Smart City Research Between 1997 and 2020: A Systematic Literature Review

Souad El Hilali and Ahmed Azougagh

Abstract Smart city has been a subject of great interest in research and practice. Since its first appearance in early 1998, the Smart City concept is still unclear in terms of context and perspective. The aim of this article is to track the evolution of this emergent field of research between 1997 and 2020 through a systematic literature review based on the Theory method.

Keywords Smart City research · Systematic literature review · Grounded theory · Evolutionary perspective

1 Introduction

The economic development and the technological advances of the second half of the twentieth century have contributed to the promotion of urban development. Thus, it has led to a rural migration of the population to cities that can offer their inhabitants more opportunities for work, education, quality of life, etc. [1–3]. Similarly, according to Florida [4] and Kourtit [5], current trends indicate the third revolution in urban development. Cities are no longer only clusters of inhabitants but generators of creative and innovative potential. However, this rapid growth of the last thirty years has resulted in many challenges related to limited resources, pollution and, social inequalities. Therefore, there is a need for more innovative management of cities [6, 7]. Several approaches can be considered to address these challenges. Some approaches rely on the use of information and communication technologies [8, 9]. Other approaches rely on human capital including learning, creativity, cooperation among relevant actors, and the generation of new knowledge [10, 11]. Cities that have succeeded in addressing these challenges in a smart and innovative way have achieved the label of "Smart City". This concept is gaining

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growing attention from academics and practitioners becoming the new paradigm of smart and innovative urban development [12].

This article presents a systematic literature review on the smart city. The systematic literature review is based on Grounded Theory method. The objective of our literature review is to analyze the existing literature and to see how it has evolved over the last decades to contribute to the advancement of knowledge in this field. We expect that this literature review—which aims to cover a large part of the literature—will bring out relevant concepts and eventually research questions.

2 Method

2.1 A Systematic Literature Review

The art and science of gathering information from primary data is a very critical but often unaddressed area of research. Systematic literature reviews are an indispensable tool in today's research practice. According to Tranfield [13], they differ from narrative reviews by their use of a scientific, transparent, and replicable process. These literature reviews make it possible to reduce bias through an in-depth search of the various studies undertaken on a particular subject. These types of reviews, being well structured and probative, give users confidence and are a source of information about the evolution of knowledge on a given subject [14]. Systematic literature reviews do not provide answers but they do record what is known and what is not known concerning the research question [15]. In this article, we will apply a systematic and rigorous approach to conduct a literature review using Grounded Theory [16] as an analysis process.

2.2 Grounded Theory Approach for Reviewing Literature

Grounded Theory. Grounded theory was founded by the two sociologists Glaser and Strauss in 1996 in American hospitals as a result of their experience with near-death patients [13]. The main question the two authors asked was: how to generate a theory from data collected and analyzed in a rigorous manner. The goal of a grounded theory approach is to generate theories. In other words, a researcher who adopts a grounded theory approach is guided by data.

Grounded theory is based on data. Data may be empirical or theoretical. In fact, grounded theory can be used in conducting literature reviews as a method of analysis. The use of this method in literature reviews consists of searching, selecting, analyzing, and presenting data from the literature in a rigorous manner in order to highlight a concept or develop new theories. There are two schools of thought in grounded theory, the Glaserian school [14] and the Straussian school [15] which gave rise to the Charmazian grounded theory [16] after an epistemological break from positivism to constructivism. We will adopt the Straussian school of thought to evoke grounded theory in systematic literature reviews.

Table 1 Five stage approach for reviewing literature

Stages	Steps
1. Definition	• Defining inclusion and exclusion criteria • Identifying research areas • Finding the relevant sources • Choosing the keywords
2. Research	• Searching the bibliographic references in the different sources
3. Selection	• Refine the document sample
4. Analysis	• Open coding • Axial coding • Selective coding
5. Presentation	• Present and structure the content

Five Stage Approach for Reviewing Literature. The purpose of using a Grounded Theory approach to the literature review is to achieve a substantive and theoretically relevant analysis of the topic at hand. Many good reviews have used a similar approach, largely in a tacit way. The Grounded theory method of literature analysis has five steps and is iterative in nature. In the first "Definition" step, four steps are taken to identify the most appropriate data set. It is only in the second "Research" step that the research studies are actually conducted. The third "Selection" step refines the sample of studies to be examined. The fourth "Analysis" step shows how qualitative research methods, based on Grounded Theory, obtain real value from the selected studies. The fifth step, "Presentation", includes the two key steps of writing a coherent synthesis document, which should show not only the results and insights obtained but also the main decisions made during the literature review process (Table 1).

3 Results

3.1 Definition

Inclusion and Exclusion Criteria. Since the concept of "smart city" is an emerging concept, we are interested in all existing literature on the subject. The articles included in the review must contain the word "Smart City" or "Smart Cities" in their abstract and/or in their full text. Both conceptual and empirical researches related to the smart city were included. Hence, articles that mention the word smart city without treating it in their content are excluded. Furthermore, the literature analyzed is essentially Anglo-Saxon with a limited number of French references given the abundance of Anglo-Saxon literature compared to French literature. The literature also includes grey literature sub-subject to intellectual property rules. The articles taken into account must contain the definition of the smart city. The period considered is between 1997, the year in which the concept

Table 2 Stages of the systematic literature review based on Grounded Theory

	Inclusion criteria	Exclusion criteria
Topic	Documents containing the word "Smart City" or "Smart Cities"	Other documents not containing "Smart City" or "Smart Cities" in their text
Type of study	Conceptual and empirical studies	–
Language	English and French	Other languages
Document types	Peer-reviewed articles and grey literature	–
Content of the documents	Definition of "Smart City"	Any other document that does not address the subject in its content
Publication period	1997–2020	–

was born, and 2020. The choice of this period aims to integrate all the existing literature about the smart city to track its evolution. Table 2 summarizes the inclusion and exclusion criteria considered.

Identification of the Research Area. The concept of the smart city is a multi-disciplinary one and is of interest to researchers from different disciplines (Architecture, Urban Planning, Geography, Data Science, Economic and Management Sciences). We are mainly interested in research that falls within the framework of economic and management sciences.

Based on the results of the Web of Science database 2020, we have identified all the disciplines and sub-disciplines in which Smart City research is being conducted. Smart city research is dominated by the Information and Communication Technology (ICT) fields.

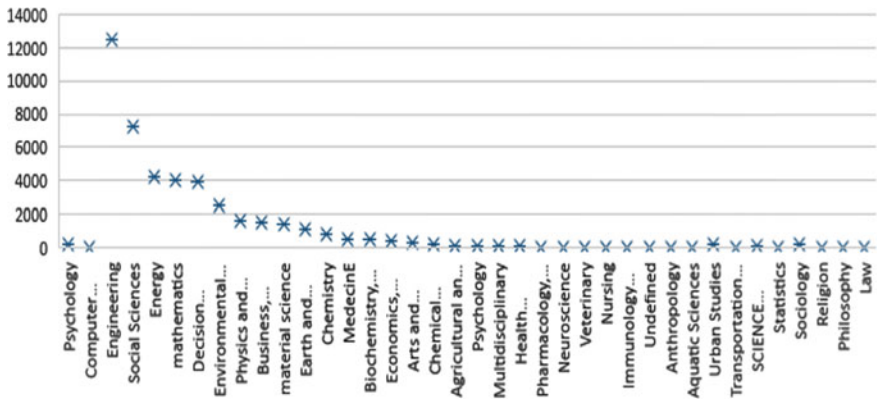

Fig. 1 The number of researches on Smart City per domain

Indeed, the majority of smart city research is in the computer sciences (leading discipline) followed by engineering, social sciences and energy and environment. Figure 1 shows the distribution of research by discipline.

Finding the Relevant Sources. The first step in a literature review study is to locate relevant literature by targeting certain international journals and conferences. In general, this approach is appropriate for topics that have been studied for a long period of time and have become a well-developed area of research [17]. However, for a contemporary concept like "smart city", relevant literature is collected by searching online databases, and this has become an upcoming culture among researchers [18–20]. Thus, we chose the scientific databases made available to researchers by the National Center for Scientific and Technical Research (CNRST) (Fig. 2).

Among these different databases, we excluded the databases specialized in natural sciences such as MathScinet, Aluka, Jstore and Global plants. As a result, we have integrated the following databases: Scopus, ScienDirect, Jstore, Web of Science, Springer for the Anglo-Saxon literature and CAIRN.info for the French literature. In addition, we conducted an additional search of the journals included in the 2019 Journal Citation Reports database (Social Science Editions). This literature also included news articles. Additional relevant articles were identified through the review of reference lists of all articles were also included but not limited to peer-reviewed journals. This step is considered by the authors to be imperative in

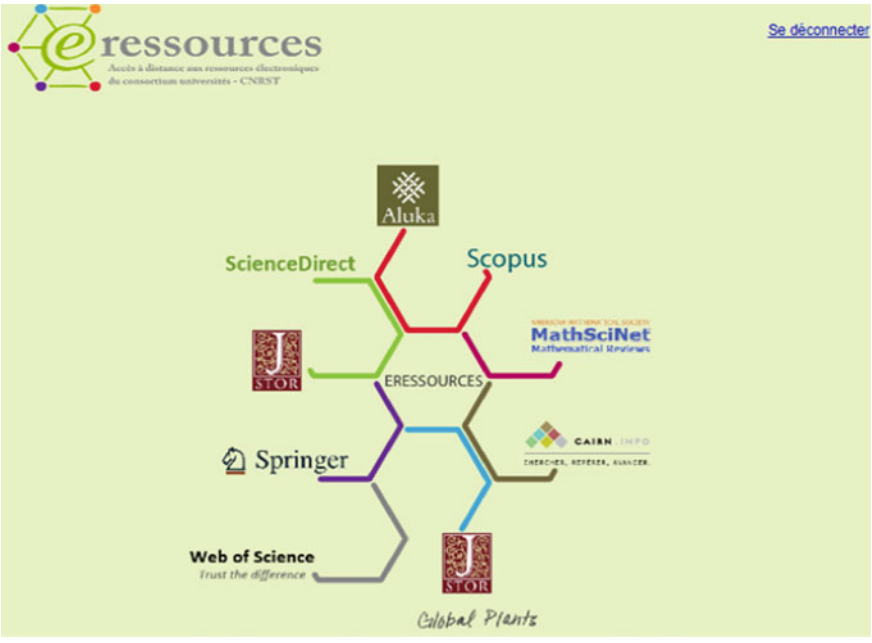

Fig. 2 List of scientific databases made available to researchers by CNRST

order to take into account relevant work that was not identified by the selected databases. Among these different databases, we excluded the databases specialized in natural sciences such as MathScinet, Aluka, Jstore and Global plants.

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Choosing Keywords. The queries used to search the major databases contain the term "Smart City" as well as other terms or labels relevant to research in this area. Figure 3 shows the frequency of occurrence of these specific labels.

The results presented in the figure above indicate that the "Smart City" label is the most frequently used among other city terms or labels. These are more or less similar to "Smart City". The "Smart City" label is followed by the "Sustainable City" and "Creative City" labels. This wave of labels can be explained by the technological development, which is largely about computer science. The

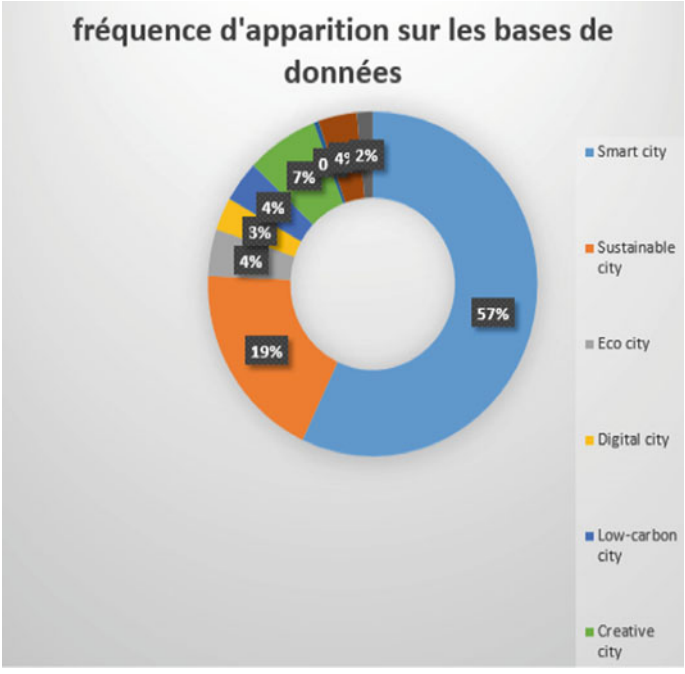

Fig. 3 Frequency of occurrence of similar labels used in the literature until 2020

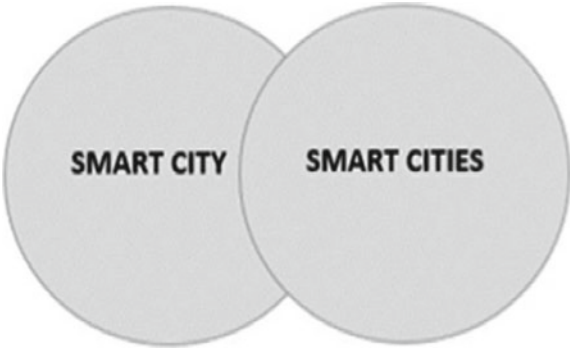

Fig. 4 Results of using the Boolean operator "OR" in the search

"Sustainable City" label is more related to environmental sciences, while "Creative City" is related to urban studies. In addition, the "Smart City" and "Digital City" labels seem to have relatively more technical connotations, unlike the other labels, which have relatively more environmental and urban connotations.

The keywords "Smart city" and "Smart Cities" were used to conduct the search since other researchers used them in their search. To do this the phrase "Smart City" OR "Smart Cities" was entered on the search bar of all selected databases. The objective of using the Boolean operator "OR" is to extract all documents containing both the word "Smart city" and the word "Smart Cities" in their titles, abstracts or texts (Fig. 4). The choice of these keywords was also used by the other researchers.

3.2 Research

The search was conducted simultaneously in the six selected databases. The total number of results obtained is about 140,000. It differs from one database to another. The Scopus database contains the most results (a total of 86,476 documents) which shows that researchers interested in the Smart City field tend to publish their work in Scopus indexed journals (Fig. 5).

Moreover, there is a very notable gap between the number of works found on the CAIRN.info reference database (only 427 articles) and on other databases. This proves that this field of research is not yet well developed in the French literature. Figure 6 shows this gap.

Furthermore, a time analysis was conducted, the objective of this time study is to analyze the temporal trend and distribution of Smart City research and to understand what the main factors of this temporal trend are. To achieve these objectives, the articles identified in the databases were organized in chronological order and classified according to the year of publication to list them. Figure 7 shows the number of articles on Smart City over the past twenty-three years. As the trend line highlights, the first study regarding this topic was in 1997. This year was marked by

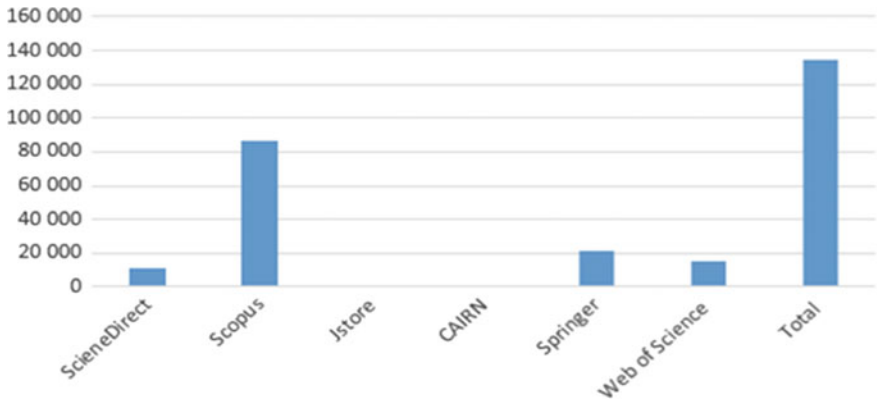

Fig. 5 Number of results obtained per database

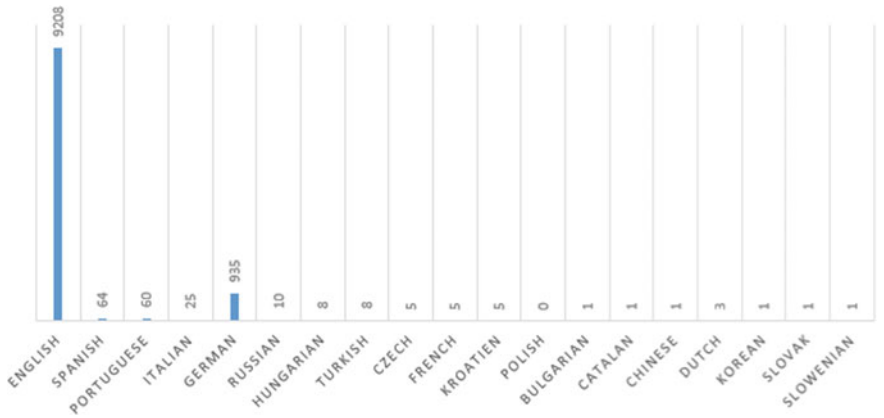

Fig. 6 Language used in the research on Smart City

the adoption of the Kyoto Protocol, which aims to reduce greenhouse gas emissions in order to protect the environment.

China has become the most productive country in recent decades in terms of Smart City research. In the first decade, the main countries producing research on the topic were mainly European countries. In the second decade, China, Japan and the United States topped the list while European countries were displaced to the bottom. China remains the predominant country. China, Japan, and the United States are at the top of the list (in dark blue in Fig. 8) followed by Italy and the United States (in dark blue in the figure) and other countries with modest research in the subject.

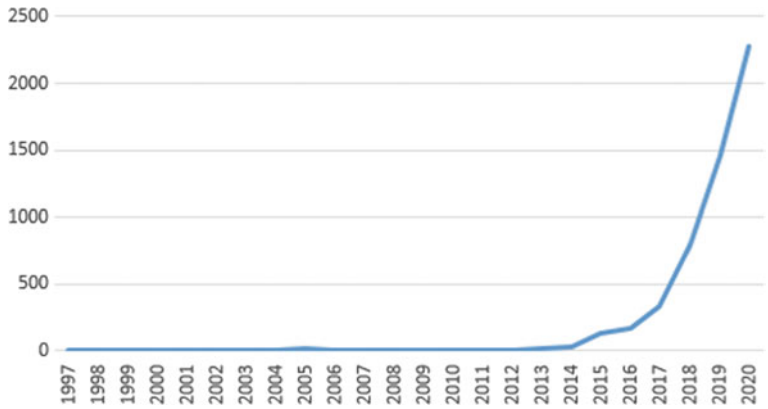

Fig. 7 Number of papers about smart city

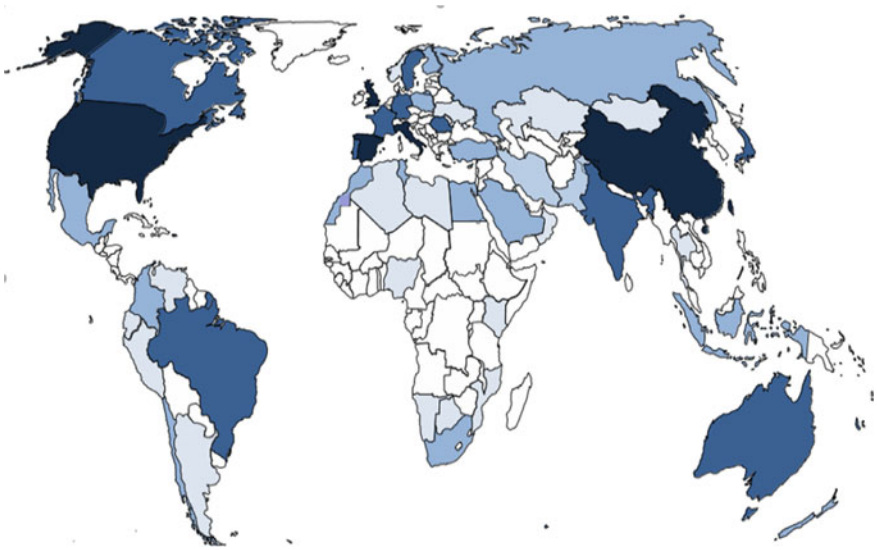

Fig. 8 Smart city research world map (the more intense blue, the higher the productivity). WOS. 2020

3.3 Selection

In accordance with the eligibility criteria, a total of 180 papers were identified from the six selected databases and 191 articles from a direct review of the journals listed in the Journal Citation Reports (JCR). A total of 371 articles were eligible for selection after excluding duplicates. Figure 9 shows the selection process.

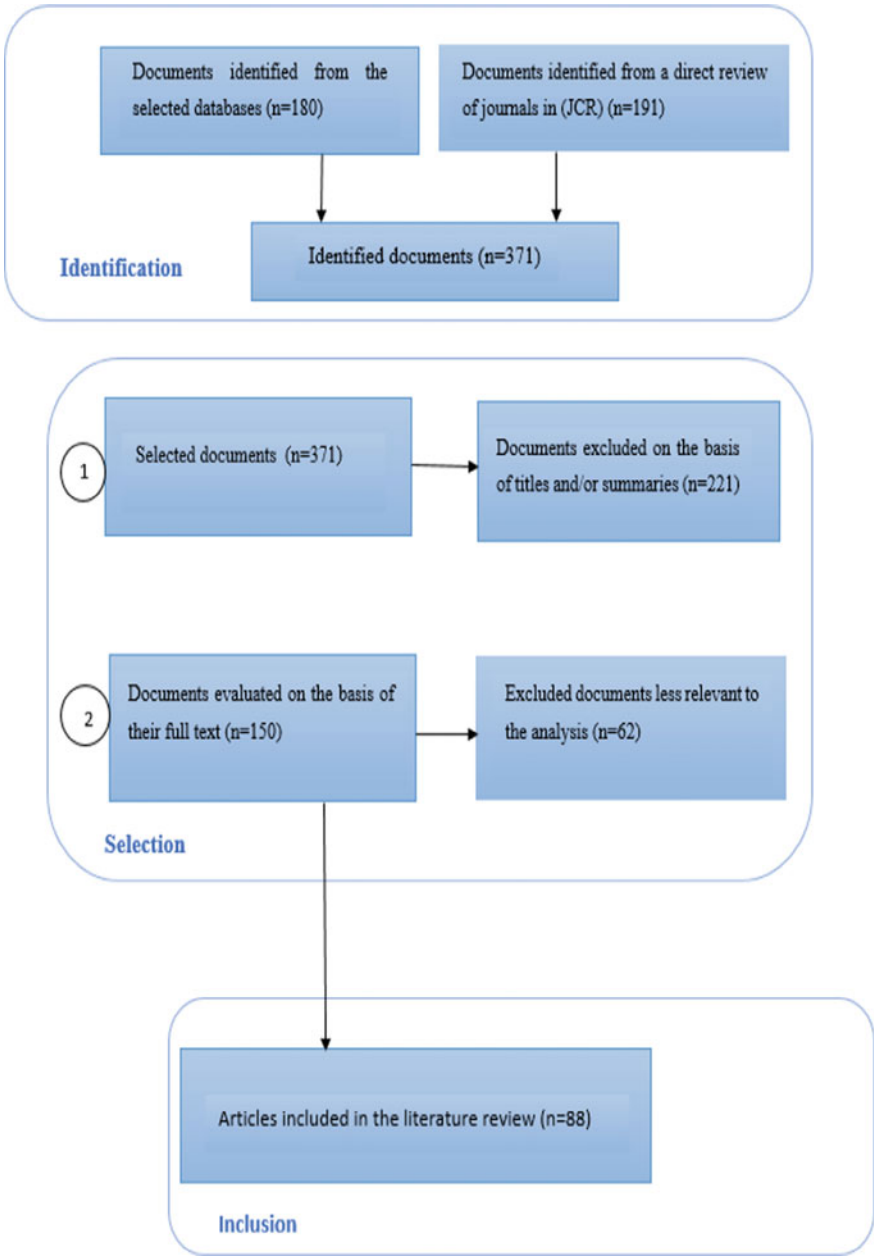

Fig. 9 The selection process

The first sorting was based on the title and the abstract. 221 papers were excluded either because they did not deal with the topic in their content. The second

filtering was based on the reading of the introduction and the conclusion. We supposed that if the results were not included in the introduction or the conclusion, then the topic was not relevant for our analysis. A total of 62 papers were excluded. The final selection of 88 articles was eligible for full-text analysis.

3.4 Analysis

The analysis was conducted document by document by reading each document in order to retain ideas and conclusions relevant to our research. The open coding consists of a re-reading of the selected documents in order to bring out concepts. Our main category is the concept of "Smart City". A priori we have retained three main approaches to explain the Smart City. A technological approach, a human resource approach and a collaborative approach. These three approaches constitute categories for our main category for which there are sub-categories (Fig. 7). A linkage of the different documents was done in order to extract these categories (Fig. 10).

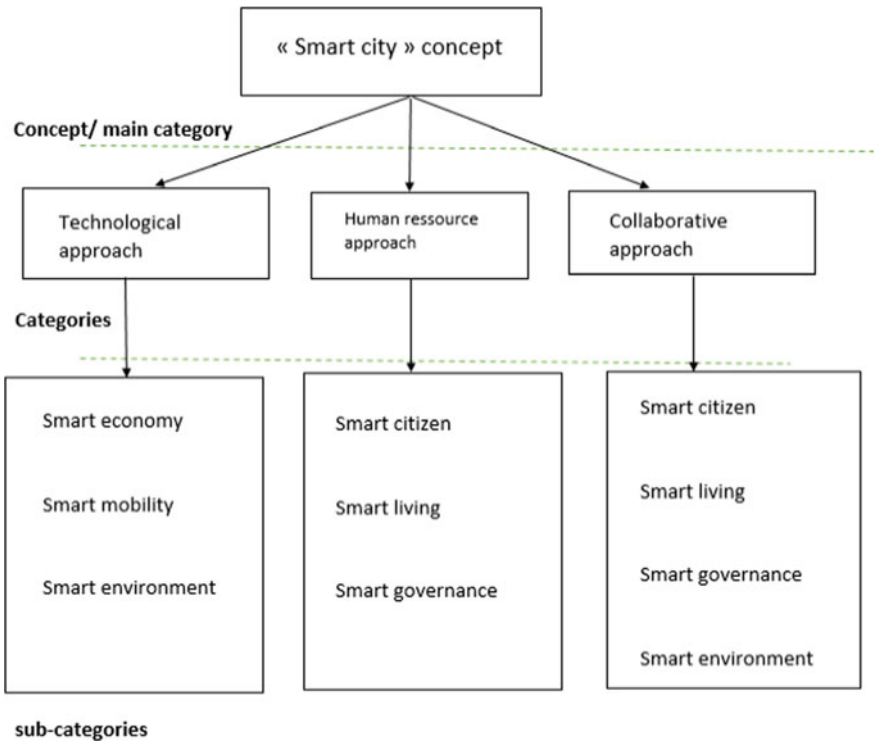

Fig. 10 The coding process

4 Conclusion

It is crystal clear that the smart city concept is still evolving and gaining much interest among researchers from various disciplines and from all over the world. Our literature analysis based on grounded theory method resulted in three main approaches to address the smart city subject. The first one called technological approach, highlights the opportunities provided by Information and Communication Technologies to enhance the urban fabric, stressing technology as the distinctive attribute of a Smart City. Second, the human resource approach through the continual updating and development of social knowledge, this approach emphasizes human and social capital as the driving force of urban transformation. Finally, the collaborative approach, the concept of collaboration is central to this approach, which focuses on the constructive connections between various urban actor networks. These three schools of thoughts are dominant in the literature. In this regard, some comprehensive perspectives of smart city do mix these three approaches putting people in the center of the city's projects by making technology closer and connecting them to divers stakeholders in a holistic approach in order to respond to the city's problems. Nonetheless, more theoretical understanding of the smart city concept is needed in order to generate smart city theories. The grounded theory that we used to analyze the literature can also be used to analyze empirical data in order to contribute to the advance of knowledge in the field.

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