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Development of a Maturity Model for Assessing Smart Cities: A Focus Area Maturity Model

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Abstract: The concept of smart cities has gained significant attention due to the potential of smart cities to optimize city services and enhance citizens' quality of life. Cities are investing in digital transformation to become smarter, sustainable, and resilient. Therefore, there is a need to build a comprehensive and holistic model to assess smart city initiatives. This paper aims to develop a model that can capture the maturity of smart city adoption across various functional domains. These domains are divided into focus areas that capture different dimensions of a smart city and grouped into seven groups: ICT, economy, environment, social, resources, services, and governance. Each focus area has a set of maturity levels that describe the capabilities and outcomes of the city at different stages of development. To develop the model, the focus areas were extracted from the literature based on 16 models that have been reviewed. Assessing these models helped in identifying gaps and building the foundation of the model. Using the information extracted from the literature, a focus area model was designed and developed. The model development included seven main phases, which were: scope, design, populate, test, deploy, and maintain. The current paper validates the proposed model using the Delphi method, which involves the participation of a panel of sixty field experts. The experts evaluated the model's correctness and completeness based on their experience and provided feedback. This feedback was used to revise and finalize the model. The smart city maturity model provides a framework for benchmarking, planning, and improving smart city initiatives. Cities can use the model to measure their performance and evaluate their weaknesses and strengths. The model is also the most comprehensive in terms of the scope of the focus areas included, and the results show that the model has a high level of accuracy and consistency and can effectively assess smart city adoption.

Keywords: focus area maturity model; smart city evaluation; smart city adoption; assessment framework; digital transformation; sustainability; Delphi method; capabilities; maturity matrix

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1. Introduction

Cities worldwide face population growth, rapid urbanization, improper resource management, and inadequate infrastructure. These challenges pose environmental threats, drain resources, weaken infrastructure and the economy, and trigger social problems such as high crime rates and inequality. To manage and mitigate these problems, cities are racing to digital transformations and to become smarter. According to the World Cities Report 2020 [1], the global demand for smart cities grew from USD 622 billion in 2017 to USD 1 trillion in 2019 and is forecasted to reach USD 3.48 trillion by 2026. The United Nations' 2030 Agenda for Sustainable Development emphasizes the need for smart and sustainable cities globally, particularly the sustainable development goal (SDG) 11: "make cities and human settlements inclusive, safe, resilient and sustainable" [2] (p. 26). Successful smart city implementation will contribute to achieving the SDGs [3,4].

Smart city implementation not only helps governments provide more efficient services but also promotes innovation, encourages private–government partnerships, enhances decision-making processes, improves project financing, and promotes sustainability [5,6]. However, many technical, social, economic, and strategic challenges must be overcome to realize the benefits of the smart city concept. Contemporary cites are characterized by complexity, diversity, and intelligence [7], which can be barriers to smart transformation. Therefore, it is crucial to ensure the availability of reliable governance systems that can plan, manage, and measure smart transformation.

Academic studies and practitioners have provided a variety of conceptualizations of smart cities. The definition in [8] (p. 11) focuses on the main characteristics of a smart city: "a city well performing in a forward-looking way in the six characteristics (economy, people, governance, mobility, environment, living), built on the smart combination of endowments and activities of self-decisive, independent and aware citizens". Other definitions emphasize the role of technology. For example, the International Data Corporation defines smart cities as cities that use ubiquitous networks, wireless sensors, and intelligent management systems to solve current and future challenges and create new services [9].

Standards bodies such as the British Standards Institution (BSI) adopt a holistic view of smart cities and the utilization of best practices when defining a smart city as "a city where there is effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens" [10] (p. 18). The International Telecommunication Union Telecommunication Focus Group on Smart Sustainable Cities (ITU-T FGSSC) analyzed 120 definitions to develop a comprehensive definition of a smart city: "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects" [11] (p. 13).

On the basis of the definitions in the literature, this paper defines a smart city as a city that innovatively utilizes ICT enablers to enhance the quality of life for citizens in a sustainable and balanced environment while considering the economic and social aspects of society. This definition highlights the vital role of ICT in a smart city while emphasizing that the smart city concept is about more than just technology. To achieve the desired outcome of smart city adoption, namely improving citizens' quality of life, smart city projects should also consider sustainability and a balanced lifestyle.

The literature acknowledges the need for proper governance tools to facilitate smart city adoption and connect forces in different domains [12]. However, previous attempts to build models and frameworks have not considered all city domains [13], failed to engage stakeholders in model building or implementation, missed differences between different domains [14], or ignored the level of granularity [15]. Several smart city metrics and performance indicators have been proposed, but most cannot provide comprehensive evaluations of complex systems such as smart cities. One reason that cities lack standards to measure their progress [16–18] is the absence of a globally accepted definition of the smart city concept [19].

The objective of this study is to is to develop a model that can capture the maturity of smart city adoption based on different focus areas. Cities can use the model to measure their performance and evaluate their weaknesses and strengths.

This paper builds on the past efforts of various practitioners and scholars to develop a tool that addresses these gaps. Specifically, a maturity model for assessing smart city implementation is developed and empirically examined. Maturity models can help entities to achieve continuous improvements. Cities can use maturity models to assess their situation and determine the capabilities required to build a smart city [9]. Smart city maturity models are important for the proper evaluation of smart city implementation to prioritize funding and improve city performance. This model will provide significant

input to all smart city stakeholders and empower cities to successfully undergo smart transformation to face urban challenges.

The smart city maturity model was developed through an extensive literature review and analysis. This article is structured as follows: Section 2 gives background information about the smart city concept and smart city assessment. Section 3 describes the methods used to develop the model. Section 4 presents and discusses the results. Finally, the paper is concluded in Section 5.

2. Related Work

Studies such as those reported in [12,14] have highlighted the importance of tools for assessing and evaluating smart city implementation. Frameworks and practices for smart city assessment belong to five main categories: best practices, ranking frameworks, index-based frameworks, initiative-based evaluation, and maturity models. Some background information about the five categories is outlined in Sections 2.1–2.5.

2.1. Best Practices

International, regional, and local standards bodies issue best practices to ensure the quality of services and enable cities to perform benchmarking. These bodies include the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the International Telecommunication Union (ITU), the European Committee for Standardization (CEN), the British Standards Institution (BSI), and the National Institute of Standards and Technology (NIST). These organizations have published standards that define a smart city and specify relevant indicators for assessment, such as ISO 37120:2018 (Sustainable cities and communities—Indicators for city services and quality of life), ISO 37153:2017 (Smart community infrastructures—Maturity model for assessment and improvement), ISO/IEC 30146:2019 (Information technology—Smart city ICT indicators), PAS 181:2014 (Smart city framework—Guide to establishing strategies for smart cities and communities), and ITU-T L.1603 (Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals). However, applying best practices in real-life projects can be challenging.

2.2. Ranking Frameworks

Ranking frameworks compare cities by using specific criteria, which allows cities to act based on their relative positions. The European smart cities ranking (ESCR) [8,20] is a very well known ranking framework. Giffinger and colleagues studied 58 medium-sized cities to define a ranking mechanism for European cities based on six main characteristics: society, environment, economy, governance, mobility, and living. They also identified 31 factors and 74 indicators that can be used to measure cities' performance. A limitation of ranking systems is that they focus on the final results and do not capture enough detail about cities' strengths and weaknesses. Moreover, these frameworks do not consider cities as complex and unique systems that require comprehensive yet specific measurements based on local context.

2.3. Index-Based Frameworks

Index-based frameworks use key performance indicators. The CITYKeys project, which is funded by the European Commission, has developed a indices-based performance measurement framework for monitoring smart city implementation [21]. A limitation of these frameworks is that they are subject to data availability.

2.4. Initiative-Based Evaluation

Initiative-based evaluation is similar to the framework developed by [22] to examine smart city initiatives based on a set of identified critical success factors. This framework includes management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and the natural environment and provides

a comprehensive conceptualization of the smart city. However, initiative-based evaluation frameworks may encourage isolation and barriers between different sectors of smart city projects.

2.5. Maturity Models

A maturity model is an assessment tool for establishing the current situation and identifying necessary improvements to progress in maturity. Maturity models have been used as assessment tools in many sectors to ensure continuous improvement such as process management, project management, knowledge management, sustainability management, risk management, supply chains, education, government, construction, and healthcare [23]. Maturity models can be applied to measure the success of smart city adoption [24].

Maturity models comprise several components [25]:

- The domain is the model's first layer and provides a high-level view of the scope;
- The domain components, sometimes referred to as focus areas or factors, are the significant aspects of the domain, such as critical success factors;
- The domain subcomponents, also called capabilities or processes, provide further details. Achieving the capabilities will determine the level of maturity;
- The levels can be present in any number, depending on the model scope and application. Maturity can range from the minimum value, i.e., the quality of the elements underlying the processes is in the lowest required state, to the maximum value, i.e., no further improvements are needed [26];
- The assessment tool defines how the capabilities will be measured against the maturity scale using qualitative (descriptions) or quantitative (numerical scales) approaches. Assessment can either be self-assessment or performed by a third party.

Maturity models can be classified into two types based on stages, fixed levels, and focus areas. The fixed levels have a specific number of levels of maturity for all defined focus areas. A well-known fixed-level model is the CMM. It is popular and simple to implement but is not recommended for complex environments [23]. The focus area maturity model divides the functional domain into a number of focus areas that need to be developed to achieve maturity in the functional domain. Related focus areas can be grouped to facilitate the assessment. Each focus area includes (1) different capabilities that represent the steps of development of the focus area and (2) different numbers of maturity levels. The final maturity is a combination of the maturity levels of the focus areas.

The focus area maturity model has been used to develop models in disciplines such as enterprise architecture [27], information security [28], software governance [29], master data management, disaster risk management, and social media [30]. However, the focus area maturity model has not been used to develop a smart city maturity model. This research adopts the focus area approach for three key reasons:

1. The focus area maturity model facilitates the measurement of different dimensions within a smart city, each of which has different maturity levels. This is not possible in fixed-level models;
2. A smart city is a complex system that depends on multiple interconnected processes that must be measured. The focus area maturity model illustrates the interdependencies between processes and enables the measurement of incremental improvements;
3. The focus area maturity model can include any number of levels. Including a greater number of incremental levels allows more detailed guidance for capability improvements.

3. Research Approach

3.1. The Model Development Method

This section presents the development of the smart city maturity model based on the focus area maturity model method. It outlines the method used to guide the development of the maturity model, discusses each step of the model development and then provides information about the assessment tool created to perform the assessment. Finally, the Delphi method is presented, which is used to validate the model components.

Table 1 provides an overview of the two methods used in this study to create the smart city maturity model: the generic development framework [25] and the development framework for focus area maturity models [31]. The different phases of each method are listed in sequence under the second column (Phase), along with a description of each phase in the last column (Description).

Table 1. Maturity model development methodologies.

Methodology	Phase	Description
Generic development framework	Scope	Decide on the model focus (general or domain specific) and development stakeholders (academia, practitioners, government)
	Design	The architecture basis: Why the model is required? How it will be applied to different organizations? Who should be involved? What can be achieved?
	Populate	Specify what needs to be measured and how it can be measured?
	Test	Test the model validity, reliability, and generalizability
	Deploy	Making the model available to its intended users
Development framework for focus area maturity models	Identify the scope and functional domain	Decide on what to include and exclude
	Determine focus areas	Based on the literature review, then exploratory methods
	Determine capabilities	Capabilities define the incremental path for maturity levels' progress
	Determine dependencies	Specify the order of the capabilities within and between focus areas
	Position capabilities in matrix	Based on the specified dependencies
	Develop assessment instrument	Specify assessment questions for the capabilities based on the description
	Define improvement actions	General suggestions
	Implement maturity model	The first implementation is for model evaluation
	Improve matrix iteratively	Enough assessment data to be collected for the model evaluation
	Communicate results	To practitioners and academia

These two methods have been combined previously to develop focus area maturity models such as the software ecosystem governance maturity model [29] and the focus area maturity model for API management [32]. Figure 1 illustrates the steps followed to develop the smart city maturity model.

3.1.1. Scope

The first phase of the maturity model development was to establish scope, as shown in Figure 1. Defining the aim of the model, the gaps it will fill, the problems it will address, and the potential opportunities is fundamental. The scope must be clearly formulated, and domain(s) must be identified.

To define the scope clearly and collect information about existing maturity models for smart city assessment, a literature review was conducted following the guidelines proposed by [33]. The first step in this methodology is definition, which includes defining the inclusion and exclusion criteria, specifying the search sources, and determining the search string. The inclusion criteria were publications in English that were related to the research questions and included basic information about the model components and

levels. Publications that did not meet these criteria were excluded. Several platforms were searched: Scopus, ScienceDirect, SpringerLink, Taylor & Francis Online, ACM, and ResearchGate. The search string was ("smart" AND ("city" OR "cities") AND ("maturity" OR "assessment") AND ("model" OR "method" OR "framework")). The query string was adjusted according to the syntax of each search engine.

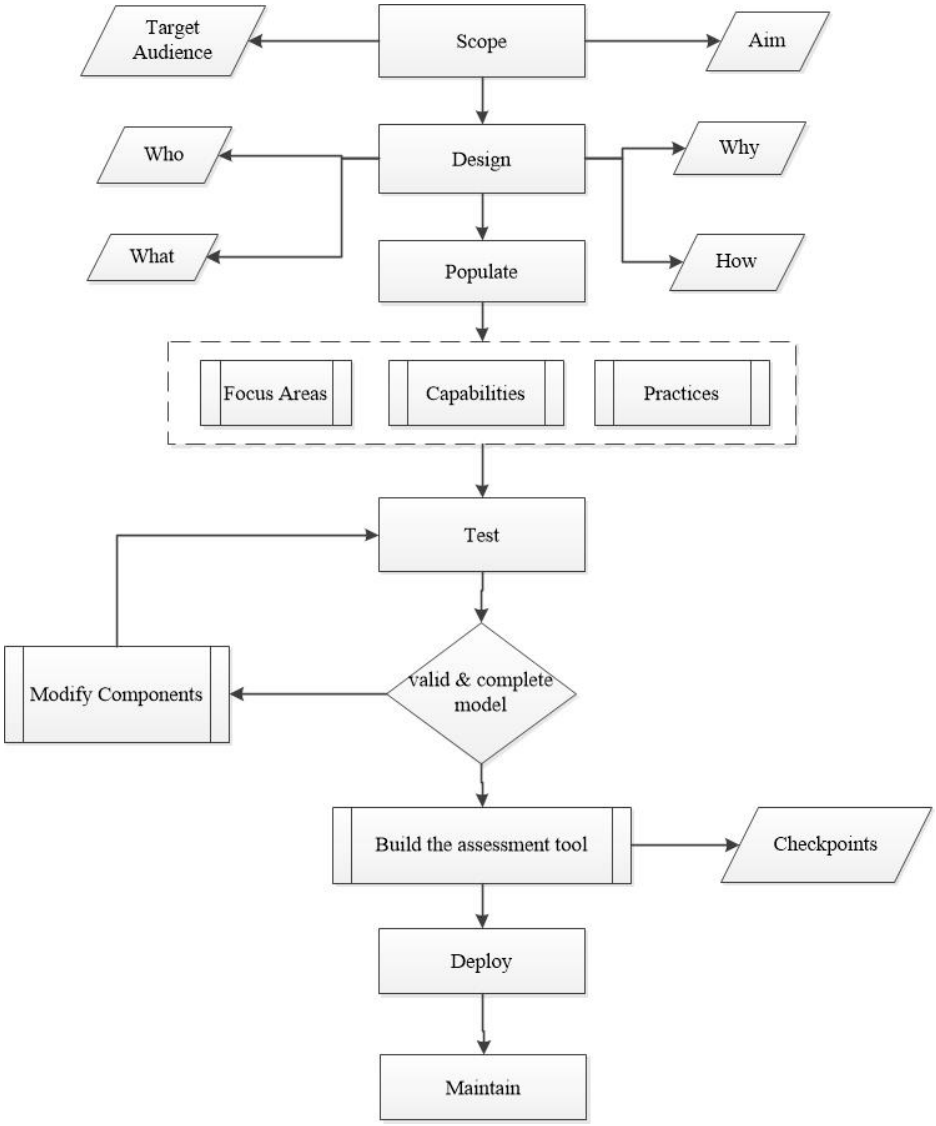

Figure 1. The development methodology of the smart city maturity model.

The next step in [33]'s review methodology is search, which includes executing the search, extracting the results, and performing a selection step to refine the results. As shown in Table 2, the initial search on 29 May 2020 yielded 1759 publications.

After removing duplicates and publications that addressed smart cities from a limited angle (i.e., a specific domain such as smart transport or smart tourism), 114 studies were considered for a second round of quality checks to ensure relevance and reliability by reading the abstract and parts of the study. Finally, 16 papers were retained for inclusion in the literature review (Appendix A). The various conceptualizations of smart city assessment models in the literature included diverse domains. Some domains were used in multiple models, whereas others were mentioned in only a single publication. The domains were extracted from the models, studied, and classified into seven logical categories: ICT, econ-

omy, environment, social, resources, services, and governance. These categories provided a clearer idea of the areas that have received attention in the literature on maturity models.

Table 2. Count of publications.

Database	No. of Papers in the Initial Results	No. of Papers after 1st Round of Exclusion	No. of Papers after 2nd Round of Exclusion
Scopus	43	37	5
Springerlink	779	32	3
Taylor & Francis	890	18	1
ScienceDirect	17	5	0
ACM	6	6	5
ResearchGate	24	16	2
Total	1759	114	16

Governments are initiating multidimensional smart city projects to satisfy citizens' needs and improve city competitiveness. However, cities have struggled to chart improvement paths and effectively measure success. Therefore, this study aims to introduce a smart city maturity model that covers all dimensions and assists governments in their smart city journeys. None of the studied maturity models included comprehensive measures encompassing all of the domains. Moreover, all of the models were based on fixed-stage models that did not consider differences between domains. Each domain may have unique specifications and components that must be considered separately. By contrast, a focus area model considers differences and can provide a reasonable improvement path that can be applied globally. The gaps identified in the literature review will be addressed by introducing a comprehensive focus area maturity model that can be used to measure the success of smart city implementation globally while considering the local differences between cities. Accordingly, the model's scope is domain specific in assessing smart city maturity. In addition, the model can be applied to any city and is not region specific.

Another critical decision in the scope phase is the model's target audience and stakeholders. The smart city maturity model developed in this research is intended for both researchers and practitioners. It will support government representatives, decision makers, all city actors, and, indirectly, citizens.

3.1.2. Design

The second phase of model development is design. In this phase, the model's foundation is constructed by answering the following questions:

- Why is the model required?

The primary goal of the model is to assist cities in measuring the maturity of smart city implementation.

- How will it be applied to different entities?

Cities can utilize the model to assess their level of maturity and then focus on the practices that need to be implemented to achieve the intended improvement.

- Who should be involved?

City officials and decision makers will be the main users of the model. However, since the model measures the city's activities, everyone in the city can be considered as a potential stakeholder.

- What can be achieved?

Cities can use the model to identify a path for improving capabilities and practices to progress and mature.

3.1.3. Populate

Once the model design is ready, the next phase is to populate. According to [25], the model's components should be defined along with what will be measured and how. The steps from the focus area development framework were followed to identify the components. First, the focus area groups and the focus areas were defined. Each group was divided into several focus areas, defined as groups of related activities, events, deliverables, or products that support the domain [34]. Grouping the focus areas into labeled categories can increase model accessibility [31]. The seven categories that were identified in the literature review were considered the focus area groups. These groups were divided into eighteen focus areas: ICT infrastructure, digital transformation, data, labor market, entrepreneurship, pollution, environmental management, education, social equity, citizen active lifestyle, water resources management, sustainable and efficient energy, urban planning and management, healthcare system, transport system, safety and security, political structure, and strategic planning. All focus areas were clearly defined to eliminate confusion in scope and precisely identify each area's capabilities.

To describe the ability to achieve the focus areas, the relevant capabilities and practices within the capabilities were defined [35,36]. According to [37] (p. 8), capabilities are "the ability to achieve a predefined goal". Capabilities can be considered the building blocks of the focus area maturity model [38]. Each focus area was studied to determine the main capabilities that should be satisfied to achieve success in that particular focus area. In general, capabilities should satisfy the following criteria: have a theoretical foundation; be measurable, clear, and precise; and have available related data. For the smart city maturity model, the capabilities and practices were extracted from the academic literature, international standards, and best practices.

3.1.4. Test and Deployment

In the test phase, experts were interviewed and consulted to verify the content of the model using the Delphi method, which will be discussed in Section 3.3. The Delphi method has been used previously to verify frameworks [39] and, more specifically, to validate maturity models [40,41].

3.2. Building the Assessment Tool

After validating the model and finalizing the components, the assessment tool was built and used to evaluate the city's level of maturity [42]. Each level within a focus area had three checkpoints: questions that can be answered by "yes" or "no" to assess the current situation [28,38]. The maturity of the focus area level was achieved only if all three questions were answered "yes". Appendix D lists all the checkpoints that are under ICT focus area as an example and below in Table 3 are the questions for measuring level one of the ICT infrastructure/connectivity focus area.

Table 3. Checkpoints to determine level 1 of ICT infrastructure/connectivity.

ICT		
Focus Area: ICT Infrastructure/Connectivity		
Broadband consistency	1	Does the broadband network cover all parts of the city?
	2	Is the broadband network accessible to all relevant stakeholders?
	3	Is the connectivity affordable and reliable?

The checkpoints were derived from the definitions of the focus areas, capabilities, and practices. The questions were also based on standards and frameworks from the literature that were related to the focus areas and capabilities. The questions were formulated considering five desirable properties [43]: unambiguous, comprehensive, direct, operational, and understandable. In addition to the mentioned properties, within each focus area there are three categories of questions according to what they measure: input, output, or outcome [44]. First, the input questions measure the resources allocated to

the focus area, such as budget and human resources. However, the input questions will measure the efforts dedicated to that focus area but do not measure whether the resources are spent efficiently or the objectives achieved. Second, the output questions measure the actions produced to accomplish the focus area's goals but do not measure the effectiveness of the actions. A typical output was the presence of a plan or strategy. Finally, the outcome questions measure the effectiveness of the actions in reaching the focus area objectives, such as questions about citizens' satisfaction. Within each focus area, the questions covered strategy, governance, people, communication, and reporting.

3.3. The Delphi Method

The goal of the test phase is to validate the components of the maturity model. The focus areas, capabilities, and practices were extracted from the literature. Testing and validation of the data were essential to ensure the model's completeness and correctness. Specifically, the objectives of the test phase were as follows:

1. Agree on the definitions of focus areas and capabilities, which is essential to establish a solid foundation for the model;
2. Identify any missing capabilities to ensure model completeness;
3. Identify any potential overlap between the proposed focus areas/capabilities to avoid confusion between the different components;
4. Identify any potential dependencies between focus areas/capabilities to build the model matrix based on any dependencies;
5. Agree on all focus areas and capabilities to ensure model validity;
6. Identify the importance of each focus area/capability to the smart city.

The Delphi method is an iterative process of gathering experts' opinions and assumes that the opinion of a group of experts is more accurate than the opinion of a single individual [45]. The process ends when it reaches the predefined level of consensus or completes the predefined number of rounds [46]. The Delphi method has been successfully used to evaluate the identification and development of concepts within theoretical frameworks such as the maturity model [39–41,47]. Figure 2 shows the steps of the Delphi method.

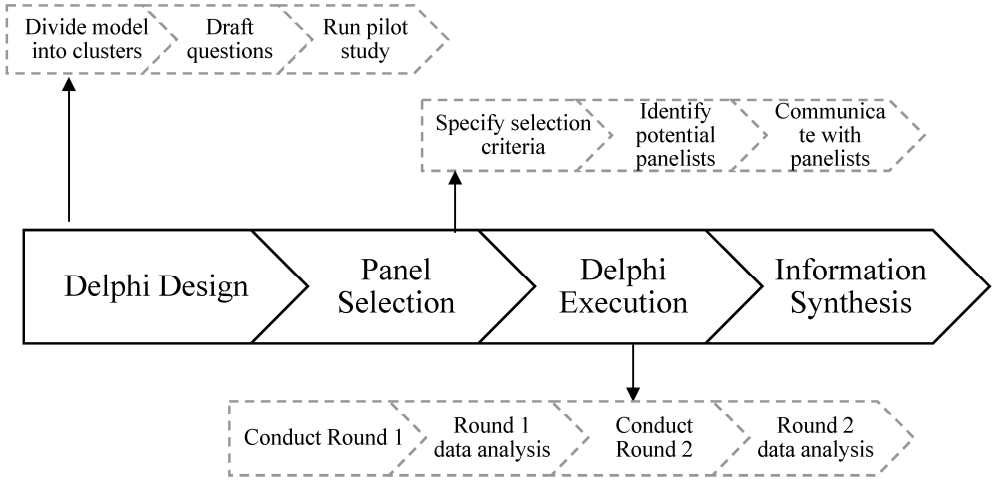

Figure 2. Steps of the Delphi method (adapted from [48] with modifications).

3.3.1. Clustering of Questions

To avoid confusing the panelists, the questions were formulated clearly and concisely and fitted the study's purpose. As shown in Table 4, the focus areas were grouped into twelve clusters, and an online tool was used to create and publish each cluster's interview questions online through a secure link shared with the panelists during the interview for better accessibility.

Table 4. Focus area clusters for interviews.

Cluster No.	Focus Area Group	Focus Area
1	ICT	ICT infrastructure, Digital Transformation, Data
2	Economy	Labor Market, Entrepreneurship
3	Environment	Pollution, Environmental Management
4	Social	Education
5	Social	Social Equity, Citizen Active Lifestyle
6	Resources	Water Resources Management, Energy Sustainability
7	Services	Urban Planning and Management
8	Services	Healthcare System
9	Services	Transport System
10	Services	Safety and Security
11	Governance	Political Structure
12	Governance	Strategic Planning

3.3.2. Panel Selection

Panel selection is essential to data credibility; an improperly selected panel may provide misleading information. In addition, choosing unmotivated panelists can result in a low response rate. The panelists were chosen based on their knowledge and extensive experience, which ranged from 8 to 41 years. In addition, to ensure a range of perspectives, panelists with diverse backgrounds and professional experiences were selected. The experts worked in government agencies, the private sector, universities, UN agencies, and NGOs and held jobs such as managers, professionals, CEOs, researchers, and lecturers. The snowball approach was used [49], asking panelists to recommend other potential participants.

3.3.3. Interview Process

The data were collected in two rounds [39]. Five panelists were assigned to each cluster (Table 4) to answer interview questions related to their area of expertise. Each interview began by explaining the study and the questions. The panelist was asked to either answer the questions during the interview or return responses (based on the panelist's preference) within a week using the link provided. If the panelist chose to send answers later, a supplemental document describing the model components was sent to the panelist along with the link.

Out of the 86 panelists who were approached to participate in the interviews, 60 participated and actively contributed to the interviews by giving their opinions and feedback in two rounds. The data were extracted from the online tool into Microsoft Excel and then downloaded into SPSS for analysis.

In the first round, the panelists were presented with four questions about their agreement with the definitions of the focus areas and capabilities. They were asked to suggest modifications when applicable, add any missing capabilities to the model, and identify any overlap or dependencies between the focus areas/capabilities.

After finalizing the focus areas and capabilities, a second round was conducted in which the panelists were asked to agree on all capabilities and practices and rate the importance of different focus area groups, focus areas, and capabilities.

3.3.4. Reliability and Validity

The following aspects of the Delphi method ensured the reliability and validity of the Delphi method:

- The selected experts were knowledgeable, experienced, and representative of the related domain. In addition, they were willing and able to participate in the Delphi process. The number and diversity of experts were sufficient to ensure a balanced and comprehensive perspective on the topic;

- The design of the questionnaire avoided leading, ambiguous, or biased questions. The experts had space to comment and give open-ended responses and comments. The questionnaire was pilot tested and refined before being administered to the panel;
- The data were analyzed using appropriate statistical methods with criteria to measure the level of agreement among the experts. The results were presented in a transparent and systematic matter that highlighted the main findings and areas of disagreement.

4. The Final Smart City Maturity Model

After the expert review and validation, the final proposed model included eighteen focus areas belonging to seven groups: ICT, economy, environment, social, resources, services, and governance. Each focus area was classified into two to four capabilities, depending on the nature of the focus area. These focus areas and capabilities were compiled to form the smart city maturity model. Cities can use this model to obtain a clear picture of the sectors they should focus on to improve smart city adoption. Figure 3 provides an overview of the model's architecture.

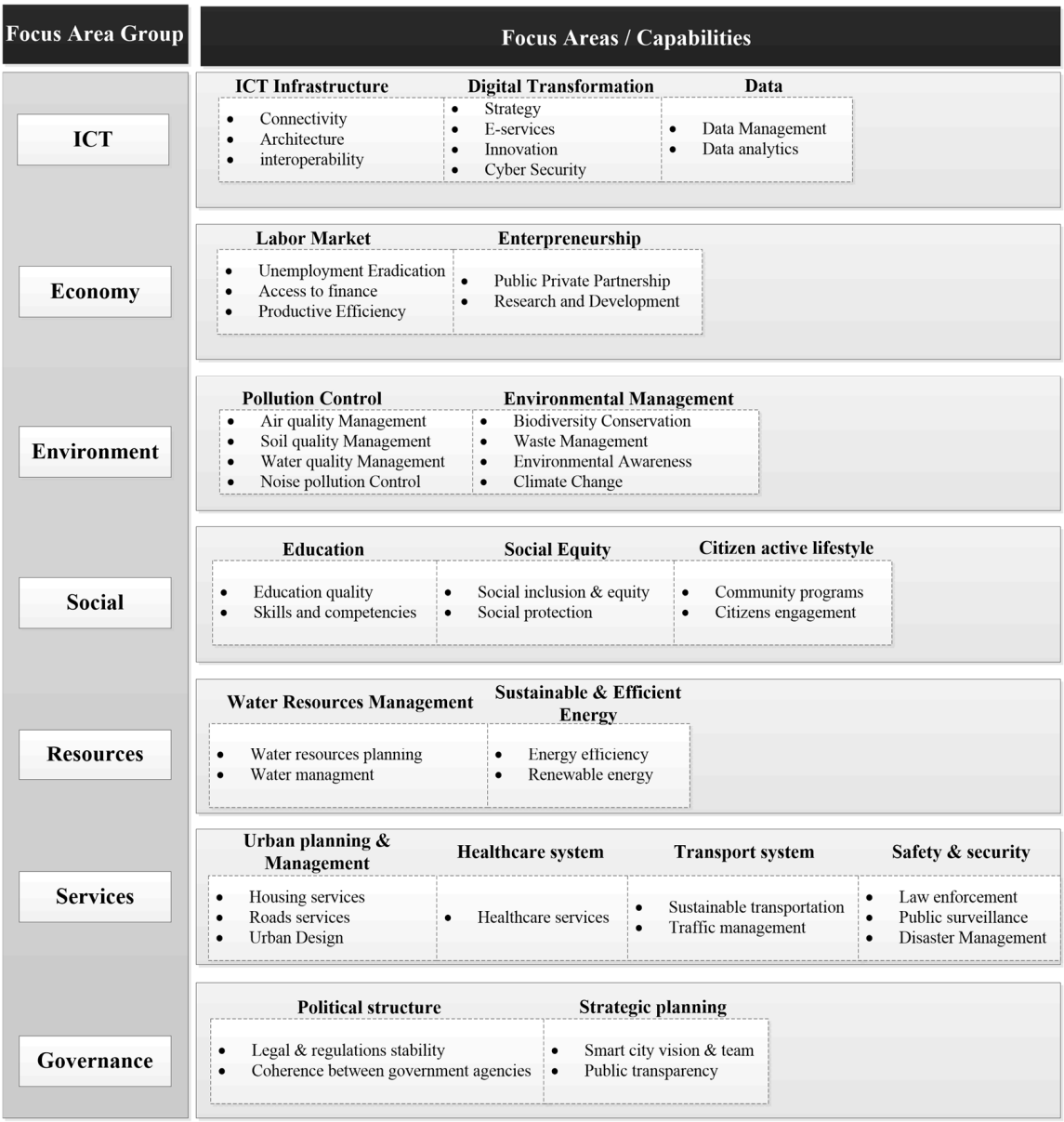

Figure 3. Final Components of the Smart City Maturity Model.

The smart city maturity matrix is available in Appendix B, which describes the five levels of maturity of each model component. The matrix also lists all practices. However, more details are included in the full model about each capability. To illustrate the concept, a list of the practices and related capabilities that are under the ICT focus area group are provided in Appendix C. Below, in Figure 4, is the capability connectivity in the focus area ICT infrastructure in:

- Focus Area Name;
- Capability Name;
- Practice Code: A unique identifier that comprises three parts: the first part is the focus area number, the second part is the capability number, and the last part is the number of the practice within the capability;
- Practice Name;
- Practice Description;

ICT Infrastructure	Connectivity	**Practice Code:** 1.1.1	**Practice Name:** Broadband consistency
		Description: The broadband network is consistent across the city	
		Practice Code: 1.1.2	**Practice Name:** Basic IoT projects
		Description: Some projects utilize IoT applications and devices	
		Practice Code: 1.1.3	**Practice Name:** Advanced IoT technology
		Description: A city-wide plan for the utilization of IoT applications and devices	
		Practice Code: 1.1.4	**Practice Name:** Ubiquitous connectivity
		Description: Ubiquitous connectivity that connects IoT devices, people, and services	

Figure 4. Descriptions of Connectivity Practices.

5. Discussion

The findings of this study indicate that the smart city maturity model involves various components. Accurately defining the model components provides a structured framework for the maturity model and ensures its ability to provide an effective assessment of smart city maturity. The components were initially extracted from the literature on smart city assessment frameworks and validated by experts using the Delphi method, as explained in Sections 3 and 4. The final key components, or focus areas, of the smart city maturity model are ICT infrastructure, digital transformation, data, labor market, entrepreneurship, pollution control, environmental management, social equity, citizen active lifestyle, water resources management, sustainable and efficient energy, urban planning and management, healthcare system, transport system, safety and security, political structure, and strategic planning. Measuring these focus areas using the developed maturity model will ensure the effectiveness of the assessment.

The model was built and evaluated using techniques and guidelines from the literature. The use of the Delphi method during model development strengthened the model's foundation and grounded the model in theory and practice.

The developed model is based on the concept of dividing the functional domains into a number of focus areas, which provides a structural approach that can guide the city in adopting a phased development approach, focusing on incremental improvements and

prioritizing investments based on assessment. Breaking down the process based on the maturity level of each capability will improve resource allocation and allow the city to focus on priorities. Over time, cities will be able to measure their progress and demonstrate their achievements.

Furthermore, the model facilitates knowledge transfer by enabling benchmarking and sharing best practices based on the assessment results. Additionally, the model can support capacity building by identifying gaps and areas for improvements.

The findings of this study have several implications for future research since there is no globally accepted definition of a smart city. The developed smart city maturity model contributes to a better understanding of what constitutes a smart city and how it can be measured. It shows how to build an effective maturity model that can effectively contribute to achieving successful digital transformation. The developed model opens new research opportunities and can be used as a basis to investigate the impact of smart city initiatives on different areas related to city development, such as sustainability, economic development, and culture. In addition, the developed model is the most comprehensive with respect to the inclusion of focus areas and has been empirically validated. The model bridges gaps in the literature and contributes to the smart city field.

Similarly, the smart city maturity model has implications for practice; governments around the world can use the proposed model to influence smart city implementation. The decision makers and planners in government can benefit from the model to set priorities and adopt and evaluate digital transformation strategies. The model not only identifies challenges but also highlights strengths and best practices. Consequently, it can be replicated in other areas or shared with other cities. Additionally, the success of smart city adoption relies on the engagement of stakeholders and the collaboration between them, and the model can be used to explore the roles of different stakeholders, such as officials, decision makers, and citizens. Establishing priorities will clarify the roles of stakeholders. Finally, the proposed model can be used to accelerate the progress of cities in sustainable development and achieving the SDGs. The practices in the model align with all of the SDGs.

Overall, the smart city maturity model offers a structured and holistic approach to the development of smart cities. Utilizing the model's recommendations can navigate the complexities of smart city development and provide a roadmap to successful smart initiatives.

6. Conclusions

This research aimed to develop a maturity model to support cities in assessing smart city adoption. The study started with a review of models in the literature to extract the main focus areas. These areas were then used to develop the model using the focus area maturity model development method. This method allowed interconnected domains within a smart city to be measured. In addition, the focus areas technique facilitated the fragmentation of domains into capabilities, thereby improving the accessibility of the model and enabling cities to concentrate on areas of improvement. To validate the model's correctness and completeness, the Delphi method was used to solicit feedback from sixty expert panelists from multiple sectors. The model was then amended based on quantitative analysis of the feedback.

This study faced three main challenges. The first was the stakeholder engagement, since developing this model required input from a wide range of stakeholders. Ensuring the involvement of all stakeholders was challenging. The second was the data availability challenge; building a such model demands access to data about the city from different angles. Some data were difficult to obtain either due to unavailability or sensitivity. The third was the heterogeneity of cities; differences in the sizes, populations, social lives, economies, and priorities of cities made it challenging to develop one model that could be applied to all cities. These challenges notwithstanding, the developed model is a significant contribution to the assessment of smart city maturity.

This research is the first attempt to develop a comprehensive maturity model for assessing smart city implementation using focus areas. The topic of smart cities is vast and constantly changing, thus any model of smart city maturity must be able to evolve. Potential avenues for future research include the deployment of the model in multiple cities; then, the data can be analyzed and used to improve the model. Additionally, during the interviews, the majority of the experts expressed interest in using the output of the maturity model assessment to improve their internal processes. Continued collaboration with government and private entities would allow the model's findings to be put into action.

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Appendix A. List of Models Included in Literature Review

No.	Maturity Model	Model Summary	Source
1	Brazilian Smart City Maturity Model (Br-SCMM)	Based on the information retrieved from Brazilian cities. The model has five levels that are not incremental. However, only the first two levels have been tested and validated.	[50]
2	Alternative Framework for Smart City Assessment	Based on the European smart city ranking [8]. The model is a ranking tool used to evaluate Seoul, Singapore, and Iskandar Malaysia to identify cities with high performance.	[51]
3	Reconciled Smart City Assessment Framework (RSCAF)	The model assesses the city's smartness by finding the gap between the actual and planned smart initiatives, using the city's primary functions as a baseline. Only the conceptual design is ready. The model levels are not defined yet.	[52]
4	Smart City Systematic and Foresight approach	It is a five-step methodological model to provide a conceptual image of smart city initiatives.	[53]
5	Smart City Assessment Methodology (SCAML)	Composed of a reference model (SCRM) and an assessment method (SCAM). Used design science research as a method for research and Brazilian cities' profiles as the initial scope of work.	[54]
6	Data Quality Driven Smart City Maturity Model (DQSC-MM)	The model evaluates the smart city maturity based on the data quality. It was developed using two surveys to collect data about model dimensions. The model is based on five leverage domains, eleven key domain areas, and five maturity levels. An application was developed to measure smart city maturity based on the model.	[55]
7	Smart City ICT Adoption Maturity Model (SCIAMM)	It is inspired by existing maturity models for smart cities, government enterprise architecture, and management models. Aimed at developing countries and has been tested on Colombian cities. It has 5 domains, 15 domain areas, 48 critical variables, and 5 maturity levels.	[56]
8	Smart City Projects Assessment Matrix (SC[PAM])	A framework to assess and evaluate smart city projects that are related and connected. The dimensions are based on European Smart City Ranking [8]. It was assessed using five case studies.	[57]

9	Bahrain National Smart City Framework	It is a national model developed to assess the kingdom of Bahrain's progress. Based on six dimensions and proposing five levels of maturity.	[58]
10	Framework for Village Smartness Maturity	Developed for the villages based on the six dimensions identified by a group of experts. The data were collected by questionnaire. The model has four levels (high, good, medium, and low). It was tested using a single case study.	[59]
11	Maturity-Based Assessment Scale	It is developed based on three main dimensions: connectivity, sustainability, and resilience. It is a descriptive model describing each of its five levels but not how to achieve them.	[60]
12	Smart City for Development Model (SC4D)	Emphasizes how smart city initiatives can impact the city's development. Based on six domains aiming to balance ICT with a city's needs.	[61]
13	Australian Smart City Ranking	Built to compare and rank the smartness of Australian cities. Based on 6 dimensions, 90 indicators, and 26 factors.	[19]
14	CityDNA	It aims to provide information about the city's smartness maturity, like human DNA provides information about the body's health and status. The model is based on ISO 37153:2017, and the indicators are based on ISO 37120:2014.	[62]
15	Multiagency Modeling of Transformation	It is a three-dimensional model that illustrates the city's transformation. It is based on the ISO 37120:2018 and ISO/IEC 30146:2019 standards. It was tested in the city of Warsaw.	[63]
16	Value Alignment Smart City Model (VASC)	A conceptual model for smart city initiatives. It assesses smart city initiatives based on a systematic literature review. The model comprises three main components: the dimensions, stakeholders, and value alignment phases. The idea of the model is mainly about stakeholders' realization of the smart city benefits.	[64]

Appendix B. Smart City Maturity Matrix

Component		Maturity Level				
		0	**1**	**2**	**3**	**4**
1	ICT Infrastructure					
1.1	Connectivity		Broadband consistency	Basic IoT projects	Advanced IoT technology	Ubiquitous connectivity
1.2	Architecture		Decentralized architecture	Basic Cloud architecture	Optimized Cloud architecture	
1.3	Interoperability		Offline data exchange	Basic data exchange platforms	Advanced data exchange	
2	Digital Transformation					
2.1	Strategy		Ad hoc transformation processes	City-wide strategy	Optimized strategy	
2.2	E-services		Multi-channel e-services	Enable e-participation	Optimized and integrated e-services	

2.3	Innovation	Recognize innovation occasionally	Limited innovation recognition	Strategic innovation recognition	
2.4	Cybersecurity	Ad hoc cybersecurity practices	Strategic cybersecurity practices	Optimized cybersecurity practices	
3	Data				
3.1	Data Management	Data collection	Limited data management	Strategic data management	
3.2	Data Analytics	Basic data reporting	Predictive data analysis	Strategic data management	
4	Labor Market				
4.1	Unemployment eradication	Limited attention to unemployment	Strategic solutions for unemployment	Optimized unemployment strategy	
4.2	Access to Finance	Limited access to finance	Strategic financing pockets	Optimized financing strategy	
4.3	Productivity Efficiency	Decentralized productivity measurement	Centralized productivity measurement	Improving productivity	
5	Entrepreneurship				
5.1	Public-private partnership	Basic practices for PPP	Well-established PPP practices	Optimized PPP practices	
5.2	Research and Development	Basic research and development	Well-established research and development		
6	Pollution Control				
6.1	Air Quality Management	Basic efforts to enhance air quality	Well-defined policies for air quality control	Enforced policies for air quality control	Implement air pollution prevention measures
6.2	Water Quality Management	Basic efforts to enhance water quality	Well-defined policies for water quality control	Enforced policies for water quality control	Implement water pollution prevention measures
6.3	Soil Quality Management	Basic efforts to enhance soil quality	Well-defined policies for soil quality control	Enforced policies for soil quality control	Implement soil pollution prevention measures
6.4	Noise Pollution Control	Basic efforts to measure noise	Well-defined policies to monitor noise pollution	Enforced policies for noise pollution control	Implement noise pollution prevention measures
7	Environmental Management				
7.1	Biodiversity Conservation	Basic efforts against biodiversity	Well-defined biodiversity metrics	Benchmarked biodiversity regulations	Proactive practices for biodiversity
7.2	Waste Management	Basic waste management efforts	Well-defined waste management metrics	Advanced waste management regulations	Proactive waste management practices

7.3	Environmental Awareness	Basic efforts for improving awareness	Well-defined environmental awareness metrics	City-wide optimized efforts for awareness	
7.4	Climate Change	Basic efforts against climate change	Well-defined climate change metrics	Benchmarked climate change regulations and policies	Proactive practices for climate change
8	Education				
8.1	Education Quality	Basic efforts for education quality	Clearly defined quality standards	Optimized quality standards	
8.2	Skills and Competencies	Basic skills assessment	Robust skills reforms	Optimized skills reforms	
9	Social Equity				
9.1	Social inclusion and Equity	Basic social inclusion acknowledgment	Robust system for social inclusion	Optimized social inclusion culture	
9.2	Social Protection	Basic social protection programs	Robust system for social protection	Optimized social protection programs	
10	Citizen active lifestyle				
10.1	Community Programs	Basic community programs	Robust system for community programs	Comprehensive community programs	
10.2	Citizen's engagement	Basic citizens' engagement plans	Robust system for citizen's participation	Citizens proactive engagement	
11	Water Resources Management				
11.1	Water Resources Planning	Ad hoc water resources planning	Strategic water resources planning	Optimized water resources planning	
11.2	Water Management	Limited water management	Advanced water management	Optimized water management	
12	Sustainable and efficient energy				
12.1	Energy Efficiency	Limited energy efficiency monitoring	Advanced energy efficiency monitoring	Optimized energy efficiency monitoring	
12.2	Renewable Energy	Limited renewable energy implementation	Strategic renewable energy implementation	Optimized renewable energy implementation	
13	Urban Planning and Management				
13.1	Housing Services	Limited housing services quality	Advanced housing services quality	Optimized housing services quality	
13.2	Road Services	Limited road services quality	Advanced road services quality	Optimized road services quality	
13.3	Urban Design	Limited urban planning standards	Advanced urban planning and design	Optimized city urban design	
14	Healthcare System				
14.1	Healthcare services	Uncoordinated healthcare services	Integrated healthcare services	Preventive healthcare services	
15	Transport System				
15.1	Sustainable Transportation	Limited initiatives for sustainable transportation	Advanced for sustainable transportation	Optimized sustainable transportation initiatives	

15.2	Traffic Management	Limited traffic management initiatives	Integrated traffic management system	Optimized traffic management system
16	Safety and Security			
16.1	Law enforcement	Limited efforts to fight the crime	Strategic law enforcement system	Optimized law enforcement system
16.2	Public surveillance system	Limited security measures	Advanced public security system	Optimized public security system
16.3	Disaster Management	Limited disaster recovery plans	Strategic disaster recovery plans	Optimized disaster recovery plans
17	Political Structure			
17.1	Legal and Regulations Stability	Limited stability in the political system	Stable political system	Optimized political system based on democracy
17.2	Coherence between government agencies	Siloed operating model	Consistent integration between agencies	Optimized integration between agencies
18	Strategic Planning			
18.1	Smart city vision and team	Project-focused strategy	Strategic smart city vision	Optimized smart city strategy
18.2	Public transparency	Limited access to decision-making processes	Transparent system for decision making	Decision-making processes based on citizens' feedback

Appendix C. Practices of ICT Focus Area Group

ICT infrastructure	Connectivity	Practice Code: 1.1.1	Practice Name: Broadband consistency
		Description: The broadband network is consistent across the city	
		Practice Code: 1.1.2	Practice Name: Basic IoT projects
		Description: Some projects utilize IoT applications and devices	
		Practice Code: 1.1.3	Practice Name: Advanced IoT technology
		Description: A city-wide plan for utilization of the IoT applications and devices	
		Practice Code: 1.1.4	Practice Name: Ubiquitous connectivity
		Description: Ubiquitous connectivity that connects IoT devices, people, and services	
ICT infrastructure	Architecture	Practice Code: 1.2.1	Practice Name: Decentralized architecture
		Description: Decentralized systems architecture that can support silos projects only.	
		Practice Code: 1.2.2	Practice Name: Basic Cloud architecture
		Description: Consolidated, scalable Cloud-based architecture	
		Practice Code: 1.2.3	Practice Name: Optimized Cloud architecture
		Description: Optimized Cloud-based architecture that supports agile development	
ICT infrastructure	Interoperability	Practice Code: 1.3.1	Practice Name: Offline data exchange
		Description: Projects are implemented in silos that do not communicate, and no mechanism for online data exchange between different entities.	
		Practice Code: 1.3.2	Practice Name: Basic data exchange platforms
		Description: Some pilots are implemented with open data platforms to exchange data	
		Practice Code: 1.3.3	Practice Name: Advanced data exchange
		Description: Systems communicate seamlessly through cross-organizational collaboration	

Digital Transformation	Strategy	Practice Code: 2.1.1	Practice Name: Ad hoc transformation processes
		Description: Ad hoc processes in place for digital transformation.	
		Practice Code: 2.1.2	Practice Name: City-wide strategy
		Description: Well-defined, city-wide strategy for identifying the latest technology and clear processes for adoption.	
		Practice Code: 2.1.3	Practice Name: Optimized strategy
		Description: Periodic review of the digital transformation strategy to ensure linking the investments to outcomes.	
Digital Transformation	E-services	Practice Code: 2.2.1	Practice Name: Multichannel e-services
		Description: Enable the stakeholders to perform online transactions any time and through multiple channels.	
		Practice Code: 2.2.2	Practice Name: Enable e-participation
		Description: Social participation of stakeholders in e-services that shape the decision-making process.	
		Practice Code: 2.2.3	Practice Name: Optimized and integrated e-services
		Description: Optimized and integrated online services that are based on best practices.	
Digital Transformation	Innovation	Practice Code: 2.3.1	Practice Name: Recognize innovation occasionally
		Description: Ad hoc recognition for innovative ideas	
		Practice Code: 2.3.2	Practice Name: Limited innovation recognition
		Description: Innovative ideas are considered by individual organizations' practices.	
		Practice Code: 2.3.3	Practice Name: Strategic innovation recognition
		Description: City-wide recognition for innovative ideas with a defined budget for the ideas' implementation.	
Digital Transformation	Cybersecurity	Practice Code: 2.4.1	Practice Name: Ad hoc cybersecurity practices
		Description: Initial and ad hoc practices in place for cybersecurity	
		Practice Code: 2.4.2	Practice Name: Strategic cybersecurity practices
		Description: Well-defined strategy that is implemented by a dedicated entity with adequate resources (human and financial) assigned.	
		Practice Code: 2.4.3	Practice Name: Optimized cybersecurity practices
		Description: Optimized cybersecurity practices by evaluating and benchmarking the performed practices.	
Data	Data Management	Practice Code: 3.1.1	Practice Name: Data collection
		Description: Lack of data centralization, no integration between organizations for data sharing, access to data is limited and data can have accuracy issues	
		Practice Code: 3.1.2	Practice Name: Limited data management
		Description: The city acknowledges data significance and data is treated as a critical asset.	
		Practice Code: 3.1.3	Practice Name: Strategic data management
		Description: Data is used on a city-wide scale to give citizens information and achieve a proactive decision-making process.	
Data	Data Analytics	Practice Code: 3.2.1	Practice Name: Basic data reporting
		Description: Only descriptive data analytics exists that can explain the data	
		Practice Code: 3.2.2	Practice Name: Predictive data analytics
		Description: Predictive data analytics exists to forecast the future.	
		Practice Code: 3.2.3	Practice Name: Strategic data analytics
		Description: Advanced prescriptive city-wide data analytics that is used to guide the decision makers in achieving best-case scenarios.	

Appendix D. Assessment Tool for ICT Focus Area Group

Capability	No.	Checkpoint
Focus Area: ICT Infrastructure		
Connectivity		
Broadband consistency	1	Does the broadband network cover all parts of the city?
	2	Is the broadband network accessible to all relevant stakeholders?
	3	Is the connectivity affordable and reliable?
Basic IoT projects	4	Do you have projects that use IoT devices for providing real-time data?
	5	Is the provided data utilized by the relevant stakeholders?
	6	Do you have a clear plan or strategy for IoT applications and devices utilization on a city-wide level?
Advanced IoT technology	7	Do you have the needed governance system (i.e., standards, action plans, regulatory measures, and administrative capacity) to enforce the IoT strategy?
	8	Do you analyze the city's connectivity and IoT projects' performances to improve policies, standards, and outcomes?
	9	Do you benchmark your standards, programs, and achievements internationally and encourage best practices adoption?
Ubiquitous connectivity	10	Are all related services, devices, and people connected seamlessly
	11	Is the effectiveness of the connectivity evaluated and reported to the stakeholders?
	12	Do you benchmark your standards, programs, and achievements internationally and encourage best practices adoption when it comes to ubiquitous connectivity?
Architecture		
Decentralized architecture	13	Are the systems architecture needs clearly identified and serve the projects' requirements?
	14	Do you have a consistent understanding across all sectors of the significance of centralized architecture?
	15	Do you have access to the infrastructure resources required to deploy your projects?
Basic Cloud architecture	16	Do you have a city-wide strategy for Cloud-based architecture?
	17	Do you have the needed governance system (i.e., standards, action plans, regulatory measures, and administrative capacity) to enforce the Cloud-based strategy?
	18	Does your process of workload allocation support agile development?
Optimized Cloud architecture	19	Do you regularly evaluate your Cloud workloads to optimize performance and cost?
	20	Did you evaluate the outcome and impact of the Cloud's implementation?
	21	Do you benchmark your standards, programs, and achievements internationally and encourage best practices adoption?

Interoperability		
Offline data exchange	22	Is data exchange between systems possible through data extraction and data import operations?
	23	Do all smart city projects have steering authority to ensure they follow city guidelines and standards
	24	Do your systems support open protocols to ensure their independence from the complexity of other systems/devices?
Basic data exchange platforms	25	Do you follow any predefined standards, local or international, to ensure the security, performance, scalability, and resilience of systems?
	26	Does the steering authority ensure that the project output will not interfere with other implemented projects?
	27	Have you implemented an open data platform by coordinating data exchange between different organizations?
Advanced data exchange	28	Do your systems allow real-time data collection?
	29	Are all related functions grouped in shared systems that have cross-organizational ownership?
	30	Does the data flow between systems in both directions eliminate redundancy?
Focus Area: Digital Transformation		
Strategy		
Ad hoc transformation processes	31	Is there awareness regarding the need for a digital transformation strategy?
	32	Do you have a clear digital transformation strategy for the city?
	33	Do you have a cross-sectorial body that provides support and ensures effective implementation of the strategy?
Citywide Strategy	34	Do you proactively bring in the latest technology trends based on the predefined strategy?
	35	Is the strategy communicated and reported properly to all relevant stakeholders based on a clear mechanism for stakeholder involvement and citizen engagement?
	36	Do you refer to the strategy before any change or modification?
Optimized Strategy	37	Do you periodically evaluate, report, and reflect on the strategy?
	38	Do you amend the strategy based on feedback gathered from relevant stakeholders and citizens?
	39	Do you benchmark your strategy to international standards and other cities' strategies?
E-services		
Multi-channel e-services	49	Do all government agencies have an active web presence that provides all the needed information?
	41	Are the majority of the services that are offered by the government and private sector available online?
	42	Are the offered services accessible through multiple channels?

Enable e-participation	43	Do you have citywide guidelines/standards to define and regulate organizations' web presence?
	44	Do you measure the quality of services regularly and communicate reports to stakeholders and citizens?
	45	Do you utilize social media channels to ensure public involvement in the decision-making process?
Optimized and integrated e-services	46	Do you perform process reengineering of the processes behind the services offered?
	47	Do you evaluate the offered e-services regularly and perform revisions based on the citizens' feedback?
	48	Do you benchmark your standards, e-services, and achievements internationally and encourage best practices adoption?
Innovation		
Recognize innovation occasionally	49	Does the city promote an innovation culture?
	50	Does the city provide access to innovative resources that can be utilized in smart city applications?
	51	Do the city's organizations support agility?
Limited innovation recognition	52	Does the city provide enough incentives to encourage innovation?
	53	Does the city provide programs that cultivate innovation?
	54	Do the research centers the and academic community play a strong role in shaping the city strategy?
Strategic innovation recognition	55	Do you have a designated entity and defined budget to facilitate innovation and measure the efficiency of implementation?
	56	Do you analyze the effect and expected value of innovation on digital transformation?
	57	Does the city benchmark its innovation ecosystem with global standards?
Cybersecurity		
Ad hoc cybersecurity practices	58	Do you have education and training programs directed at cybersecurity professionals?
	59	Does the city conduct cybersecurity awareness campaigns directed at different categories (i.e., government, private organizations, citizens) to raise awareness?
	60	Do you have laws and legalizations that regulate data protection, online identity and data theft, and online antisocial behavior?
Strategic cybersecurity practices	61	Does the city have a dedicated entity responsible for managing cyber risks city wide?
	62	Does the government offer incentives to adhere to cybersecurity adoption?
	63	Does the cybersecurity strategy cover business continuity plans?
Optimized cybersecurity practices	64	Does the city respond promptly and act systematically against cybercrime incidents?
	65	Do you revise your cybersecurity strategy to ensure it is up to date and matches international standards?
	66	Are you part of any bilateral or multilateral international agreements for cybersecurity cooperation?

Focus Area: Data		
Data Management		
Data collection	67	Does the city acknowledge data ownership and provide clear guidance to data sources?
	68	Are data-sharing platforms available to stakeholders to empower them?
	69	Is there awareness regarding data management processes?
Limited data management	70	Do you have a citywide data management strategy that ensures proper data collection, processing, utilization, and distribution?
	71	Are the data management policies, standards, and guidelines communicated properly to the stakeholders?
	72	Are data governance roles and responsibilities clearly defined and communicated?
Strategic data management	73	Do you regularly evaluate the effectiveness of data management strategy and modify based on the metrics results?
	74	Do you apply data management best practices and international standards?
	75	Do you continually improve your data management strategy, standards, and practices?
Data Analytics		
Basic data reporting	76	Do you have a consistent understanding across all sectors of the significance of analytics and how to utilize them in decision making?
	77	Are all the data sources digitized, cleaned, documented, and accessible to the concerned stakeholders for analytics?
	78	Do you have a city-wide strategy for analytics services?
Predictive data analytics	79	Are the analytics services embedded in all the processes of all sectors?
	80	Do you have a workforce with the needed skills to utilize data analytics possibilities?
	81	Do you use structured and unstructured data and big data?
Strategic data analytics	82	Is the analytics strategy and operations subject to regular evaluation and benchmark reviews?
	83	Do you utilize the latest tools in machine learning, artificial intelligence, and data visualization to achieve data analytics objectives?
	84	Has the city reached the level of prescriptive analytics, where it can automatically suggest the best actions and optimization options?

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