Article

Key Factors for Assessing Small and Rural Municipalities' Readiness for Smart City Implementation

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Abstract: The concept of a 'smart city' is now commonly used to describe the use of various digital and other technologies, to collect data to provide information that can be used to manage resources efficiently and provide a better standard of living for the citizens. Small and rural municipalities in developing countries face growing challenges in managing their resources, to provide basic services such as housing, education, transport, health, water and electricity to the citizens. This research is aimed at identifying key factors that could assist small and rural municipalities to assess their readiness for smart city implementation. A systematic literature review methodology was employed to provide an exhaustive summary of substantiated research relevant to the research aim and to synthesize key factors that are crucial to assess small and rural municipalities' readiness. This study was conducted between January and July 2022. As a contribution, this study identified and synthesized key factors to be addressed when determining a municipality's readiness to become a smart city. Through the use of ATLAS.ti to analyze the data, the study identifies the following key factors: infrastructure, the environment, skills, innovation, technology, the economy, citizens, culture, finance, the public sector, private organizations, data, management, policies, internet connectivity, education and energy. Advancing these key elements should also help small and rural municipalities, who are not yet ready to actuate a smart city, to prepare for such an endeavor, in order to address service delivery issues, the economy and the quality of life of their citizens.

Keywords: infrastructure; municipality; readiness; smart city; technology

1. Introduction

The rapid growth of populations in small and rural municipalities is affecting social, physical, economic and institutional infrastructures [1,2]. The deterioration of infrastructure calls for smart ways of doing things, to improve citizens' quality of life, along with service delivery and utilities [3,4]. Cities around the world are now focusing increasingly on smart city development, to improve how they manage their resources [5,6].

Not only big metros, but also small and rural municipalities are considering the implementation of smart city services to enhance their day-to-day operations [4,7,8]. Yet, from a South African perspective, many small and rural municipalities are struggling to realize the concept of a smart city successfully—this is due to a lack of clarity on the key factors that can be used to guide them in assessing their readiness for a smart city implementation [9,10]. A smart city or municipality should be able to connect with citizens in real-time, to collect data from them using the Internet of Things (IoT) technologies [11–13]. The connection or interaction between local governments (small and rural municipalities) and citizens is important for improving the quality of life of those citizens, as well as municipalities' service delivery [14–16]. When developing a smart city, comprehensive planning, which is specific to a local government, is required, and it should take into account a number of key factors [2,6,8].

Globally, municipalities are grappling with environmental issues, complex ecosystems, the economy and the management of social issues, to mention but a few [12,17,18]. Small and rural municipalities in most countries are trying to move forward towards implementing the principles of smart cities, but are often overwhelmed by numerous challenges which hinder the realization of the smart city concept [14,19].

Some of these challenges are that most small and rural municipalities do not know where to start when realizing the smart city concept [12,20]. In addition, key factors that are important for assessing such municipalities' readiness to become smart cities are not explicitly articulated in the existing policies or the literature [2,21]. Furthermore, many of these municipalities require precise guidelines to help them assess their readiness, before attempting to realize the smart city concept [11,15,22].

Assessing small and rural municipalities' readiness is paramount in any changeover to a smart city, as that offers implementers or planners insight into the current status of a municipality's or city's key components and infrastructure [3,8]. Knowing their baseline will help municipalities to implement and enhance the necessary key components and infrastructure, as a route to become smart cities [20,23,24].

In the literature, few studies holistically examine factors that are important in assessing small and rural municipalities' readiness for smart city implementation, especially from the perspective of developing countries [23,25,26]. Existing studies tend to focus on infrastructure, technology, data and smart city services, while largely ignoring other factors, such as education, energy, policy, management and many more [3,23,27].

This study further explores an earlier paper by Mashau, Kroeze and Howard [28] who synthesized the different indicators in an effort to develop an integrated framework to assess small and rural municipalities' readiness for smart city implementation. The initial paper did not expose the key factors that are critical in assessing such levels of readiness. There is a need to synthesize the key factors into a single, comprehensive but concise schema to address the gap in the literature. Therefore, this study aims to identify the key factors that can be used to assess small and rural municipalities' readiness for smart city implementation. A network diagram provides a bird's eye view of the key factors and the relations between the individual factors.

This research article is structured as follows: Section 2 presents an overview of the literature on the smart city concept and the key aspects thereof. Section 3 provides an overview of the research method applied to select relevant articles for this study. Section 4 discusses the key factors to consider in assessing small and rural municipalities' readiness for smart city implementation and Section 5 concludes the study.

2. Literature Review

2.1. Defining a Smart City

A smart city is also known as an intelligent city or a digital city [4,29]. This concept is gaining traction globally, with a range of scholars proposing different definitions. Since there is no consensus as yet, a clear and consistent definition will help researchers and practitioners to better understand this concept [5,16,30].

In the literature, a smart city is defined as a city which is interconnected through technology [16,31]. Some define a smart city as a city that successfully integrates digital infrastructure to improve its services and optimize its resources [12,21,23]. This study adopts a definition by Mashau et al. (p. 264, [28]), who defines a smart city as "a digital integration of information systems components to collect digital data and analyse it in real-time to monitor and manage the city infrastructure and to allocate resources effectively, thereby improving service delivery and the quality of life of the citizens".

2.2. Smart City Strategic Aspects

Smart city development is dependent on an association being formed between environmental, physical, socioeconomic and political aspects, rather than focusing on a few smart city dimensions which are deemed to make a municipality "smart" [3,15]. Globally,

municipalities are seeking to implement smart services to improve their economy, service delivery, and manage their resources [7,32]. Some see smart services as indicators to guide municipalities in developing effective smart cities [7,14]. However, few studies postulate that smart city services are seen as an innovative way that effectively connect citizens and municipalities [14,15,33].

As mentioned, most small and rural municipalities struggle with service delivery because of limited resources [14,29]. A certain mechanism is required to assist them in managing their available resources effectively [18,26,29]. There is a suggestion that the adoption and realization of the smart city concept may help such municipalities improve how they manage their resources, in order to improve their economy, service delivery, and the quality of life of their citizens [34,35].

Realizing the smart city concept involves various strategic aspects. These aspects include the support of management, citizens, the appropriate infrastructure, stakeholder involvement, suitable technology, data, connectivity, and up-to-date policies, to name a few [3,7,36].

Social, economic and digital infrastructure are the drivers of a smart city [14,33]. Notably, the technology needed for a smart city to function, as such, is dependent on the availability of digital infrastructure [21,37]. Technology and digital infrastructure are critical in promoting an innovative spirit among citizens and diverse stakeholders [23,33,34]. In most organizations, technology is now the main driver in the quest to achieve strategic objectives [11]. Even if modern digital infrastructure and technology are in place, internet connectivity is important for connecting a municipality with its citizens [23,24].

The literature emphasizes that citizens, technology, digital infrastructure and internet connectivity are critical for digital data generation [13,31,37]. Citizens use mobile devices to access technologies that are integrated with a range of systems [2,21,24]. Each transaction that citizens perform, is an important source of data which can be analysed, in order to generate information to guide the decision-makers in a smart city [15,36,38].

Top management support is crucial for any attempts to work towards becoming a smart city: as the literature indicates, top management should understand the objectives of such a project and anticipate the value that the smart city concept will bring to their municipality, if the managers are to support such a transition [2,15].

For a municipality to procure suitable technologies, digital infrastructure, and secure internet connectivity, officials must have the buy-in of top management [14,15] as they are the highest decision-making structures in municipalities [39]. They are the role players who decide which projects to fund [2,15]. If a smart city project receives support from top management, the latter will allocate or authorize sufficient funds. Without sufficient financing or budgeting, it might be impossible for small and rural municipalities to work towards becoming smart cities [2,15,29].

Each municipality is governed by policies that serve as an action plan for resolving social, quality of life and service delivery issues [19,39]. Therefore, when small and rural municipalities develop such policies, they should consider critical aspects associated with smart city implementation [1,2,38]. Unfortunately, policies sometimes may delay efforts to innovate or realize the smart city concept [5,40].

3. Method

In this research, the researchers followed a systematic literature review approach to identify and review the literature pertinent to those key factors deemed critical in assessing small and rural municipalities' readiness for smart city implementation [41,42].

3.1. Search Strategy

To search the literature from the database listed in Table 2, the following keywords were used: (1) "factors" AND "smart city" AND "small municipality" AND "readiness", (2) "factors" AND "smart city" AND "rural municipality" AND "readiness", (3) "factors"

AND "smart city" AND "local government" AND "readiness". In the search, double quotation marks (") were used to find specific phrases in the articles.

The searches were performed across the following databases: ACM digital library, AIS eLibrary (AISeL), Ebscohost, IEEE Xplore digital library, JSTOR, Proquest (ABI/INFORM collection), ScienceDirect or Elsevier, and Scopus. The researchers selected these databases because they are commonly used in Information Systems (IS) research [42].

The search focused on peer-reviewed articles published in the Information Systems domain from 1 January 2015 to 31 December 2021. The initial search from all listed databases retrieved 216 articles.

3.2. Filtering Strategy

Inclusion criteria were stated to include studies that were eligible for systematic review. The researchers also formulated exclusion criteria, which were specified to exclude certain studies from the review [43,44]. See Table 1.

Table 1. Adapted inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
• Studies focusing on the small and rural municipalities' readiness for smart city implementation • Studies that clearly discuss the factors that can be used to assess small and rural municipalities' readiness for smart city implementation • Studies focusing on factors for smart city development	• All research articles published before 1 January 2015 or after 31 December 2021 • Duplicated research articles • Studies not written in English • Studies that were not peer-reviewed • Studies not related to the smart city concept

Following the removal of 74 duplicated articles from the original 216 records, the researchers manually screened the 142 remaining articles by examining the title, keywords and abstracts for their relevance. 61 of these articles were screened further by reading the full text, and 35 articles were selected for a final review pool because of their relevance to the research aim. The analysis of all of the literature in the review pool was conducted between January and July 2022.

In the last phase, more articles were identified through forward and backward searches. Forward searches were used to find the latest articles referencing the sources identified during the initial screening, while backward searches were used to identify older references from the initial review pool of 35 sources. During these searches, six additional sources, deemed relevant to the research aim, were identified and added to the review pool. In total, 41 articles were reviewed to achieve the aim of the study (cf. Table 2 and Figure 1).

Table 2. An overview of the initial search results and the articles selected for review after filtering, based on the inclusion and exclusion criteria.

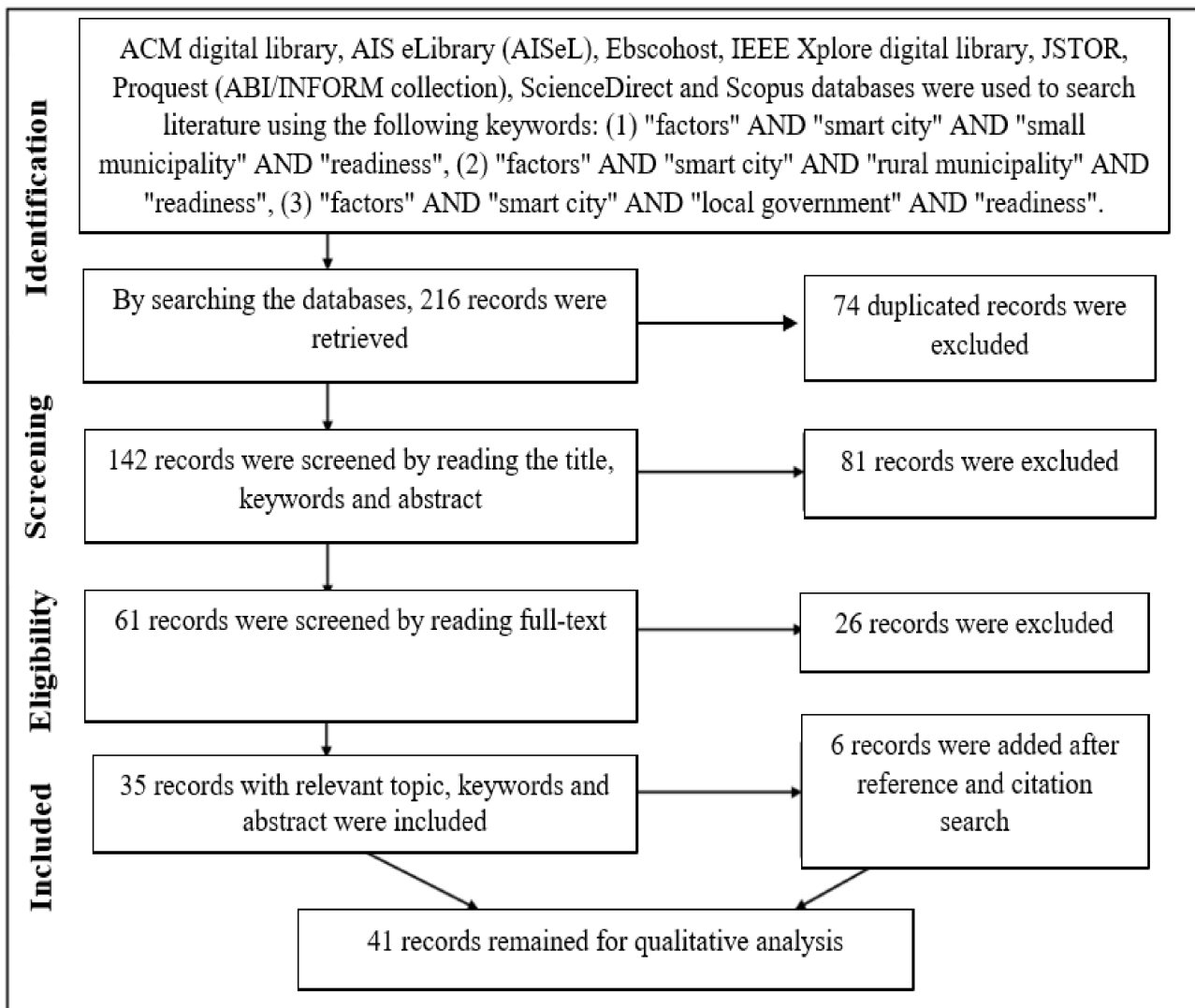| Database Name	Initial Search Results	Final Review Articles
ACM digital library	11	2
AIS eLibrary (AISeL)	31	5
Ebscohost	0	0
IEEE Xplore digital library	2	1
JSTOR	9	3
Proquest (ABI/INFORM collection)	42	7
ScienceDirect	116	16
Scopus	5	1
Forward and backward search results	0	6
Total	216	41

Figure 1. Literature identification diagram.

4. Discussion of the Key Factors to Assess Small and Rural Municipalities' Readiness for Smart City Implementation

As indicated in Section 3, this study conducted a systematic literature review to gain more insight into the topic and to identify significant key factors when assessing small and rural municipalities' readiness. This was achieved by analyzing the literature using ATLAS.ti. Following the review of the final selection of 41 articles, 305 codes were created.

In the literature, a limited number of studies examined the key factors deemed critical when assessing small and rural municipalities' readiness for smart city implementation [8]. Few authors agreed on the indicators or key factors to be used to assess such municipalities [12,20,45]. Alawadhi [2] and Chourabi [21] agreed on eight such indicators. Some scholars identified technology, the environment, policies, governance, organization, people/citizens, infrastructure and management as key factors [2,21], but others emphasized infrastructure, human capital, information, data, culture, social norms, innovation and skills, amongst others [19,23,31]. In addition, some reported that internet connectivity, population size, and household income play important roles in the development of smart cities in small and rural municipalities [14].

This study employed ATLAS.ti to create a network diagram identifying 18 key factors (including "smart city" as the central element, cf. Figure 2) to use as indicators to guide the assessment of small and rural municipalities' readiness for smart city implementa-

tion [4,29]. Technology is generally viewed as a main strategic element for the creation and development of a smart city [34,37,46], but notably, some sources advocate infrastructure as the main strategic element [17,22,47]. Based on the analysis conducted, infrastructure is mentioned most frequently, followed by technology [1,26,32].
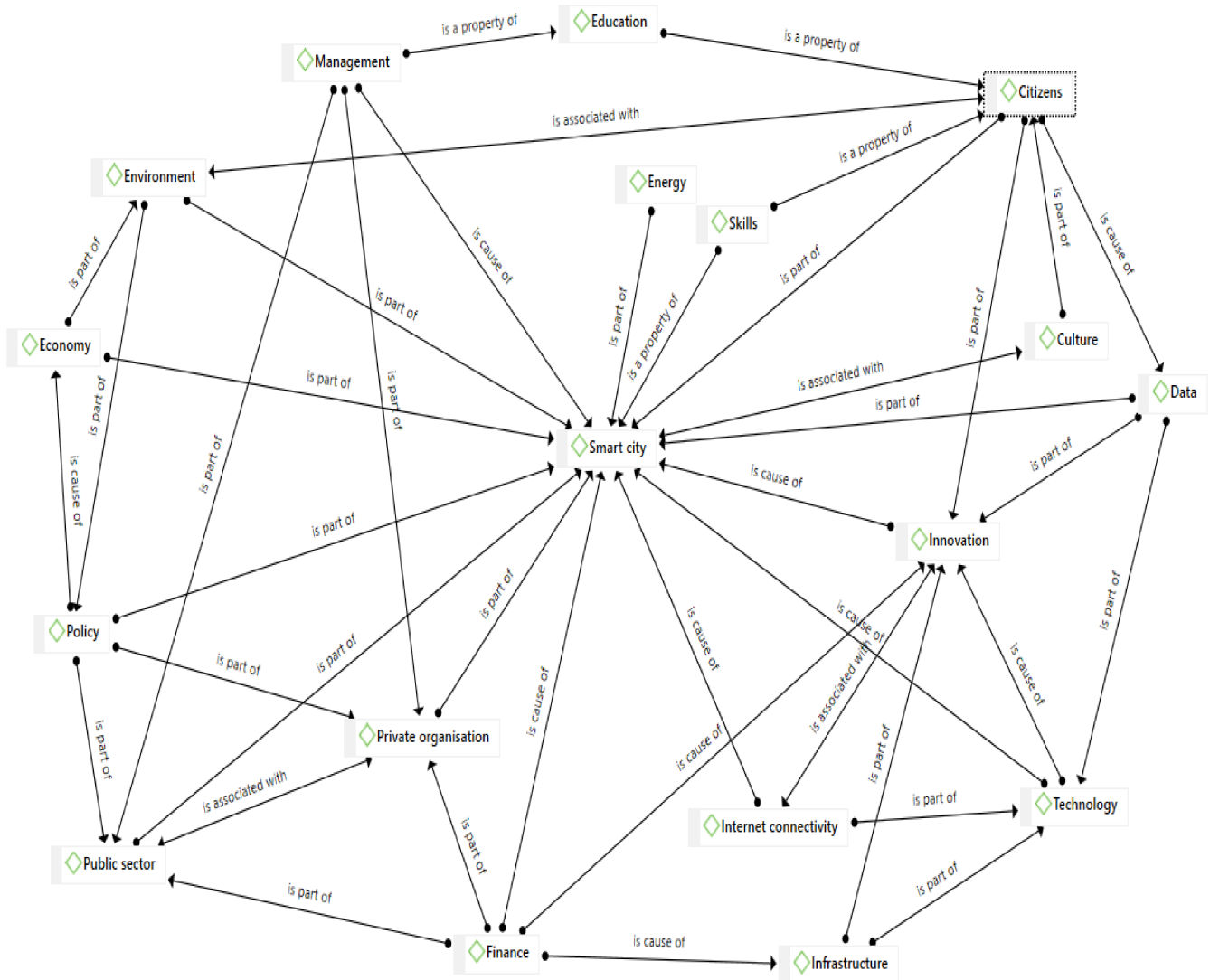

Figure 2. Smart city key factors network diagram.

Infrastructure and technology are interdependent when collecting data from citizens [21]. Thus, citizens should have access to smart devices and know how to operate such devices and technologies, if they are to contribute data to their smart city [27,30,48]. Internet connectivity links technology and infrastructure, and connects municipalities and citizens [3,7,23]. Such connections are envisaged to promote an innovative spirit across and within municipalities [3,40].

To effectively use technology, infrastructure and internet connectivity, municipalities should be financially sound, allocating enough of their budget to procure and improve critical components of a smart city's network [7,23,46]. Without adequate financial resources, it might be challenging to put in place the basic components of a smart city [32,46,49]. Moreover, municipalities must have the committed support of top management, who have to approve the allocation of funds [2,15]. To that end, top management need to build partnerships with both the public and private sectors [6,17,50]. These sectors' contributions to smart city projects can take the form of donations, or they might act as service providers [13,39,49].

Municipality policies should be tailored in a way that supports the development of a smart city [46]. When developing those policies, issues related to energy, public and private participation, budget, procurement and education should be factored in [8,50]. Policies are thus key to the sustained development of any smart city and its economy [5,35].

Figure 2 shows the relationship between the different key factors that can be used to assess small and rural municipalities' readiness for smart implementation. Although Alawadhi [2] and Chourabi [21] insist that technology, the environment, policies, governance, organization, people/citizens, infrastructure and management are the only crucial factors to use as indicators when assessing small and rural municipalities' readiness for smart city implementation, these were not deemed sufficient.

As Figure 2 shows, citizens and public servants should possess certain attributes, if they are to play a valuable role in their municipality realizing the smart city concept. A municipality should ensure that citizens are empowered with the relevant skills and knowledge to contribute meaningfully to their municipality's smart city endeavors. Thus, educated and skilled citizens are an integral part of any municipality's attempts to innovate [31].

Culture, data, the economy, education, the environment, finance, innovation, infrastructure, management, policy and technology were identified as factors that also influence the readiness assessment and realization of the smart city concept. However, infrastructure, technology, education, innovation, policy and management are all dependent on other factors [22,48,49]. Thus, this study did not disregard the other factors listed in Figure 2, since they are key when assessing the readiness of small and rural municipalities. All of these key factors have significant value for the smart city development and implementation.

5. Conclusions

This paper was aimed at identifying the key factors that can be used to assess small and rural municipalities' readiness for smart city implementation. To achieve this purpose, the research reviewed the literature following a systematic literature review approach. Thus, this paper presented the findings of a systematic literature review. The researchers analyzed the coded data to generate a network diagram using ATLAS.ti. In total, 18 key factors (cf. Figure 2) were identified that may be crucial in assessing small and rural municipalities' readiness for smart city implementation.

The identified key factors can serve as a starting point for those small and rural municipalities wishing to assess their readiness to become smart cities. Furthermore, policymakers may use the key factors in this evaluation tool to align their policies with the smart city concept or smart city development. The researchers and municipalities may use these factors as key indicators to assess small and rural municipalities' readiness for smart city implementation.

Although the identified key factors have not yet been validated by experts they can be used in provisional pilot projects to determine how ready small and rural municipalities are. The results of the structured literature review also provide a basis for future research seeking to evaluate the proposed network diagram of smart city key factors through further empirical work. For example, semi-structured interviews can be conducted with strategic role players in municipalities to validate or improve the current version of the diagram.

Conflicts of Interest: The authors declare no conflict of interest.

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