11 Scientometric review and analysis: a case example of smart buildings and smart cities

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Abstract

Over the years, there has been an increase in research outputs in the built environment leading to the need to make meaning out of this increasingly large corpus of research. The use of manual desktop review has been criticised for its lack of rigour, subjectivity, quantitative justifications, and capacity. In recent years, researchers have been adopting systematic techniques such as the scientometric review analysis. The scientometric analysis is a quantitative study of the intellectual evolution of research themes, based on large-scale datasets. In this chapter, fundamental issues concerning the use of scientometric review analysis in built environment research have been presented systematically. Sources of data, techniques, and software tools are discussed. Lastly, a case example that includes simplified steps of scientometric analysis has been presented using smart buildings and smart cities as the research theme. The chapter serves as a guide for the use of scientometric analysis as a secondary research methodology in the built environment.

Introduction

Understanding the dynamics of knowledge in the various disciplines is vital not only to expanding the knowledge base but also to identifying the diverse aspects of such disciplines. Research techniques, such as scientometrics, bibliometrics, and informetrics, provide avenues through which to study and reflect on the dynamics of a discipline. There are significant overlaps between these three techniques in terms of their methodologies, theories, and applications, but they differ in their subject background (Mooghali *et al.*, 2011). Bibliometrics was designed to analyse books and articles statistically and other forms of communication, while scientometric, as its name implies, is focused on scientific publications (otherwise known as the science of science) with the motive being to guide decision-making or policy formulation. However, informetrics has been streamlined for the domain of information science and, thus, has found limited application across disciplines. Brookes (1990) and Hood and Wilson (2001) provided a further in-depth discussion on the history, inter-relationships, and differences between these three statistical record techniques. An application of bibliometric research in the built environment can be seen in the study of Olawumi *et al.* (2017). Owing to word limitations, readers interested in the similarities and differences of the scientometric, bibliometric, and informetric analyses can refer to Mooghali *et al.* (2011) and Qiu *et al.* (2017).

Scientometric analysis or review has several definitions in the literature. Nalimov first coined the term in 1969 (Siluo and Qingli, 2017). Olawumi and Chan (2018) described the scientometric analysis as a technique that enables "concise capturing and mapping of scientific knowledge", while according to Qiu *et al.* (2017), it is a discipline which employs statistical methods to "quantify the scientific research personnel and their achievements". Also, according to Tague-Sutcliffe (1992), scientometrics is the quantitative scrutinising of scientific activities such as publication records. Chen and Song (2019) define it as a "research of literature-based discovery". In recent years, scientific mapping software, such as CiteSpace, VOSviewer, Gephi, and BibExcel, among others, has been adopted to generate a visualisation and overview of the underlying knowledge dynamics.

The aim of the current study, as discussed in this chapter, was to illustrate and present scientometric network analysis as a secondary research methodology, using the CiteSpace software. A case study, on the theme smart buildings and smart cities, was adopted in this chapter to show the application of scientometric analysis as a secondary research methodology in the built environment. The rationale of the study was to provide an in-depth guide to readers in the use of scientometric analysis of the literature towards enabling them to map the trend and structure of any research field or topic. The scientometric analysis of the smart building and cities research field is used in this chapter to track the evolution of the concepts, establish the trending research themes, and identify the key research clusters. The study is expected to guide new entrants to this field towards becoming well-established researchers seeking collaboration opportunities.

Smart buildings and smart cities

During the last two decades, the concept of smart cities has become a widespread theme of discussion in scientific literature and international policies (Albino *et al.*, 2015). Rana *et al.* (2019) defined a smart city as "a technologically advanced and modernised territory with a certain intellectual ability that deals with various social, technical, economic aspects of growth based on smart computing techniques to develop superior infrastructure constituents and services" (Rana *et al.*, 2019, p. 503). As described by Bakıcı *et al.* (2013), a smart city interconnects people, information, and city elements in order to create a sustainable city. Cities are becoming more complex every day with the rising expectations of the characteristics in modern cities together with rapid urbanisation (Nam and Pardo, 2011). According to Peris-Ortiz *et al.* (2017), rapid urbanisation results in complex challenges to managing cities in terms of achieving sustainable urban development. These challenges have anticipated the requirement of smart cities and escalated the development of strategies to enable the realisation of smart cities. Schaffers *et al.* (2011) suggested that the concept of a smart city is a response to the requirement to guide pathways of urban development in strategic directions to address the challenges and achieve sustainability.

With reference to Lazaroiu and Roscia (2012) and Bakıcı *et al*. (2013), a smart city represents a society, which consists of average technological capacity, inter-connectedness, sustainability, comfortability, attractiveness, and security (Bakıcı *et al.*, 2013). The development of smart cities has gained widespread attention in research, practice, and policies based on the belief that smart cities create a more liveable environment, which will provide more benefits for the citizens (Milenković *et al.*, 2017). According to Ramaprasad *et al.* (2017, p. 15), the concept of smart city was identified as a "multi-disciplinary concept that embodies not only its information technology infrastructure but also its capacity to manage the information and resources to improve the quality of lives of its people".

Since most of our lives are spent in buildings and/or using built infrastructure, smart buildings will constitute necessarily a critical component of smart city development. Kathiravelu *et al.* (2015) defined smart buildings as a scenario of the prevalent use of ubiquitous computing, integrating IoT elements, including sensors, computing elements, and control algorithms incorporated into the buildings. Smart buildings differ from conventional buildings from inception of the designing process, and have wider potential and benefits than merely remote control (Batov, 2015). Chourabi *et al.* (2012) and Soyinka *et al.* (2016) highlighted the importance of smart buildings in achieving sustainable urban development to overcome the current urban challenges. Consequently, there has been an increase in research output on smart buildings and cities in the built environment. Hence, the purpose of this chapter was to map these studies towards providing readers with an in-depth understanding of the key issues in research themes concerning smart buildings and cities.

Usefulness of and approaches to scientometric analysis

The use of scientometric reviews plays a key role in synthesising structural patterns, identifying the direction and frontiers of research, extracting original findings from publications, and assessing the performance of authors and institutions, among others, within the pre-defined research field. Chen and Song (2019) suggested that scientometric review could help to identify challenges and difficulties being faced in the evolution of a scientific field. More so, according to Chen and Song (2019), it could be a valuable tool for early researchers to identify saturated and emerging research themes towards providing them with an overview and visualisation of the intellectual landscape of the research field. A scientometric review can also help in the characterisation of the development of a research field (Mooghali *et al.*, 2011) and the mapping of the various research clusters (Olawumi and Chan, 2018). With the advent of scientometric software, which only makes use of the records of publications, such as title, abstract, keywords, acknowledgement, and references, without the main body of the research publication, mapping a research field might be slightly or more disadvantaged using the available mapping software. There are three main approaches to using scientometrics to analyse a specific research field: the influence metric, the intellectual composition, and the knowledge base metric (Siluo and Qingli, 2017; Olawumi and Chan, 2018). The influence metric is focused on measuring the influence and co-operation among authors, using criteria such as their institutional and geographical affiliations, publishing journals, languages, document types, and research funding. The intellectual composition metric is used to examine and address the development and evolution of the research field by taking into consideration aspects, such as research keywords, subject areas or categories, research clusters, and methodological approaches. The emphasis of the knowledge base metric is on measuring the longitudinal distribution of the research growth and citations, visualising h-index analysis and geospatial analysis as well as the emerging, salient, and future direction of the pre-defined research field.

Research method

This section contains an overview of a typical research approach for scientometric analysis.

Defining the research problem

This involves defining the purpose of the study and search technique, which are related and vital to the overall quality of the study. It is an important task because the quality of the output depends on the input, and the result of the analysis would depend on it. The most common technique is the keyword search technique. The keywords which serve as the query should be chosen carefully to reflect the research domain, and should be reviewed by domain experts. This process is non-trivial as the keywords should be refined iteratively before final adoption (Chen and Song, 2019). Chen and Song (2019) proposed a cascading, citation expansion search technique by backward or forward expansion from a seed article. However, the method requires "constant programmatic access to a master source of scientific articles" (Chen and Song, 2019). A search query of "smart buildings" or "smart cities" was used in this study.

Data retrieval

There are two different types of databases, which are the citation databases and bibliographic databases. The citation databases are more comprehensive and detailed as they contain both bibliographical and citation information (Jayasree and Baby, 2019). Data for scientometric analysis are retrieved often from citation databases, and those used most in the built environment are Scopus and Web of Science (WoS). Other databases include Google Scholar, Dimension, CiteseerX, Pubmed, and MathSciNet. The decision about which of the databases to use depends often on the purpose of the study. WoS is a database that contains more influential journals, while Scopus has a broader coverage compared with WoS (Saka and Chan, 2019a). Combining different databases is encouraged to cover as many datasets as possible. However, the major challenge is the removal of repetitive data and dataset forms. Thus, Scopus, WoS, or other databases are being used separately as a source of data for analysis. WoS was adopted as the database in this study with a search query of "smart buildings" or "smart cities", which resulted in 28,962 documents.

Pre-processing

The output of the data search should be refined to suit the aim of the study. This may include refining according to the document type, language, year, countries/regions, and research area. The document type includes articles, conference proceedings, book chapters, and other materials. Articles are adopted often because they contain the latest developments in the research domain. However, all the document types can be combined for various reasons, such as new research areas, and when the aim of the study is to evaluate holistically or to avoid publication bias (Saka and Chan, 2019b). Also, depending on the aim of the study, some countries/years/languages/research areas can be excluded. It is noteworthy that the refining options often serve as a limitation and might include bias in the study. Thus, refining the data search should be considered diligently.

In this study, the output was refined using built environment research areas, articles (as document types), English language, and year range from 2005 to 2019. The year 2020 was not included because more articles would be published, and a minimum span of 10 years is sufficient to show intellectual evolution in a research domain (Jin *et al.*, 2018). The pre-processing stage resulted in 1,564 journal articles that served as the input dataset in this study.

Data analysis tools

Many tools are used for scientometric analysis, including CiteSpace, VOSviewer, CitNetExplorer, Sci^2, BibExcel, HistCite, Pajek, Publish or Perish, Scholarmeter, and Gephi (Jayasree and Baby, 2019). These tools have strengths and weaknesses, and there are no one fits all tools. However, the most popular tools in the built environment are CiteSpace, VOSviewer, and Gephi (Oraee *et al.*, 2017; Hosseini *et al.*, 2018; Darko *et al.*, 2020).

1. CiteSpace is a free Java application created by Chaomei Chen for visualising and analysing the intellectual evolution of research domains. The data source for CiteSpace includes WoS, Scopus, Lens, CSCD, CSSCI, and PubMed. The application uses both a time-based and graphical approach for visualisation. The various nodes that can be generated with the tool include a co-authorship network, network of co-authors' institutions, network of co-authors' countries, the network of co-occurring phrases, document co-citation network, author co-citation network, and journal co-citation network, among others. Refer to Chen (2014) for further details about the use of CiteSpace. The tool provides comprehensive analysis options, but this might be overwhelming for new users.

2. VOSviewer was created by Nees Jan Van Eck and Ludo Waltman. It uses distance-based visualisation of the network, and the software is easy to use but offers less functionality compared with CiteSpace (Van Eck and Waltman, 2014). The major functionalities of the tool are to create maps and to explore the maps with input from databases such as WoS, Scopus, Dimensions, PubMed files, and reference files such as RIS, RefWorks, and Endnote files. Refer to van Eck and Waltman (2019) for further details about use.
3. Gephi is focused more on network visualisation than network analysis (van Eck and Waltman, 2014). Gephi is a software application for visualising, manipulating, exporting, spatialising, and filtering all types of networks (Bastian *et al.*, 2009). Thus, it is often combined with other tools for analysis.

The combination of CiteSpace and VOSviewer (Saka and Chan, 2019a) or the combination of CiteSpace, VOSviewer, and Gephi (Darko *et al.*, 2020) is becoming more popular in the built environment. CiteSpace was adopted in this study for visualisation of the smart building and smart cities research domain.

Data analysis techniques

The following are some of the conventional analysis techniques using CiteSpace:

a. Co-author analysis:

    a. Co-authorship network: The network presents the relationship between the authors in the dataset. Nodes represent the authors and the links represent the collaboration between the authors. This network shows the porosity of the research domain and how the researchers collaborate and interact with each other to form smaller research communities.

   b. Network of institutions/faculties and countries/regions: The network presents the contributions of institutions and countries to a research domain and the collaboration between them.

b. Co-word analysis

   a. Network of co-occurring keywords: Keywords are essential parts of research publications, be they journals, conference papers, books, magazines, and even webs or blogs (where they are referred to as “tags”). They are assigned to a piece of information for better description and indexing. According to Olawumi and Chan (2018), keywords provide a more concise way to understand a concept as well as the content of research publications. According to Zhao (2017), keywords illustrate the trend of a research field. In research publication, keywords are categorised broadly in two ways: author keywords and keyword plus (Olawumi and Chan, 2018). Author keywords, as the name infers, are keywords provided by the authors of the publication, while keyword plus is based on the classification of the publishing journal.

   b. Network of co-occurring subject categories: This network evaluates the subject categories of the documents in the dataset. The subject categories are usually assigned by the database, depending on the scope of the document.

c. Co-citation analysis

   a. Author co-citation network: The author co-citation network provides a pattern of connection among the diverse authors whose research publication appears as cited references within the same journal paper (Olawumi and Chan, 2018).

   b. Document co-citation network: The network evaluates the cited references in the dataset to show the articles/documents that have been highly cited and referred in the dataset.

c. Journal co-citation: The network presents the co-cited journals in the dataset and inferences can be drawn from the aim and scope of the top-cited journals as regards the research direction in the dataset.

d. Citation burst and centrality: The citation burst analysis within the CiteSpace software application is based on Kleinberg's algorithm (Kleinberg, 2002), and it portrays the citation increase within a short period (Olawumi and Chan, 2018). Meanwhile, the betweenness centrality is based on the work of Freeman (1977), and is described as the degree to which a node or point on the network lies within the shortest path between other nodes.

Data analysis and results

CiteSpace was used to generate the networks, presented below, using the 1,564 articles from WoS as the input. Since the period examined in the study was from the year 2005 to 2019, the "Years per slice" option was set to 1, and selection criteria were set to top 20 levels of the most cited or occurred items from each slice. Also, the pathfinder utility option in CiteSpace was used for the network pruning to remove redundant links.

Co-author network

The network shows the collaboration between the authors in the 1,564 articles with 194 nodes and 184 links. The network has modularity (Q) of 0.967 and mean silhouette (S) of 0.625, which are the quantitative representation of the network structure. The Q relates to the overall structural properties of the network, and a value greater than 0.7 reflects the porosity of the clusters, while the S indicates the homogeneity of the clusters (Chen, 2014). Thus, the network consists of loosely packed clusters that are homogenous, as shown in Figure 11.1. The size of the nodes corresponds to the number of author publications in the dataset, and authors such as Satish Nagarajaiah and Billie F. Spencer, Jr. are noticeable in the network. The top five productive authors in the network are shown in Table 11.1 (Section A). Most of the research clusters are smaller in size, which indicates that they do not collaborate significantly with other clusters. This shows the porosity of the research domain of “smart building” or “smart cities”. Citation burst occurred in 2005 for Billie F. Spencer, Jr. (strength = 3.27, 2005–2006) and Shankar Narasimhan (strength = 3.27, 2006–2008). This means that the work of the authors gained significant attention from researchers in this domain during the specified period. This often coincides with the publication of notable or significant research works that attract more citations from other researchers.

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Analysis of co-occurring keywords

The network analysis of the co-occurring keywords, as shown in Figure 11.2, has 136 nodes and 388 links. According to Olawumi and Chan (2018), the node sizes represent the frequency of occurrence of the keyword in the dataset. The keyword analysis network also has modularity, Q = 0.5013, and a mean silhouette value, S = 0.7117. The Q-value implies that the nodes within the network are moderately packed, while the S-value shows a high homogeneity in the keyword clusters. The network analysis revealed some high-frequency keywords (Figure 11.2) in the research *corpus* which were: “system” (frequency, f = 229), “smart city” (f = 219), “model” (f = 144), “city” (f = 138), “building” (f = 129), “performance” (f = 125), “management” (f = 101), "design" (f = 88), "optimization" (f = 88), "sustainability" (f = 85), "simulation" (f = 80), "smart grid" (f = 80), and "energy" (f = 75).

The influence and significance of the keywords were analysed using the betweenness centrality and citation burst. Also, the centrality scores were normalised between the interval of 0 and 1, and a node with a higher centrality score links two or more large clusters of nodes (Chen, 2014; Olawumi and Chan, 2018). Such nodes also help to pinpoint key and critical research publications.

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Keyword nodes with betweenness centrality scores included: "building" (centrality = 0.36), "system" (0.25), "performance" (0.25), "structural control" (0.21), "design" (0.19), "model" (0.17), and "optimization" (0.17), among others. These keyword themes were shown to be shaping and connecting the development of the emerging concept of smart buildings and smart cities. For the co-occurring keywords citation burst, 14 keywords were identified from the analysis network. These keywords, with citation burst, as shown in Table 11.1 (Section B), were the salient topics and themes relating to smart buildings and smart cities. A finding of interest was that keywords, such as "structural control", "demand response", "technology", "smart grid", "internet of things", "energy consumption", and "neural network" had citation bursts and high frequencies. The results portend that these salient research themes are critical to developing the smart buildings and cities within the built environment.

Analysis of author co-citation network

The research *corpus* extracted from the WoS records formed the dataset for the author co-citation analysis, as shown in Figure 11.3, which has 299 nodes and 1,142 links. The network had modularity (Q = 0.7449) and a mean silhouette (S = 0.6089), which showed slightly loose clusters of authors. Also, the node size of each author in the analysis network indicates its co-citation frequency, while the links show an "indirect co-operative alliance" between the authors based on the metric of their co-citation frequency. Based on the network analysis (Figure 11.3), the ten highly cited authors were identified, of which two of the most cited authors were international organisations, which reflected significant interest in the concept of smart buildings and cities worldwide. These highly cited authors were the European Commission (frequency, f = 74, Belgium*), Spencer Billie (f = 65, United States), Caragliu Andrea (f = 63, Italy), Giffinger Rudolf (f = 58, Austria), Yang Jann (f = 50, United States), the UN (f = 45, United States*), Batty Michael (f = 45, United Kingdom), Nagarajaiah Satish (f = 44, United States), Neirotti Paolo (f = 44, Italy), and Komninos Nicos (f = 42, Greece). The diversity in the affiliation of the authors showed the growing interest and evolution of the research fields of smart buildings and cities.

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The authors, with high citation bursts within a short period, were identified from the analysis network (Figure 11.3). These authors included Spencer Billie (burst strength = 15.65, 2005–2014), Yang Jann (burst strength = 13.08, 2005–2010), Nagarajaiah Satish (burst strength = 12.29, 2006–2010), Narasimhan Sriram (burst strength = 12.16, 2006–2010), Lombardi Patrizia (burst strength = 9.56, 2017–2019), Perez-Lombard Luis (burst strength = 8.97, 2016–2019), Dyke Shirley (burst strength = 8.31, 2006–2014), Angelidou Margarita (burst strength = 8.29, 2017–2019), and Dong Bing (burst strength = 8.18, 2017–2019). Publications, including communique and research papers by these authors, have shaped the concept and research field of smart buildings and smart cities. Hence, their works are worth following.

Nodes, with betweenness centrality, and their values were identified from the analysis network which were Deb Kaushik (centrality = 0.28), European Commission (0.26), Kolokotsa Denia (0.19), Song Gangbing (0.19), Soong Tsu Teh (0.18), Yang G (0.15), and Spencer Billie (0.13), among others. These authors had made notable and influential contributions in the research fields of smart buildings and smart cities. These authors also helped to connect the various research clusters and communities.

Document co-citation network

Figure 11.4 shows the document co-citation network with modularity of 0.83 and a mean silhouette of 0.41, which depicts a loosely clustered network but less homogenous than cases A and B. Table 11.1C shows the list of the top five documents that were well cited in the dataset. These documents were well placed in the network, as shown in Figure 11.4. Notably, Neirotti *et al.* (2014) examined the concept of smart city and assessed the trend at a global level. The network shows six categories, sub-categories, and the coverage index (CI) was defined. From the study it was evident that a unified concept for smart cities was lacking and it was concluded that the concept was contextual. Similarly, Caragliu *et al.* (2011) and Albino *et al.* (2015) also examined the concept of a smart city. This suggested that the concept of smart city is multi-faceted and dynamic.

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Citation burst occurred for 18 of the articles and the top five included: Spencer Jr. and Nagarajaiah (2003) (burst strength = 9.05, 2006–2011), Ramallo *et al.* (2002) (burst strength = 8.15, 2006–2010), Zanella *et al.* (2014) (burst strength = 5.57, 2017–2019), Oldewurtel *et al.* (2012) (burst strength = 5.43, 2016–2017), Yang and Agrawal (2002) (burst strength = 4.78, 2006–2008). The most recent burst included Kramers *et al.* (2014) (burst strength = 3.96, 2017–2019) and Zanella *et al.* (2014) (burst strength = 5.57, 2017–2019). The top articles with citation burst were related more to smart buildings, which include smart structures, while the latest articles with burst related more to smart cities. It could be deduced that the concept of smart structures preceded the concept of smart cities, which has been gaining more attention in recent years.

Conclusions

The use of scientometric analysis is becoming widespread because of the increase in research outputs. The use of scientometric analysis varies, depending on the aim of the study, which might be for comparison of the research domains, intellectual evolution of the research domains, or a combination of both. Consequently, the aim, data retrieval approach, pre-processing, analysis tools, and techniques are of utmost importance in the scientometric analysis, as these would determine the quality of the outputs.

A simplified application of scientometric analysis has been presented in this chapter for the research domain of smart buildings and smart cities as an example for further illustration. The method will continue to gain widespread usage in research because of its usefulness and the meteoric increase in research outputs over the years.

Although scientometric analysis is easy to use and apply to the *corpus* of articles, it requires a comprehensive understanding of the research domains. Also, the method can be used as a secondary research method in the built environment because of its rigour and quantitative justifications. In this chapter, articles not written in English were not part of the analysed *corpus*, which was a limitation to the study. Also, researchers interested in applying the scientometric analysis of research areas can follow the steps illustrated under the method section towards replicating the scientometric approach.

CiteSpace was used as a tool for the scientometric analysis of the trend and structure of smart buildings and cities in the extant literature via the generation of the co-author network, co-occurring keywords network, co-author citation network, and document co-citation network. Keywords such as “structural control,” “demand response,” “technology,” “smart grid,” “Internet of thing,” and “energy consumption” were determined as the salient keywords with the highest burst strength and are the significantly important topics and themes in smart buildings and smart cities. Therefore, it can be determined that these keywords play an essential role in the development of the research areas of smart buildings and smart infrastructure.

More so, the chapter identified key researchers such as Deb Kaushik, Kolokotsa Denia, Spenser Billie, among others, who have contributed and are influential to the development of the concepts of smart building and cities. Hence, it is recommended for research students and researchers interested in the field of smart buildings and cities to follow their work. The diverse countries of the first ten highly cited authors, which include Belgium, United States, Italy, Austria, the United Kingdom, among others, illustrate growing interest in the research areas of smart buildings and cities. Hence, the highlights of the key authors, keywords, and research clusters provide relevant information for researchers who are interested in collaborations within the areas of smart buildings and cities. Future studies can work on the salient as well as the upcoming research themes identified in the study towards undertaking in-depth research on it.

Table 11.1 Scientometric analysis for co-authors, keywords, and document co-citation network

1A – Top authors		
Author	Institution	Country (counts)

Satish Nagarajaiah	Rice University	United States (7)
Billie F. Spencer, Jr.	University of Illinois at Urbana-Champaign	United States (5)
Shankar Narasimhan	Indian Institute of Technology Madras	India (5)
Rodney A. Stewart	Griffith University	Australia (4)
Jeong Tai Kim	Kyung Hee University	South Korea (4)
1B – Keywords citation bursts		
Keywords	Burst strength	Span
Structural control	10.2232	2006–2015
Demand response	9.3014	2014–2017
Technology	8.0586	2017–2019
Smart grid	7.8353	2015–2016
Internet of thing	7.7321	2017–2019
Bridge	6.5231	2006–2011
Active control	5.8332	2008–2010

Energy consumption	5.6142	2014–2017
Neural network	4.8727	2006–2015
Hybrid control	3.7626	2006–2009
Identification	3.6335	2006–2010
Smart structure	3.5736	2008–2015
Policy	3.4641	2011–2015
Prediction	3.4492	2014–2015
1C – Document citation and betweenness centrality		
Article	Centrality	Total citation
Caragliu *et al.* (2011)	0.21	50
Neirotti *et al.* (2014)	0.09	50
Albino *et al.* (2015)	0.03	45
Ahvenniemi *et al.* (2017)	0.01	33
Batty *et al.* (2012)	0.43	32

Source: Original.

Figure 11.1 Co-author network.

Figure 11.2 Network analysis of co-occurring keywords.

Figure 11.3 Network analysis of authors' co-citation.

Figure 11.4 Document co-citation network.

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