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AN INVESTIGATION INTO THE ELUSIVE CONCEPT OF SMART CITIES: A SYSTEMATIC REVIEW AND META-SYNTHESIS

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Resumo

Despite almost two decades of research, several authors have identified a lack of agreement on the concept of smart cities. In this article, we provide a systematic review and a meta-synthesis analysis of the concept of smart cities. We find that there is convergence in the literature on the following key characteristics of smart cities: a) Advanced ICT Technology; b) Sustainability; c) Innovative and high-skilled society; d) High-tech governance and citizen participation; and, e) Knowledge-based economy. Based on these findings, we suggest a new concept: A smart city is the sustainable utilisation of advanced ICT technologies that improve the governance and the citizen participation of the innovative and high skilled knowledge-driven societies. Our study is a robust effort to understand smart cities and presents a new concept encompassing their five key characteristics that deserve to be further considered in future investigations.

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Abstract
Despite almost two decades of research, several authors have identified a lack of agreement on the concept of smart cities. In this article, we provide a systematic review and a meta-synthesis analysis of the concept of smart cities. We find that there is convergence in the literature on the following key characteristics of smart cities: a) Advanced ICT Technology; b) Sustainability; c) Innovative and high-skilled society; d) High-tech governance and citizen participation; and, e) Knowledge-based economy. Based on these findings, we suggest a new concept: A smart city is the sustainable utilisation of advanced ICT technologies that improve the governance and the citizen participation of the innovative and high skilled knowledge-driven societies. Our study is a robust effort to understand smart cities and presents a new concept encompassing their five key characteristics that deserve to be further considered in future investigations.

Keywords: smart city, systematic review, meta-synthesis

1. Introduction

Many authors point out the potential benefits of information use for city management, especially for efficiency gains (Bulu, 2014; Albino et al., 2015; Belanche-Garcia et al., 2015). The use of information technology has promoted profound social changes, with a significant transformation of large urban centers (Barns et al., 2017). Urban infrastructure has undergone a process of instrumentation by technologies that deliver and analyze complex data in real time, such as the Internet of Things (IoT), autonomous systems, cloud and cognitive computing (Steele, 2017; Mohamed et al., 2018; Krishna et al., 2019). Some studies already point to positive results about infrastructure integration to improve efficiency in urban services (Kumar et al., 2018).

The modernization of Dubai, in 1999, introduced the smart city concept (Anthopoulos, 2017). One of the critical milestones that propelled this city was the Kyoto Protocol in 1997, as it brought new perspectives about modern cities, especially concerning sustainability (Cocchia, 2014). Another critical breakthrough was the Europe 2020 Strategy policy, in 2010, giving prominence to smart cities and smart growth. Since then, there has been a continuous increase in academic interest in the subject, with a significant volume of scientific articles published (Dameri and Cocchia, 2013).

Despite two decades of scientific investigation, the controversy over the definition of what is a smart city remains (Chourabi et al., 2012; Marsal-Llachuna et al., 2015; Schiavone et al., 2019). Several authors point out the complexity of precisely defining the underlying interests of promoting this concept as a generic solution to urban development problems (Caragliu et al., 2011; Datta, 2015).

A consensual aspect regarding the definition of smart cities does not exist, making the following questions of this study relevant. How can a smart city be defined? What are the primary characteristics of a smart city? Answering these questions is the core goal of this article. To answer them, we developed a meta-synthesis of studies that have already done systematic reviews of the of the smart city concept.

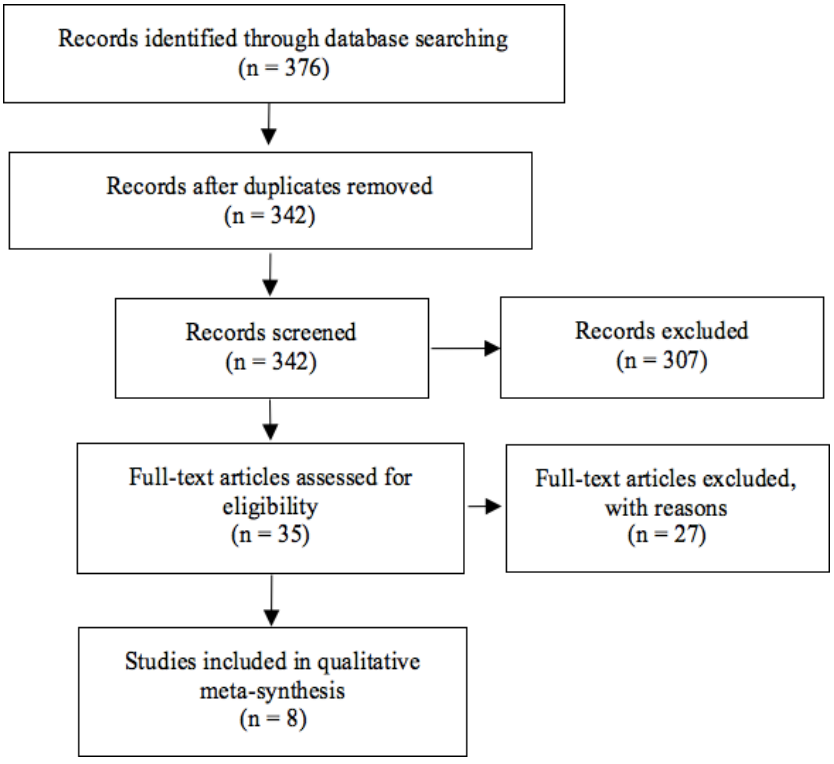
The identification of common aspects in the definitions of smart cities shows that the concept is not as fuzzy as previously stated in the literature. The study clarifies that there are more common points in definitions of smart cities than divergences. In this sense, it contributes to the dissemination of smart cities and to the development of new public policies based on what

is consensual among the researchers, guiding with more precision the action of politicians and decision makers.
Our investigation is presented into five sections, including the introduction. In section 2 we describe the procedures used in the systematic review of literature and meta-synthesis. In section 3 we describe the reviewed studies. Section 4 presents a synthesis and discusses the results while section 5 concludes presenting the main findings and the implications for theory and practice.

2. Materials and Methods

In this research, we do a meta-synthesis based on systematic literature reviews of the smart city concept. We used the systematic review of the literature to select the studies that composed the sample used in meta-synthesis. We elaborate two research questions: "How can a smart city be defined?" and "What are the main characteristics of a smart city?" Our primary goal is to explore the literature in order to establish an integrated concept of a smart city based on the comparison of the systematizations of smart cities definitions done by other well-known and respected researchers. The individual contribution of each study is necessary to merge convergences and divergences on the subject.
Based on the above research questions, we conducted a systematic literature review using the 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses' (The PRISMA Statement, referred to as PRISMA from here on), which ensures transparent and complete reporting (Liberati et al., 2009; Moher et al., 2009; Wray et al., 2018). Despite the emergence of the method in health studies, it has been widely used in systematic literature reviews in the social sciences (Cucciniello et al., 2016; Voorberg et al., 2017; Mergela et al., 2018; Ianiello et al., 2019). Figure 1 shows the research phases of PRISMA procedure in our study.

Figure 1
Flow diagram of the search strategy



Our search comprised the period 1997-2020, which encompasses the beginning of the Kyoto Protocol in 1997, one of the main milestones for the development of smart cities, until 2020. Nonetheless, we have identified significant results for meta-synthesis only from 2015. The identification of the keywords connected to the subjects of the study are as follows. We identified a total of 6 keywords employing a brainstorming process which are “smart cities definition”; “smart cities core components”; “smart cities bibliometric”; “smart cities characteristics”; and, “smart cities perspectives”.

The keywords were combined in order to constitute a series of strings, to be applied in the search on the databases. By combining keywords through simple operators and Boolean logic, complex searches can be constructed in order to avoid too generic and broad results; e.g."smart city AND definition"; "smart cities AND core components"; "smart cities AND bibliometric"; "smart cities AND characteristics"; “smart cities AND systematic literature review"; “smart cities AND perspectives"; as well as derivatives of these terms.

The articles searched for this study are from the following academic databases: Web of Science, Scopus, Elsevier's Science Direct, Oxford Journals, Taylor and Francis and Springer Link databases. The databases were selected because they are known to include theoretical studies and to have been used as sources for other systematic literature reviews related to smart cities (e.g., Mora et al., 2017; Kummitha and Crutzen, 2017; Camboim et al., 2018; Yigitcanlar et al., 2018).

In the initial search, we found 376 peer-reviewed papers. The exclusion criteria were: (1) full-text not available within the selected database; (2) article that was not written in English; and (3) article or review published in a book. Next, we removed duplicate articles remaining 342 articles in our database. Following the guidelines of the conventional systematic review methodology, inclusion criteria were applied to the 342 studies by two researchers. The inclusion criteria for our sample were: (1) publication was a systematic literature review, with defined research questions, search process, data extraction and data presentation; (2) publication was academic and peer reviewed in nature; (3) publication dealt with investigation of smart city concept; (4) the study described keywords and Boolean operators used; (5) reported the databases used. In case of doubt, the researchers included the paper in the sample of what they would read in full.

After the record screen, 35 articles were selected for full-text assessment. We read them in full to see the detailed procedures and findings, checking the inclusion criteria described above. Among the 35 articles, 8 of them were about systematic reviews of the concept of smart cities, and they were used for our meta-synthesis. The selected sample is characterized by the quality of journals that published the articles with nowadays impact factor superior to 2.0; h-index higher than 25; or Scimago Q2 or higher, as can be seen in Table 1.

Meta-synthesis is defined as a qualitative study that uses results of other qualitative studies related to a research topic (Zimmer, 2006). It involves aggregation and interpretation of non-quantitative findings (Finfgeld-Connett, 2010). Several fields of studies use meta-syntheses, such as social sciences, education, and marketing (Siau and Long, 2005; Vrontis et al., 2016). Meta-synthesis has also been used in urban studies (Retzlaff, 2010; Karpouzoglou and Zimmer, 2016; Arafah and Winarso, 2017).

Meta-synthesis is analogous to meta-analysis since it aims to integrate knowledge of several studies (Littell et al., 2008). Meta-analysis is characterized as a quantitative while meta-synthesis uses a qualitative approach. Meta-synthesis does not use vast literature (Noblit and Hare, 1999; Clemmens, 2003). It should be emphasized that in meta-synthesis studies it is more important to observe the quality of sources than quantity. The exclusive selection of articles published in peer-review journals and the transparency of the search process generates a rigorous meta-synthesis study (Walsh and Downe, 2005; Hoon, 2013).

Some examples of methods used to develop meta-syntheses are meta-summaries (Sandelowski

et al., 2007), meta-ethnography (Paterson, 2001), and grounded theory (Kearney, 1998). In this study, we employ the meta-ethnographic one. A meta-ethnographic approach follows the stages proposed by Noblit and Hare (1999) to interpret, translate, and synthesize the literature already systematic reviewed. Our focus is to present existing relationships between studies while preserving and revealing differences between them. Besides, we use content analysis (Krippendorff, 1980; Elo and Kyngäs, 2008) looking for metaphors, phrases, ideas that express the concept of a smart city. Theresults were crossed among the different studies in order to have a holistic understanding of the smart city concept.

3. Description of Studies Reviewed

In this section, we present the results of the literature selected according to the criteria described in the previous section. The selected studies are all systematic literature reviews. Therefore, their results represent the synthesis of characteristics of smart cities concepts found in several studies done by respected researchers.

"Smart Cities: Definitions, dimensions, performance, and initiatives". Albino et al. (2015) conducted an extensive literature review and presented definitions of smart cities divided into two domains: hard domains and soft domains.

(1) Hard domains: based on constructions, energy networks, natural resources, water resources management, urban waste management, mobility, and logistics. In this first group, the use of technology plays a vital role in the more efficient operation of the systems.
(2) Soft domains: focus on education, culture, innovation policies, social inclusion, and government. In this group, the use of technology is not decisive, but it can contribute as an intermediary for the development of efficient relationships.

"What makes a city smart? Identifying core components and proposing an integrative and comprehensive conceptualization". Gil-Garcia et al. (2015) found four essential components in definitions of smart cities:

(1) Environment: characterised by natural environment/sustainability and infrastructure of the city.
(2) Society: described by a knowledge-based economy and environment favours business; human capital and creativity; governance, engagement, and collaboration.
(3) Government: understood by institutional arrangements; management and administration of the city; and public services.
(4) Technology/data: communication and information technologies; orientation for data and information.

"Smart sustainable cities of the future: An extensive interdisciplinary literature review". Bibri and Krogstie (2017) have identified two mainstream approaches to smart cities:

(1) The technology and ICT-oriented approach: focus on the efficiency and advancement of hard infrastructure and technology (transport, energy, communication, waste, water) through ICT.
(2) The people-oriented approach: focus on the soft infrastructure and people, i.e., social and human capital in terms of knowledge, participation, equity, safety, and so forth.

Table 1
Eight studies included in our meta-synthesis

ID	Author	Date	Topic Area	Database consulted	Studies reviewed	Citations
S1	Albino et al.	2015	Smart city definition and measurement	Academic databases.	82	1620
S2	Gil-Garcia et al.	2015	Core components	Academic databases and Google Scholar	209	199
S3	Bibri and Krogstie	2017	Sustainability	Academic databases and Google Scholar	187	402
S4	Mora et al.	2017	Bibliometric study of smart cities scientific production	Google Scholar; ISI Web of Science; IEEE Xplore; Scopus; SpringerLink; Engineering Village; ScienceDirect; and Taylor and Francis Online	1067	155
S5	Kummitha and Crutzen	2017	Smart city definition	Wiley online library, the Oxford Journals database, Taylor and Francis, Springer Link, Scopus, Sage, and Elsevier's ScienceDirect	161	191
S6	Camboim et al.	2018	Creativity and innovation	Web of Science and Scopus Elsevier	110	21
S7	Yigitcanlar et al.	2018	Drivers of smart cities	Three hundred ninety three different databases, including ScienceDirect, Scopus, Web of Science, Wiley online library, a Directory of open access journals.	78	117
S8	Ismagilova et al.	2019	Information System	Journals listed in the 'Information Management' category of the Academic Journal Guide 2018	104	119

"The first two decades of smart-city research: a bibliometric analysis". Mora et al. (2017) carried out a bibliometric study and proposed a network analysis. They got the identification of two main groups: one group called holistic, and another called technocentric:

(1) Holistic group: characterised by a balanced view of human, social, cultural, economic, environmental, and technological aspects. The main link in this group was provided by the work of Giffinger et al. (2007), and other well-quoted works support it in smart cities literature (Hollands, 2008; Caragliu et al., 2011; Schaffers et al., 2011). This group is also characterised by a network of contacts between documents collected, providing evidence on the exchange of knowledge among related researchers.
(2) Technocentric group: characterised by providing a technological vision of smart cities, composed of documents disconnected from each other.

"How do we understand smart cities? An evolutionary perspective". Kummitha and Crutzen (2017) based on the results of the literature review proposed a division of studies on smart cities into four schools:

(1) Restrictive school: it presents a high relevance of technological and low human aspects. The focus of this school is primarily on the technology used to operationalize a smart city, mainly on integrating ICT devices, connectivity, and data production (Calzada and Cobo, 2015).
(2) Reflective school: it proposes a more significant interaction between human and technological aspects in smart cities. For the authors of this school, technology stimulates human capacity and knowledge, contributing to social improvement in a locality. Technology plays a role in enhancing citizens' ability to innovate and take part in solving the city's social problems.
(3) Rational or pragmatic school: it is based on the belief that the development of intelligent communities characterises a smart city. Local communities' capabilities drive a smart city concept. Thus, factors such as education, social learning, and human capital are fundamental aspects of smart city characterisation. These capabilities mediate human interactions and technology. Also, the role of citizens in the design, construction, and maintenance of smart cities is emphasised. In this context, the creation of new democratic governance structures and processes is essential to empower citizens and communities to give intelligence to cities.
(4) Critical school: it does not have a clear definition of what a smart city is. Despite this, authors point out imperfections and gaps in definitions and beliefs of other schools. They criticise the imprecision of what characterises a smart city, with several cities around the world self-proclaiming their intelligence without having human or technological conditions for it (Bunnell, 2015).

"Driving elements to make cities smarter: Evidence from European projects". Camboim et al. (2018) identified in literature four smart cities dimensions:

(1) Governance dimension: focus on collaboration between the different stakeholders that actively participate in a collective decision-making process to make or implement public policy or manage public programs or assets.
(2) Environmental-urban dimension: related to the built infrastructure, mobility, urban design, facilities and amenities, and natural environment.
(3) Socio-institutional dimension: related to diversity and plurality, civic engagement and social cohesion, and normative-legal framework. This dimension encompasses both formal (i.e., rules, laws and municipal ordinances) and informal institutions (i.e., partnerships, negotiations, networks) that are arranged to solve problems, enforce rules, or allocate resources.

(4) Techno-economic dimension: considers the dynamics of the knowledge economy. This dimension comprehends all aspects that can foster innovation and entrepreneurship activities in a "glocal" perspective.

"Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework". Yigitcanlar et al. (2018) present five domain-orientation to deal with the concept of smart cities:

(1) Technology: according to this domain smart cities are viewed predominantly by techno-centric urbanisation, and in several studies, it has recognised the contribution of technology to improve the functioning of urban systems.
(2) Economy: studies are related to smart cities policies and better public economic performance. Besides, highlighting the role of new creatures, which are not only innovative technologies but also the professional knowledge of their development.
(3) Society: the authors highlight the need to overcome the risks of social exclusion and gentrification. In this sense, the proposed solution concerns the incorporation of local actors and communities in the process of developing smart cities.
(4) Environment: there is a lack of empirical evidence in studies regarding the benefits of smart cities to the environment and sustainability and they show the negative impacts of developed smart city projects. To solve the environmental problems of smart cities, the authors suggest the inclusion of the citizen with the role of seeking forms of urban development with an emphasis on environmental protection.
(5) Governance: authors present the criticisms of the top-down model prevalent in Asian countries. As a solution, they point to the triple-helix model, emphasising the collaboration between the actors (universities, government, and business) as a critical element for the promotion of participatory governance and the expansion of the use of new technologies.

"Smart cities: Advances in research - An information systems perspective". Ismgilova et al., (2019) identified in literature four different emphases regarding the definitions of smart cities:

(1) Technology: according to the authors, most definitions of smart cities highlight the technological aspects, including the use of smart hardware devices. Technology helps to enable social, environmental, economic and cultural progress.
(2) Citizens: based on smart inhabitants, educational degree, quality of social interaction, integration with public life and openness to the broader world.
(3) Management and operational: definitions that are based on the improvement of city management and governance using intelligent technologies.
(4) Well-being and sustainability: in these definitions, the balance between the economic needs and the quality of life, recognised among other points for the sustainable development of the cities, is explicit.

Considering all the above works, we have identified two approaches regarding the systematization of definitions regarding smart cities. The first approach is the identification of smart cities characteristics, synthesizing what is familiar and recurrent in definitions presented in the literature. The second approach is to classify definitions, agglutinating concepts of smart cities according to conventional patterns. We discuss these two approaches in the following item.

4. Discussion

After analyzing the results of each article in the sample, we sought to translate concepts found among them. The identified characteristics in the previous section were compared in pairs to

analyze a correspondence between the results found in different studies. We call studies A, G, B, M, K, C, Y, which refer to the studies of Albino et al. (2015), Gil-Garcia et al. (2015), Bibri and Krogstie (2017), Mora et al. (2017), Kummithaand Crutzen (2017), Camboim et al. (2018), Yigitcanlar et al. (2018), and Ismgilova et al. (2019), respectively.

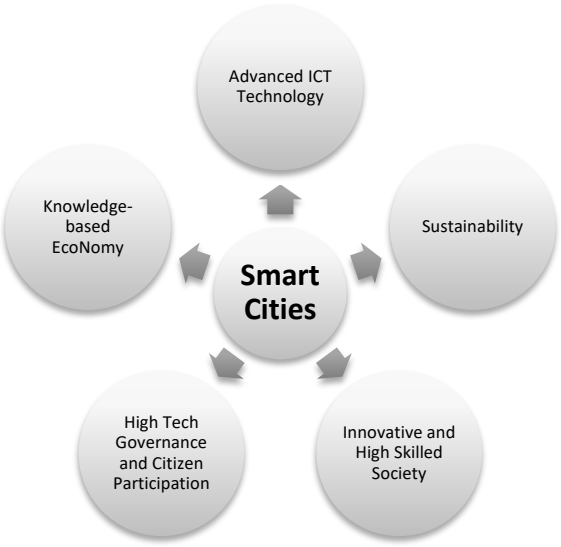
The number following the letter (e.g., A, G, B, M, K, C, Y, and I) represents a characteristic identified in the concept presented by the authors, as summarized in section 1.3. For example, A1 refers to the characteristic "Hard Domain" and "↔" denotes an analogous relationship between variables. For example, A1↔ B1 means the first characteristic identified by Albino et al. (2015) corresponds to the first characteristic identified by Bibri and Krogstie (2017); NULL means no matching of a characteristic in other studies. Table 2 shows the correspondence obtained in the comparison of the systematic literature review studies.

Through the reading of the selected papers, it was possible to see the homogeneity of the group of studies that proposed the characteristics identification. We were able to identify in the results presented in a logical form (technology, environment/sustainability, society/citizens, governance, and economy) and in a synthetic form (hard domains and soft domains). Regarding the divergences, only the critical school category (K4) was not represented in other studies. This category was used by Kummitha and Crutzen (2017) to group authors who did not propose new definitions for smart cities but criticized existing ones.

Despite the criticism about the lack of consensus on the definition of a smart city or even ifit is a fuzzy concept, we found that there is a convergence toward five characteristics, as summarized in Figure 2: a) Advanced ICT Technology; b) Sustainability; c) Innovative and high skilled society; d) High Tech Governance and Citizen Participation; e) Knowledge-based economy. A brief discussion of the five convergent characteristics of the definitions found is presented following the figure.

Figure 2

Five common characteristics in smart cities definitions



Linking of existing urban infrastructure (housing, transport, ports, roads) to new intelligent technologies such as Internet of Things (IoT) and 5G networks to enable the provision of information in real time, given more economical and political efficiency (Caragliu et al., 2011; Bibri and Krogstie, 2017; Mora et al., 2017; Yigitcanlar et al., 2018; Ismgilova et al., 2019). One of the most used examples to illustrate this feature is the city of Songdo (South Korea), which has implemented an extensive network of sensors in the infrastructure, and several

urban operating systems to manage transportation, buildings, public lighting, and other aspects of urban life (Carvalho, 2015).

The characteristic sustainability show concerns about the balance between conservation and development (Yitigcanlar and Lee, 2014; Camboim et al.,2018; Ismgilova et al., 2019). The central aspects are an efficient use of energy, new mobility patterns, re-scheduling of spatial scales at the municipal level, and the establishment of environmentally friendly agreements. However, these goals have been criticised for lack of transparency on their results (Calzada and Cobo, 2015; Yigitcanlar et al., 2018), even in smart cities created with these purposes, such as Masdar in the United Arab Emirates. Yigitcanlar et al. (2018) point to the lack of evidence of the smart city contribution to sustainability, which is an important research agenda related to this dimension.

In relation to "Innovative and high skilled society", a city is smart if it has a community that has learned to learn, adapt and innovate (Coe et al., 2001; Gil-Garcia et al., 2015; Bibri and Krogstie, 2017). To enjoy technologies, people need to develop the knowledge and skills necessary to use them. Therefore, the absorption capacity of technology determines the smart city success (Caragliu et al., 2011). In this sense, more recent research is seeking to answer which skills are essential for citizens of smart cities (Zait, 2017).

The governance domain in the definitions of smart cities addresses aspects such as the use of intelligent technologies (i.e., Internet-of-Things and Artificial Intelligence) to improve public management (Camboim et al., 2018; Yigitcanlar et al., 2018; Ismagilova et al., 2019). In addition, the authors alluding to this domain promote the discussion based on models or perspectives such as the triple-helix to drive collaboration between several stakeholders (Leydesdorff and Deakin, 2011; Gil-Garcia et al., 2015; Meijer and Bolívar, 2016; Camboim et al., 2018; Yigitcanlar et al., 2018).

Finally, smart cities also distinguish by presenting communications infrastructure, and a political-economic environment conducive to the development of high-value-added businesses (Hollands, 2008; Gil-Garcia et al., 2015; Camboim et al., 2018; Yigitcanlar et al., 2018). An example that illustrates this feature is the city of Edmonton in Canada, which promoted the design of an environment geared to attract new business, especially in sectors that use or develop advanced technologies such as information and biotechnology sectors (Hollands, 2008).

5. Future research studies

The study has made it possible to identify the literature gaps that could potentially be addressed by future research. In relation to "Advanced ICT Technology", it is possible to mention the gaps related to the following subjects: improvement of cybersecurity and data privacy, identifying the most effective technologies for smart cities, risks of corporate path dependency, and technical aspects related to best practices for data exchange, processing and storage standards (Kummitha and Crutzen, 2017; Yigitcanlar et al., 2018; Ismgilova et al., 2019).

In relation to "Innovative and high skilled society", the contribution of the higher education centers and skilled labor to the smart city's development have been identified as the greatest challenges. By adopting this perspective, it is possible to analyze the smart cities implementation based on a bottom-up view, in other words, human capital based (Albino et al., 2015; Kummitha and Crutzen, 2017). In addition, indicators should be identified in future studies to describe how advanced a smart city is in relation to this feature.

These aspects are also associated with research gaps related to "Knowledge-based economy". Among the research challenges is the clarification of the role of intangible capital growth in smart cities (Gil-Garcia et al., 2015; Kummitha and Crutzen, 2017; and, Yigitcanlar et al., 2018).

Table 2.
Comparison of systematic literature reviews of smart cities definitions.

	Albino *et al.* (2015)	Gil-Garcia *et al.* (2015)	Bibri and Krogstie (2017)	Mora *et al.* (2017)	Kummitha and Crutzen (2017)	Camboim *et al.* (2018)	Yigitcanlar *et al.* (2018)	Ismgilova *et al.* (2019)
Albino *et al.* (2015)								
Gil-Garcia *et al.* (2015)	G1,G4 ↔ A1 G2,G3 ↔ A2							
Bibri and Krogstie (2017)	B1 ↔ A1 B2 ↔ A2	B1 ↔ G1,G4 B2 ↔ G2,G3						
Mora *et al.* (2017)	M1 ↔ A2 M2 ↔ A1	M1 ↔ G, G3 M2 ↔ G1, G4	M1 ↔ B2 M2 ↔ B1					
Kummitha and Crutzen (2017)	K1 ↔ A1 K2, K3 ↔ A2 K4 ↔ NULL	K1 ↔ G4 K2,K3 ↔ G2,G3 K4 ↔ NULL NULL ↔ G1	K1 ↔ B1 K2, K3 ↔ B2 K4 ↔ NULL	K1 ↔ M1 K2, K3 ↔ M2 K4 ↔ NULL				
Camboim *et al.* (2018)	C1,C3 ↔ A2 C2, C4 ↔ A1	C1 ↔ G3 C2 ↔ G1 C3 ↔ G2 C4 ↔ G4	C1,C3 ↔ B2 C2,C4 ↔ B1	C1,C2,C3 ↔ M1 C4 ↔ M2	C1,C2,C3 ↔ K2,K3 C4 ↔ K1 NULL ↔ K4			
Yigitcanlar *et al.* (2018)	Y1, Y4 ↔ A1 Y2, Y3, Y5 ↔ A2	Y1 ↔ G4 Y2, Y3 ↔ G2 Y4 ↔ G1 Y5 ↔ G3	Y1, Y4 ↔ B1 Y2,Y3,Y4 ↔ B2	Y1 ↔ M2 Y2,Y3,Y4,Y5 ↔ M1	Y1 ↔ K1 Y2,Y3,Y4,Y5↔K2, K3 NULL ↔ K4	Y1, Y2 ↔ C4 Y3 ↔ C3 Y4 ↔ C2 Y5 ↔ C1		
Ismgilova *et al.* (2019)	I1, I4 ↔ A1 I2, I3 ↔ A2	I1 ↔ G4 I2 ↔ G2 I3 ↔G3 I4 ↔ G1	I1 ↔ B1 I2,I3,I4 ↔ B2	I1 ↔ M2 I2,I3,I4 ↔ M1	I1 ↔ K1 I2,I3,I4 ↔ K2,K3 NULL ↔ K4	I1 ↔ C4 I2 ↔ C3 I3 ↔ C1 I4 ↔ C2	I1 ↔ Y1 I2 ↔ Y3 I3 ↔ Y5 I4 ↔ Y4, Y2	

Finally, we found out research gaps concerned to the ethical aspects data-driven management, the analysis of the users perception in relation to the technologies used in smart cities, the engagement of citizens in the governance of smart cities, and clarification of open data and open government benefits (Camboim et al., 2018).

6. Conclusions

We have developed a systematic review of the literature on the smart city concept and meta-synthesis. The primary aim was to identify an integrated definition of this construct. The results show a confluence around two main categories despite a variety of existing definitions, first dealing with technological and second with human and community aspects. We highlight that no absolute incompatibility was found between these two categories.

Our study analyzed the results of a systematic literature review on smart city concepts proposed for several authors. For instance, some of these articles used in our investigation explored more than a thousand references in their systematic literature review. The sample used contemplates production over smart cities of the last 20 years. In this sense, the meta-synthesis results represent a robust effort to understand the smart city concept precisely.

Our findings show that the authors who have carried out systematic literature reviews on the subject have found more convergences on the concept than divergences. Moreover, our meta-synthesis attests the applicability and utility of this kind of analysis to solve problems of conceptual dispersion. The effort to synthesize the overlaps found in the reviewed studies made it possible to propose a new concept based on five characteristics used to define a smart city (advanced ICT technology, sustainability, innovative and high skilled society, high tech governance and citizen participation, knowledge-based economy).

Based on the results and insights of this study, we define which smart city is “the sustainable utilization of advanced ICT technologies that improve the governance and the citizen participation of the innovative and high skilled knowledge-driven societies”. This concept encompasses previous definitions provided by respected researchers in the field and can be used in future studies. Those five characteristics found out from previous studies related to the definitions of smart cities deserves, as already pointed out to be further investigated. Our findings contribute to the literature on smart cities in the academic as well as in a managerial sense. For the academic community it presents a new, modern and well research concept of smart city. For managers and public policy makers it contributes systematizing the main characteristics of smart cities that deserves not only be further studied by taken into account in the day by day activities of the implementation of smart cities.

References

Albino, V., Berardi, U., and Dangelico, R. M. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology*, 22(1), 3–21.

Anthopoulos, L. G. (2017). Understanding Smart Cities: A tool for smart government or an industrial trick? (Vol. 22). Cham: Springer International Publishing.

Arafah, Y., and Winarso, H. (2017). Redefining smart city concept with resilience approach. *In: IOP Conference Series: Earth and Environmental Science*, 70(1).

Barns, S., Cosgrave, E., Acuto, M., and Mcneill, D. (2017). Digital infrastructures and urban governance. *Urban Policy and Research*, 35(1), 20-31.

Belanche-Gracia, D., Casaló-Ariño, L. V., and Pérez-Rueda, A. (2015). Determinants of multi-service smartcard success for smart cities development: A study based on citizens’ privacy and security perceptions. *Government Information Quarterly*, 32(2), pp.154–163.

Bibri, S. E., and Krogstie, J. (2017). Smart sustainable cities of the future: An extensive interdisciplinary literature review. *Sustainable Cities and Society*, 31, 183–212.

Bulu, M. (2014). Upgrading a city via technology. *Technological Forecasting & Social Change*, 89, pp.63–67.

Bunnell, T. (2015). Smart city returns. *Dialogues in Human Geography*, 5(1), pp.45–48.

Calzada, I., & Cobo, C. (2015). Unplugging: Deconstructing the smart city. *Journal of Urban Technology*, 22(1), 23-43.

Camboim, G. F., Zawislak, P. A., & Pufal, N. A. (2019). Driving elements to make cities smarter: Evidences from European projects. *Technological Forecasting and Social Change*, 142, 154-167.

Caragliu, A., Del Bo, C., and Nijkamp, P. (2011). Smart Cities in Europe. *Journal of Urban Technology*, 18(2), 65–82.

Carvalho, L. (2015). Smart cities from scratch? A socio-technical perspective. *Cambridge Journal of Regions, Economy and Society*, *8*(1), 43–60.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., ... and Scholl, H. J. (2012). Understanding smart cities: An integrative framework. In *2012 45th Hawaii international conference on system sciences* (pp. 2289-2297). IEEE.

Clemmens, D. (2003). Adolescent motherhood: a meta-synthesis of qualitative studies. *MCN: The American Journal of Maternal/Child Nursing*, *28*(2), 93-99.

Cocchia, A. (2014). Smart and Digital City: A systematic literature review. In R. Dameri and C. Rosenthal-Sabroux (Eds.). *Smart City - How to Create Public and Economic Value with High Technology in Urban Space* (VII, chapter 2, pp. 13–43). Berlin: Springer.

Coe, A., Paquet, G., and Roy, J. (2001). E-Government and Smart Communities: A Social Learning Challenge. *Social Science Computer Review*, 19(1), 80–93.

Dameri, R. P., and Cocchia, A. (2013). Smart City and Digital City: Twenty Years of Terminology Evolution. *In:X Conference of the Italian Chapter of AIS, ITAIS 2013*, 1–8.

Datta, A., 2015. A 100 smart cities, a 100 utopias. *Dialogues in Human Geography*, 5(1), 49–53.

Elo, S., and Kyngäs, H. (2008). The qualitative content analysis process. *Journal of advanced nursing*, 62(1), 107-115.

Finfgeld-Connett, D. (2010). Generalizability and transferability of meta-synthesis research findings. *Journal of Advanced Nursing*, 66(2), 246–254.

Giffinger, R., Fertner, C., Kramar, H., & Meijers, E. (2007). City-ranking of European medium-sized cities. Cent. Reg. Sci. Vienna UT, 1-12.

Gil-Garcia, J. R., Pardo, T. A., and Nam, T. (2015). What makes a city smart? Identifying core components and proposing an integrative and comprehensive conceptualization. *Information Polity*, 20(1), 61–87.

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, *12*(3), 303–320.

Hoon, C. (2013). Meta-Synthesis of Qualitative Case Studies: An Approach to Theory Building. *Organizational Research Methods*, 16(4), 522–556.

Ismagilova, E., Hughes, L., Dwivedi, Y. K., and Raman, K. R. (2019). Smart cities: Advances in research—An information systems perspective. *International Journal of Information Management*, *47*, 88–100.

Karpouzoglou, T., and Zimmer, A. (2016). Ways of knowing the waste waterscape: Urban political ecology and the politics of wastewater in Delhi, India. *Habitat International*, 54, pp.150–160.

Kearney, M. H. (1998). Ready-to-wear: discovering grounded formal theory. *Research in Nursing and Health*, 21(2), 179–186.

Krippendorff, K. (1980). *Content analysis*. Beverly Hills: Sage Publications.

Krishna, R., Kummitha, R., & Crutzen, N. (2019). Smart cities and the citizen-driven internet of things: A qualitative inquiry into an emerging smart city. *Technological Forecasting & Social Change*, 140 (May 2018), 44–53.

Kumar, H., Singh, M. K., Gupta, M. P., & Madaan, J. (2018). Moving towards smart cities: Solutions that lead to the Smart City Transformation Framework. *Technological Forecasting & Social Change*, (April), 1–16.

Kummitha, R., and Crutzen, N. (2017). How do we understand smart cities? An evolutionary perspective. *Cities*, 67(May), 43–52.

Leydesdorff, L., and Deakin, M. (2011). The Triple-Helix Model of Smart Cities: A Neo-Evolutionary Perspective. *Journal of Urban Technology*, *18*(2), 53–63.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Journal of clinical epidemiology, 62(10), e1-e34.

Littell, J. H., Corcoran, J., and Pillai, V. (2008). *Systematic reviews and meta-analysis*. Oxford University Press.

Marsal-Llacuna, M., Colomer-Llinàs, J., and Meléndez-Frigola, J. (2015). Lessons in urban monitoring taken from sustainable and livable cities to better address the Smart Cities initiative. *Technological Forecasting & Social Change*, 90, 611–622.

Meijer, A., and Bolívar, M. P. R. (2016). Governing the smart city: a review of the literature on smart urban governance. *International Review of Administrative Sciences*, *82*(2), 392–408.

Mergela, I., Gongb, Y., & Bertot, J. (2018). Agile government: Systematic literature review and future research. *Government Information Quarterly*, 35(2), 291–298.

Mohamed, N., Al-jaroodi, J., Jawhar, I., Idries, A., & Mohammed, F. (2018). Unmanned aerial vehicles applications in future smart cities. *Technological Forecasting & Social Change*, (May), 0–1.

Moher, D., Liberati, A., Tetzlaff, J., and Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of Internal Medicine*, *151*(4), 264–269.

Mora, L., Bolici, R., and Deakin, M. (2017). The First Two Decades of Smart-City Research: A Bibliometric Analysis. *Journal of Urban Technology*, 24(1), 3–27.

Noblit, G, and Hare, D. (1999). *Meta-Ethnography: Synthesizing Qualitative Studies*. Beverly Hills: Sage.

Paterson, B. L., Thorne, S. E., Canam, C., and Jillings, C. (2001). *Meta-study of qualitative health research: A practical guide to meta-analysis and meta-synthesis* (Vol. 3). Beverly Hills: Sage.

Retzlaff, R. (2010). Developing policies for green buildings: What can the United States learn from the Netherlands? *Sustainability: Science, Practice, and Policy*, 6(1), pp.28– 38.

Sandelowski, M., Barroso, J., and Voils, C. (2007). Using Qualitative Meta summary to Synthesize Qualitative and Quantitative Descriptive Findings. *Research in nursing and health*, 30, pp.99–111.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., and Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. *The future internet assembly* (pp. 431-446). Berlin: Springer.

Schiavone, F., Paolone, F., & Mancini, D. (2019). Business model innovation for urban smartization. *Technological Forecasting and Social Change*, 142, 210-219.

Siau, K., and Long, Y. (2005). Synthesizing e-government stage models - A meta-synthesis based on meta-ethnography approach. *Industrial Management and Data Systems*, 105(4), 443–458.

Steele, W. E. *et al.* (2017). What's Critical about Critical Infrastructure? What's Critical about Critical Infrastructure? *Urban Policy and Research*, 1146(March), pp.1–13.

Voorberg, W. H., Bekkers, V. J. J. M., Tummers, L. G. (2017). A Systematic Review of Co-Creation and Co-Production: Embarking on the social innovation journey. *Public Management Review*, 17(9), 1333–1357.

Vrontis, D., Thrassou, A., and Amirkhanpour, M. (2016). B2C smart retailing: A consumer-focused value-based analysis of interactions and synergies. *Technological Forecasting & Social Change*, 124, 271-282.

Walsh, D., and Downe, S. (2005). Meta-synthesis method for qualitative research: a literature review. *Journal of advanced nursing*, *50*(2), 204-211.

Wray, A., Olstad, D. L., & Minaker, L. M. (2018). Smart prevention: A new approach to primary and secondary cancer prevention in smart and connected communities. *Cities*, 79, 53–69.

Yigitcanlar, T., Kamruzzaman, M., Buys, L., Ioppolo, G., Sabatini-Marques, J., da Costa, M., and Yun, J. J. (2018). Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework. *Cities*, *81*, 145–160.
Yigitcanlar, T., and Lee, S. H. (2014). Korean ubiquitous-eco-city: A smart-sustainable urban form or a branding hoax? *Technological Forecasting & Social Change*, 89, 100–114.

Zait, A. (2017). Exploring the role of civilizational competences for smart cities' development. *Transforming Government: People, Process and Policy*, 11(3), pp.377– 392.

Zimmer, L. (2006). Qualitative meta-synthesis: A question of dialoguing with texts. *Journal of Advanced Nursing*, 53(3), 311–318.