a framework comprised primarily of multiple sectors that advocates for sustainable development practises in an effort to mitigate the future difficulties associated with urbanisation. In reality, smart cities ought to be developed so that city dwellers encounter fewer difficulties than they did previously. Significant efforts have been made thus far [18].

2. LITERATURE REVIEW

Singh et al. (2023) examined Smart cities have led to the rise of energy conservation technologies to efficiently manage energy in buildings and urban areas. Through the Internet of Things, smart cities can deploy many intelligent and comprehensive applications. Since urbanisation is accelerating, smart cities must find sustainable

and efficient solutions. Despite improving energy efficiency, IoT devices still use a lot of energy and cause energy issues. Intelligent city energy management addresses contextual factors that affect energy usage from an interpretive perspective.

Buchanan et al. (2023) described Smart cities are rapidly evolving urban development's of the 21st century. The using cutting-edge technologies and data analytics, smart cities boost economic growth, infrastructure efficiency, and resident quality of life. Smart cities integrate transportation, energy, health, education, and governance. The smart city concepts, pros and downsides, implementation challenges, financial factors, application categories, quantitative analysis methodologies, and prioritization measures. Smart cities with data-driven solutions and technology can alter urban life by providing residents with personalized services. Data privacy, unequal technology access, and the need for public, commercial, and government collaboration are challenges to implementation. The sheds light on smart cities' current state and future, as well as its pros and cons. Modern technologies and data-centric techniques may help create more sustainable communities in an age of urban complexity and growth.

Alizadeh et al. (2023) examined Since 2000, smart cities have grown in theory and practise. Smart city in this study has focused on physical and technological aspects, neglecting social justice and democratic values. Even with human-centric or people-centric approaches, a comprehensive picture that combines democratic values, social fairness, and social rights is still lacking. The social justice as a major societal smart city dimension and introduces the term societal smart city. The theoretical clarifications and a case study of Tehran, Iran's capital, which has invested heavily in its technology infrastructure. The goal was achieved by a questionnaire. Social justice in Tehran is primarily influenced by four factors: information literacy α: 0.91, loading 6 variables, citizen-centric governance α: 0.92, loading 15 variables, and resilient infrastructure α: 0.9, loading 8 variables. Urban planners and politicians learn how to create a societal smart city that benefits beyond physical and technological developments by emphasising social fairness.

Noori et al. (2023) examinedNational and international policy has promoted many Smart City development models. The political, legal, and cultural differences between nations and localities, policy success will always depend on context. Policy learning, diffusion, and translation are used in most of the literature on policy transmission and mobility. The addressing both gaps, a framework might be created to carefully and incrementally formulate lessons from effective SC policy practises, disseminate them, and adapt them to the recipient's needs. The uses policy transplantation to create a conceptual framework for Smart City adoption and condenses current knowledge into a policymaker-friendly process. All necessary SC policy transplantation components and subcomponents are determined through a rigorous literature review to establish a theoretical framework. An expert panel verifies and illustrates this prescriptive theoretical framework with a case study. The framework helps academics draw conclusions and policymakers apply best practises to their own situations.

Fantin et al. (2023) examined Smart cities are gaining popularity. Smart city efforts are underway in most governments globally. The Indian government launched the "National Smart Cities Mission" to revitalise, refit, and build smart cities nationwide. The main goal of this project is to use IoT technology or build new cities to make them more sustainable and citizen-centric. Parking will become a major issue in urban India. Traffic congestion, pollution, and economic losses are caused by poor land management and planning. To capture real-time data from the physical world, IoT uses sensors and transducers. The Internet of Things addresses road safety, parking, traffic congestion, and traffic management. It analyses the benefits of IoT-based car parking systems, vehicle parking, the essential needs for vehicle parking, and modern parking system technologies.

Gago et al. (2022) examined the government has aggressively backed Spanish cities' efforts to improve social cohesion, integrate IoT, and transform digitally. The evaluation examined 61 recipient local bodies' initiatives. The performed courses of action were compared to those in the smart city reference city in Europe using defined indicators. Since technology, software, and governance were the main focus, the previous call Smart Territories National Plan closely resembles the latest generation of smart cities specialisation in intelligent buildings and a holistic approach. It provides a detailed overview of smart city priorities and advances over the previous decade to help analysts and technicians evaluate finished projects and create new development trajectories**.**

Othmanet al. (2022) examined in the digital age, information security management is essential and developing. Social connections, commerce, entertainment, and information gathering are increasingly facilitated by digital services and devices. In our digital world, over 12.3 billion IoT devices collect and store data from street cameras, smart security systems, refrigerators, wearables, and more. These devices capture much of our daily time data, including smart watch health data, refrigerator needs, air conditioning status, GPS data, etc. These internet-connected devices collect a lot of our privacy and daily routines. In this study examines whether information security management can protect private and ordinary data to keep smart cities safe. The survey found that the biggest cyber-security difficulties include in-house knowledge, funding, trouble hiring skilled security staff, weak leadership, and accountability.

Kim et al. (2021) described New smart cities use energy conservation technology to manage energy in buildings and cities. Due to the heterogeneity of buildings and complex infrastructure, municipal energy management remains difficult despite smart home energy conservation system in this study. A quantitative analysis examined smart house and city research themes, while a qualitative review identified barriers to sustainable smart cities from smart homes. The techno-functional barriers and holistic frameworks of both the smart home and city domains in this study proposes two innovative strategies for sustainable smart cities' advanced energy conservation systems: infrastructure support and a novel energy trading approach within distributed energy systems. The Bottom-up approach smart home level to smart city level proposes implementing intelligent energy management technologies, developing real-time energy monitoring, diagnostics, and controlling technologies, and integrating energy network technologies at the city level to reflect consumer behavior and energy in sustainable smart cities.

Table 1. Comparison table of literature review

Author and Year	Topic	Findings	Summary
Singh et al. (2023)	Energy efficiency in smart cities	IoT applications improve energy management but also consume energy. Smart cities need sustainable solutions.	Focus on energy efficiency in smart cities and the challenges of IoT usage.
Buchanan et al. (2023)	Smart city development and challenges	Smart cities use technology and data to enhance various aspects. Challenges include data privacy, technology access, and collaboration.	An overview of smart city concepts, challenges, and potential benefits.
Alizadeh et al. (2023)	Social justice in smart cities	Smart city development often neglects social justice and democratic values. Emphasizes the importance of societal smart cities.	Emphasis on social justice and democratic values in smart city development.
Noori et al. (2023)	Policy frameworks for smart cities	Effective policy development depends on context. Proposed framework for policy transplantation in smart cities.	A framework for policymakers to adapt and implement effective smart city policies.
Fantin et al. (2023)	IoT in Indian smart cities	IoT technology used to improve sustainability and traffic management in Indian smart cities.	Focus on the use of IoT in Indian smart cities to address urban challenges.
Gago et al. (2022)	Spanish smart city initiatives	Evaluation of Spanish smart city projects and their alignment with European standards.	Assessment of Spanish smart city initiatives and their development.
Othman et al. (2022)	Information security in smart cities	Concerns about information security in the age of IoT. Identified cyber security challenges and issues.	Examination of information security challenges in smart cities.
Kim et al. (2021)	Energy management in smart cities	Challenges in municipal energy management despite smart home systems. Proposed strategies for energy conservation.	Focus on energy conservation and management in smart cities.

3. RESEARCH METHODOLOGY

The procedure of determining which assessment instruments are most suitable for gauging intelligence across various scales, including municipalities, cities, neighborhoods, communities, and urban regions. The objective is to ascertain and select the most pertinent instruments for the research in accordance with predetermined criteria.

- ✓ **Search Strategy:** To ascertain a vast array of intelligence-related assessment instruments, the authors implemented a comprehensive search methodology. Probably a combination of keywords supplied in an appendix, this approach entailed the utilization of a search string.
- ✓ **Database Search:** "Advanced search" feature of the internet and Science was utilized to locate English-language literature that matched the specified search criteria. This preliminary investigation was conducted in 2018 July and yielded 175 documents.
- ✓ **Document Screening:** The 175 documents were vetted by the authors to eliminate those that were deemed irrelevant, following the initial search. In consequence, the database retained 58 documents.
- ✓ **Grey Literature Search:** An additional search was performed by the authors on Google using various combinations of search terms to identify grey literature that was not peer-reviewed and was not commercially published. Twenty-first page results constituted the inquiry.
- ✓ **Initial List:** After doing these searches, the writers created a preliminary list of 38 intelligence evaluation instruments.
- ✓ **Selection Criteria:** In order to refine the selection, the writers employed a series of criteria. The assessment tools that were chosen needed to satisfy the following criteria:

  - Focus on Smart and Sustainable City Assessment (SCA).
  - Contain a set of standards, metrics, or indicators that can be used for SCA.
  - Cover more aspect or theme of smartness i.e., not exclusively focusing on a single aspect like mobility.
  - Have basic information available in English.
  - Guidelines and manuals related to the tools should be freely accessible, or developers should be willing to provide free access for research purposes.
- ✓ **Final Selection:** After the application of these criteria, a total of 34 assessment systems were selected for inclusion in the study. The table presents a comprehensive compilation of several tools, including their respective release years and the major developers associated with them.
- ✓ **Overview of Approaches:** The paragraph ends by noting that the next section will provide a quick summary of the typical methods used by these particular assessment tools to evaluate intelligence.

  The process of finding, vetting, and choosing assessment instruments to measure smartness in various urban settings is essentially described in this paragraph, along with the standards that were applied to decide which instruments were appropriate to include in the study.

3.1 Framework for analysis

Quality/issue	Evaluation criteria
Comprehensiveness	The degree of incorporation of indicators pertaining to various dimensions and sub-dimensions of smartness within the chosen instruments.
Stakeholder engagement	Have participatory methods been utilised in the design, development, and implementation of the chosen tools.
Context-sensitivity	Whether the selected tools consider the demands and challenges of the context as well as the requirements of the citizens
Strategic needs	Whether the chosen instruments are in accordance with the strategic requirements and priorities
Uncertainty management	Whether adjustments have been made to iterative processes and future scenarios have been formulated to accommodate forthcoming uncertainties.
Inter linkages and interoperability	Whether interoperability and inter linkages between various indicators were taken into account during the evaluation procedure
Temporal changes	Whether particular instruments monitor temporal changes
Flexibility	Does the evaluation of the chosen tools encompass concerns pertaining to flexibility, scalability, and replicability?
Feasibility	Whether the selected instruments have taken into account matters pertaining to technical and financial feasibility.
Presentation and communication	Whether the chosen tools have implemented suitable strategies to ensure the results are effectively presented and communicated.

Action-oriented approach	Whether the results of the assessment were incorporated into the development of action plans and roadmaps for smart city implementation.

- ✓ **Importance of Comprehensive Indicators:** The text emphasizes that smart solutions should bring various social and economic, environmental, as well institutional benefits. Consequently, assessment tools should not solely concentrate on technological indicators but rather have a broader focus.

- ✓ **Facilitating a Systems-Based Approach:** The paragraph suggests that coverage of comprehensive indicator that can support a systematic approach for to understanding how smart city solutions effects and change different city sub-systems. This approach allows for a more holistic assessment of smartness.
- ✓ **Creating a List of Indicators:** To examine the extent of compliances with the comprehensiveness criterion, the authors had to gather the list of indicators. This involved conducting an extensive literature review to create a pool of potential indicators.
- ✓ **Comparison with Indicator Sets of Selected Assessment Tools:** Initial list of indicators was then matched with the indicators sets used by each of the particular assessment tools. This comparison aimed to add extra indicators if required to ensure the final list was as comprehensive as possible.
- ✓ **Classification into Themes:** The selected smartness indicators were classified into seven themes economy, people, governance, environment, living, mobility, data and 44 sub-themes. These themes are consistently used across the selected assessment tools, which helps maintain consistency in the evaluation process.
- ✓ **Use of Matrices in Evaluation:** Microsoft Excel was used to develop matrices, rows and columns corresponding to the indicators and tools, correspondingly. This structured approach allowed for a systematic evaluation of whether the selected indicators were included in each assessment tool.
- ✓ **Analysing Guidelines and Manuals:** The authors' analyzed guidelines and manuals related to each selected tool to determine whether the chosen indicators were included in the tool's assessment framework.
- ✓ **Results Presentation:** The paragraph concludes by stating that the results related to the extent of inclusion of indicators and their distribution across the themes of each selected tool would be presented.

  In essence, this paragraph sets the stage for the evaluation of assessment tools' comprehensiveness in assessing smartness. It explains the methodology used to ensure that the chosen indicators are comprehensive and covers the key steps in this process, from literature review to classification and evaluation using matrices.

3.2 The extented of inclusion of indicators in the selected tools:

The provided significant variations among assessment tools in terms of the extent of attachment of indicators with a focus on how these variations manifest at different levels.

- ✓ **Variation in Indicator Inclusion:** The text points out that there is a wide variation among the assessment tools in terms of how many indicators they include. On average, approximately 23% of the compiled indicators are included in the selected tools. The different tools vary significantly in the number of indicators they use to assess smartness**.**

- ✓ **Variation across Themes:** The text also highlights the variation in the extent of inclusion of indicators related to the seven themes. For example, while about 30% of 'mobility' indicators have been included on average, only 19% of 'economy' indicators have been included. The indicates that certain themes receive more attention in the assessment process than others.

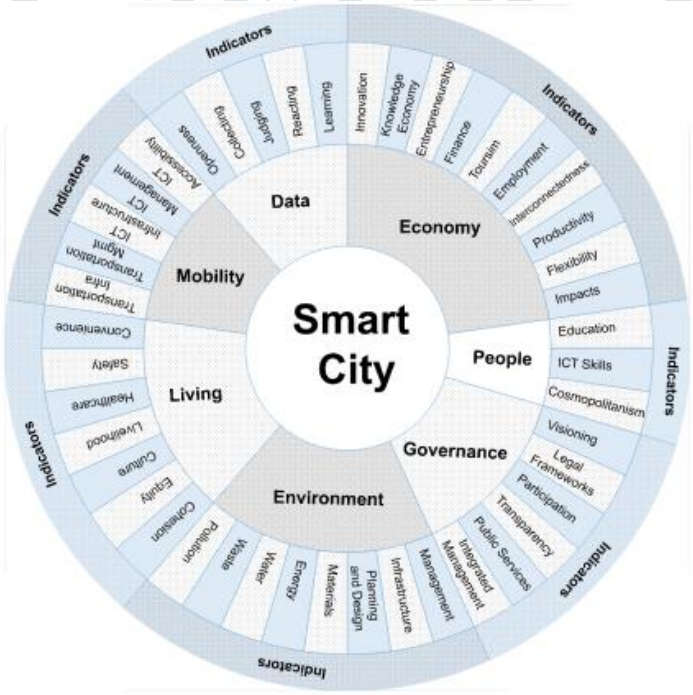

Figure 1. The smart city indicator themes and sub-themes.

- ✓ **Specific Tools:** The text mentions that specific assessment tools like Indian Engineering Services City, Squamous cell carcinoma, CITY keys, and International Telecommunication Union Telecommunication include a relatively large percentage of compiled indicators. In contrast, tools like World Water Council, Certified Supply Chain Professional, and Serial Shipping Container Codeinclude less than 10% of the indicators. This demonstrates that certain tools are more comprehensive in their coverage than others.
- ✓ **Variation at Sub-Theme and Indicator Levels:** The text notes that large variations also exist at the sub-theme and indicator levels. For instance, sub-themes like 'Innovation', 'Information Communication Technology accessibility', 'justice and 'equity ', 'ICT infrastructure', 'sources of energy' and 'ICT

management' have received other attention and have been included in a significant number of tools. On the other hand, sub-themes like 'cosmopolitanism flexibility of the labor market reacting data-informed and finance have received less attention and have been included in fewer tools.

- ✓ **Importance of Data Collection and Measurability:** The text highlights the challenge of ensuring that indicators are not only comprehensive but also measurable. Data collection can be resource-intensive, and the availability of data may vary across different sources and jurisdictions. Data comparability is also a major concern, although the data have been collected using various different protocols.
- ✓ **Recommendation for Principal Component Analysis:** The text suggests that when there are difficulties in including a comprehensive list of indicators, techniques like Main Factor Analysis can be used to select a well-adjusted and representative list of indicators. PCA is a statistical method that can help identify the most important indicators while reducing redundancy and complexity in assessment frameworks.

4. RESULTS & DISCUSSION

4.1 Distribution pattern of indicators

Distribution of Smartness Indicators The text distinguishes this analysis from the previous one, clarifying that it examines the distribution pattern of indicators within each of the selected assessment tools, rather than the extent of inclusion of compiled indicators. Thematic Inclusion Figure 2 illustrates that most of the selected tools include indicators related to all seven themes considered in the assessment. However, governance and mobility are the only themes that have been included in all the selected tools. Variation in Thematic Emphasis: The text highlights that there is significant variation among the selected tools in terms of their thematic emphasis. Some tools place more emphasis on certain themes, while others have a more balanced distribution of indicators. Common Emphasized Themes on average the analysis shows that more emphasis has been placed on the themes of 'mobility,' 'economy,' and 'environment.' These themes are more commonly covered across the selected tools table 1.3. Less Attention to 'People' and 'Data' Themes: In contrast, the themes 'people' and 'data' have received less attention in the selected tools.

Table 1.3 presents descriptive statistics about how indicators associated with each subject are distributed throughout the chosen tools.

	Mean (%)	Median (%)	Min (%	Max (%	Std (%
Economy	18.2	16.7	0	39	10
People	7.44	7.36	0	18	5
Governance	14.2	13	2	34	9
Environment	19	21.3	0	34	12
Living	16.9	18.2	0	34	10
Mobility	22	21.5	8	44	9
Data	8.29	3.82	0	88	16

This finding contradicts earlier literature that suggested a lack of attention to environmental indicators. The limited attention to 'people' and 'data' themes is notable given their significance for the successful deployment of smart cities. Importance of a Broad Understanding of Smartness: The text emphasizes that smartness in cities is a multifaceted concept that can only be achieved by appropriately acknowledging all aspects. It is crucial for Smart City Assessment tools to adopt a broad understanding of smartness and recognize the importance of people as end users of smart solutions. Acknowledging the role of people is essential for the success of smart cities. The value of Data Management The text also underscores the significance of data as a valuable resource for smart cities. It argues that SCA tools should incorporate indicators related to data management to ensure proper measures are taken for collecting and analyzing data effectively. Data plays a crucial role in the functioning of smart cities and should not be overlooked. The thematic distribution of smartness indicators across the selected assessment tools. They emphasize the need for a balanced approach that includes all aspects of smartness, with particular attention to the role of people and the importance of effective data management in smart city initiatives.

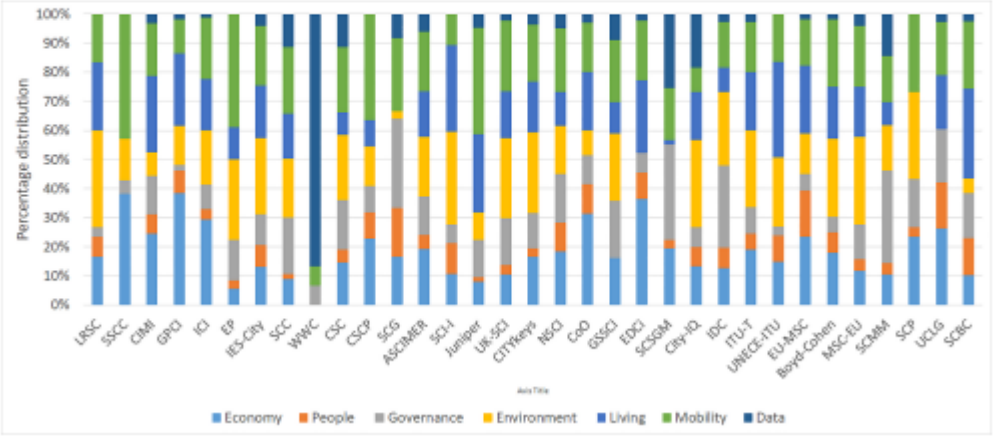

Figure 2: shows the number of indicators falling under each major topic as a percentage distribution. The distribution of each tool's component indicators throughout the seven smart city themes is depicted on the Y-axis, based on the X-axis.

The distribution pattern of intelligence indicators across the sub-topics of each evaluation instrument was examined in greater detail. The sub-theme indicator distribution pattern has been supplied to help communicate the results. Figure 2 the percentage distribution of indicators under each "mobility" sub-theme.. There are substantial discrepancies amongst the tools due to technique modifications, contextual variables, and the fact that evaluation tools were built for different purposes.

4.2 Presentation and communication:

Diverse End User Needs: The first point emphasizes that end users have varied assessment outcomes needs and expectations. High-level municipal performance and rankings may attract the public or media. Planners, policymakers, and academics need more details about methodology, performance across themes and sub-themes, strengths, limitations, and progress. Value of Detail Reporting: Detail reporting is essential for reviewing activities, addressing issues, determining goals, devising improvement initiatives, and providing policy advice. Making educated decisions and changes would be difficult without this detail. Multiple Communication Channels: Assessment results should be shared via media releases, press conferences, online performance dashboards, community workshops, and social media. This diverse communication technique can foster stakeholder interactions, improving smart city project creation and implementation collaboration. Stakeholder Engagement: Involving stakeholders in the reporting process can contribute to learning, experience-sharing, and capacity-building. It can help improve awareness of smart city benefits, improving implementation chances. Spider diagrams, interactive graphs, bar diagrams, and scatter plots are useful display tools for reporting. These visuals simplify complex knowledge. Reporting Methods Common: Ranking cities is the most popular way to report findings. To distinguish cities, this ranking may include labels like Platinum, Gold, or Silver. Benchmarking and healthy city competitiveness is popular with this method. Although overall rating is commonly utilised, less than 40% of the identified tools provide sub-theme ranking and specific performance breakdown. City-IQ and CIMI provide more detailed performance information, which can help identify smart city strengths and problems.

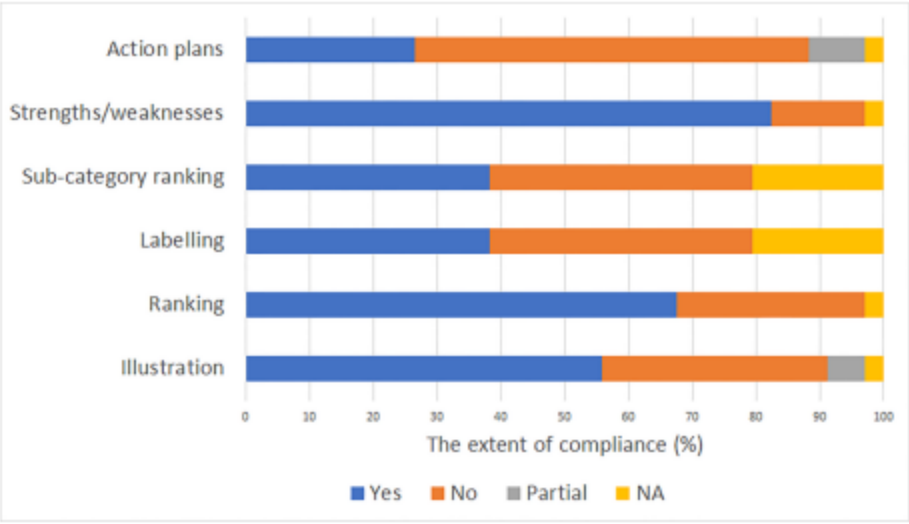

Figure 3. Source data on compliance with criteria relating to presentation, communication, and action plans.

Balanced Assessment: The mentioned tools generally perform well in terms of showing the strengths and weaknesses of smart cities, helping stakeholders make informed decisions and improve their cities' performance. In essence underscore the importance of tailored and comprehensive reporting of assessment results to meet the diverse needs of various stakeholders in the smart city assessment process. Detailed reporting, diverse

communication, and effective visualization techniques contribute to better-informed decision-making and improvements in smart city projects.

Table 1.4 Division of the indicators of smart city frameworks under the ten sectors and three impact categories:

Sectors	Impact categories			
	Environmental sustainability	Economic sustainability	Social sustainability	In total
Natural environment	12%	0%	5%	17%
Built environment	6%	5%	4%	15%
Water and waste management	11%	2%	3%	16%
Transport	8%	0%	2%	10%
Energy	6%	1%	1%	8%
Economy	1%	4%	3%	8%
Education, culture, science and innovation	0%	1%	2%	3%
Well-being, health and safety	0%	6%	6%	12%
Governance and citizen engagement	2%	0%	3%	5%
ICT	0	5%	2%	3%
In total	46%	24%	30%	100%

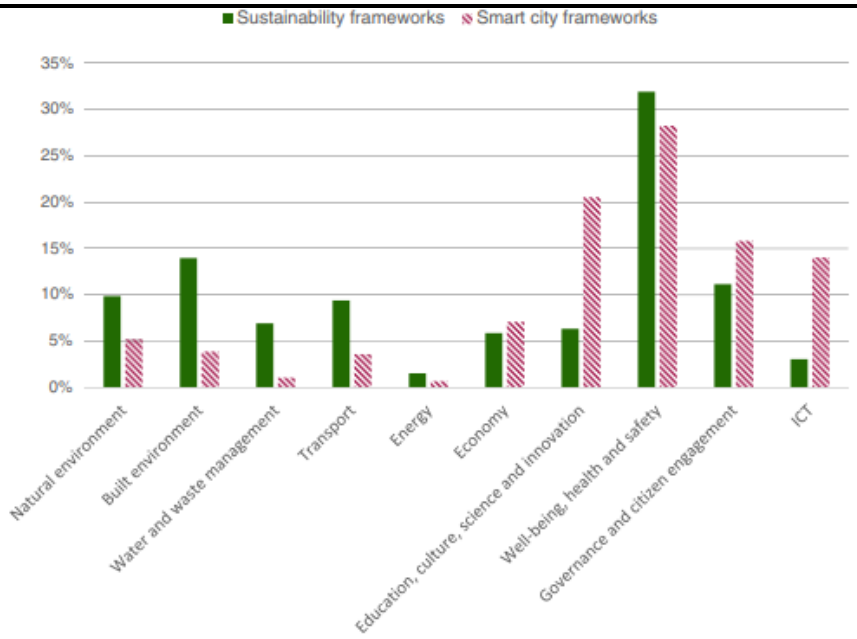

Figure4. Division of the sustainable and smart indicators under different sectors within the

The table 1.4 is divided into various sectors, which represent different areas or aspects of urban development and sustainability. Impact categories represent the dimensions or aspects of sustainability that are being assessed. In this case, there are three main impact categories: Environmental sustainability, Economic sustainability, and Social sustainability. Percentage distribution the values in the table indicate the proportion of impact within each sector that contributes to each of the three impact categories. Environmental Sustainability The first column represents the percentage of impact within each sector that relates to environmental sustainability. For example, in the "Natural environment" sector, 12% of the impact is related to environmental sustainability. Economic Sustainability The second column represents the percentage of impact within each sector that contributes to economic sustainability. For example, in the "Built environment" sector, 5% of the impact is related to economic sustainability. Social Sustainability The third column represents the percentage of impact within each sector that contributes to social sustainability. For example, in the "Well-being, health, and safety" sector, 6% of the impact is related to social sustainability. Total the last column represents the total percentage of impact for each sector. It's the sum of the percentages across the three impact categories and provides an overview of the overall sustainability impact for each sector. Overall Total At the bottom of the table, the values in the "In total" row represent the total impact distribution across all sectors for each impact category. The provides an overall view of the distribution of sustainability impact across environmental, economic, and social dimensions. These values help in assessing and understanding the sustainability impact of different sectors in urban development. They show how each sector contributes to the overall sustainability goals, whether in terms of environmental, economic, or social aspects.

CONCLUSION

The study concludes with a thorough examination of the tools used to assess smart cities, focusing on their indicators, distribution patterns and communication tactics. The study highlights several key findings and insights that shed light on the state of smart city assessment and the challenges as well opportunities it presents. Comprehensive assessment the research emphasizes the importance of a comprehensive assessment that covers various dimensions and sub-dimensions of smartness. Smart cities have many facets, and assessment tools should reflect this complexity to provide a holistic view of their performance. Thematic variation the study reveals significant variations in the inclusion of indicators in different thematic areas. While great attention is paid to the topics of mobility and governance, the topics of people and data are somewhat neglected in the selected assessment tools. This highlights the need for a more balanced approach that recognizes the role of people and data management in smart city initiatives. Effective communication of evaluation results is crucial for stakeholder engagement and the improvement of smart city projects. Adapting communication strategies to the diverse needs of end users, including the public, policy makers and academics, is crucial. Detailed reports, different communication channels and data visualization techniques play a central role in this. Sustainability Impact also looks at the distribution of smart city indicators across different sectors and impact categories, including environmental, economic and social sustainability. The analysis highlights the interconnectedness of these dimensions and the need for a balanced approach to urban development. It provides valuable insights into the current landscape of smart city assessment, identifies opportunities for improvement and highlights the importance of a holistic, people-centred and data-driven approach to building and assessing smart cities. As the world continues to urbanize, these insights can guide policy makers, urban planners and researchers in developing and accessing sustainable and intelligent urban environments.

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