SCIENTOMETRIC REVIEW AND ANALYSIS: A CASE EXAMPLE OF SMART BUILDINGS AND SMART CITIES

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Summary

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 criticized for its lack of rigor, subjectivity, quantitative justifications, and capacity. In recent years, studies 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. This chapter systematically presents fundamental issues for the use of the analysis in the built environment research. Sources of data, techniques, and software tools are discussed. Lastly, a case example that includes simplified steps of scientometric analysis is presented using 'smart buildings and smart cities' research theme. The chapter would serve as a useful guide for the use of scientometric analysis as a secondary research methodology in the built environment.

1. Introduction

Understanding the dynamics of knowledge in the various disciplines is vital to not only expanding the knowledge base but also identifying the diverse aspects of such disciplines. Research techniques such as scientometric, bibliometrics, and informetric provides avenues to study and reflect on the dynamics of a disciplines. 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 analyze books, articles statistically, and other forms of communication, while scientometric, as its name implies, focuses on scientific publications (otherwise known as the science of science) with the motive to guide decision making or policy formulation. However, informetric is streamlined to the information science domain and thus has found limited application across disciplines. Brookes (1990) and Hood and Wilson (2001) provided a further in-depth discussion on the history, interrelationships, 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). Due to word/space restriction, readers interested in the similarities and differences of the scientometric, bibliometric, and informetric analyses (*see* Mooghali et al., 2011; Qiu et al., 2017).

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

The current study, as discussed in this chapter, aims to illustrate and present the scientometric network analysis as a secondary research methodology using the CiteSpace software. A case study of "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 is to provide an in-depth guide to its readers in the use of the scientometric analysis in the literature towards enabling them to map the trend and structure of any research field or topic. Meanwhile, the scientometric analysis of the smart building and cities research field in this chapter will track the evolution of the concepts, establish the trending research themes as well as identify the key research clusters. The study is expected to guide new entrants in this field as well-established researchers looking for collaboration opportunities.

1.1 Smart Buildings and Smart Cities

In 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" (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 expected characteristics in modern cities, along with rapid urbanization (Nam & Pardo, 2011). As per Peris-Ortiz et al. (2017), rapid urbanization results in complex challenges in managing cities in the way of achieving sustainable urban development. These challenges have anticipated the requirement of smart cities and escalated the development of strategies enabling smart cities. Schaffers et al. (2011) opined that the smart city concept is a response to guide pathways of urban development in strategic directions to address such 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 technology size, interconnectedness, sustainability, comfortability, attractiveness and security (Bakıcı et al., 2013). The development of smart cities has gained widespread attention in research, practices, and policies based on the belief that smart cities create a more liveable environment, which will bring more benefits for the citizens (Milenković et al., 2017). According to Ramaprasad et al. (2017), the concept of smart city was identified as a "multidisciplinary 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" (p.15).

Since most of our lives are spent in buildings and/or using built infrastructure, smart buildings will necessarily constitute a critical component of smart city development. Kathiravelu et al. (2015) defined smart buildings as a major use case scenario of ubiquitous computing, integrating IoT elements, including sensors, computing elements, and control algorithms into the buildings.Smart buildings differ from usual buildings from the designing process and have wider potential and benefits than a 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 chapter intends to map these studies towards providing its readers with an in-depth understanding of the key issues in smart buildings and cities research themes.

1.2 Usefulness of and approaches to scientometric analysis

Scientometric reviews play a key role in synthesizing structural patterns, identification of the research directions and frontiers, extraction of original findings from publications, and assessment of the performance of authors, institutions, etc. among others within the predefined research field. Chen and Song (2019) posited that scientometric review could help identify challenges and difficulties being faced in the evolution of a scientific field. More so, according to Chen and Song (2019), it can be a valuable tool for early researchers to identify 'overcrowded' and emerging research themes towards guiding and providing them with an overview and visualization of the intellectual landscape of the research field. A scientometric review can also help in the characterization of the development of a research field (Mooghali et al., 2011) and the crystallization of the various research clusters (Olawumi & Chan, 2018). With the advent of scientometric software, which only makes use of publications records such as publication's title, abstract, keywords, acknowledgment, references, etc., except 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 utilizing scientometrics to analyze a specific research field, and these include – the influence metric, the intellectual composition, and the knowledge base metric (Siluo & Qingli, 2017; Olawumi & Chan, 2018). The influence metric focuses on measuring the impact and cooperation among authors using criteria such as their institutional and geographical affiliations, publishing journals, languages, document types, and research funding. The intellectual composition metric examines and addresses 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. Meanwhile, the knowledge base metric tends to emphasize and visualize the longitudinal distribution of the research growth, citations, and h-index analysis, geospatial analysis, as well as the emerging, salient, and future direction of the predefined research field.

2. Research Method

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

2.1 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 keyword which would serve as the query should be carefully chosen to reflect the research domain, and these are to be reviewed by the domain experts. This process is non-trivial as the keywords should be iteratively refined before final adoption (Chen & 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 & Song, 2019). A search query of '*smart buildings' or 'smart cities'* is used in this study.

2.2 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 & Baby, 2019). Data for scientometric analysis are often retrieved from citation databases, and the most used ones in the built environment are Scopus and Web of Science (WoS). Other databases include Google scholar, Dimension, CiteseerX, Pubmed, and MathSciNet. The decision on which of the database to use often depends on the purpose of the study. WOS is a database that contain more influential journals while the Scopus has a broader coverage compared to WoS (Saka & Chan, 2019a). Combining different databases is encouraged to cover as many datasets as possible. However, the major challenge relates to the removal of repetitive data and dataset forms. Thus, either Scopus, WOS, or other databases are being used separately as a source of data for the 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.

2.3 Pre-processing

The output of the 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 consists of articles, conference proceedings, book chapters, and other materials.

Articles are often adopted because they contain the latest development in the research domain. However, all the document types can be combined for varying reasons such as new research areas and when the study aims to evaluate holistically or to avoid publication bias (Saka & 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 serves as a limitation and may include bias in the study. Thus, it should be considered diligently.

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

2.4 Data analysis tools

Many tools used for scientometric analysis includes 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 is 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).

a) CiteSpace: It is a free Java application created by Chaomei Chen for visualizing and analyzing the intellectual evolution of research domains. The data source for the CiteSpace includes WoS, Scopus, Lens, CSCD, CSSCI, and PubMed. It adopts both a time-based and graphical approach for visualization. The various nodes = 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, journal co-citation network among others. See Chen (2014) for the detailed use of CiteSpace. The tool provides comprehensive analysis options; however, this might be overwhelming for new users.
b) VOSviewer: The tool was created by Nees Jan Van Eck and Ludo Waltman. It adopts distance-based visualization of the network, and the software is easy to use but offers less functionality compared to CiteSpace (Van Eck & Waltman, 2014). The major functionalities of the tool are to create maps and to explore the map with input from databases such as WoS, Scopus, Dimensions, PubMed files, and reference files such as RIS, RefWorks, and Endnote files. See van Eck and Waltman (2019) for detailed use.
c) Gephi: The tool focuses more on network visualization than network analysis (Van Eck and Waltman, 2014). It is a software for visualizing, manipulating, exporting, spatializing, 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 & 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 visualization of smart building and smart cities research domain.

2.5 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 it a journal and conference papers, books, magazines, and even web or blog contents (where they are using refer 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; while per (Zhao, 2017), it illustrates the trend of a research field. In research publication, keywords are broadly in two ways – author keywords and keyword plus (Olawumi & Chan, 2018). Author keywords, as the name infers, are keywords provided by the authors of the publication while the 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 is based on Kleinberg’s algorithm (Kleinberg, 2002), and it portrays the citation increase within a short period (Olawumi & Chan, 2018). Meanwhile, the betweenness centrality is based on Freeman's (1977) work and is described as the degree to which a node or point on the network lies within the shortest path between other nodes.

3. Data Analysis and Results

CiteSpace was used to generate the following networks with the 1,564 articles from WoS as the input. Since the study is examining from the year 2005 to 2019, ‘Years per slice’ option was set to 1, 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 for the removal of redundant links.

3.1 Co-author network

The network presents the collaboration between the authors in the 1564 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 porousness of the clusters, while the S measures the homogeneousness of the clusters (Chen, 2014). Thus, the network consists of loosely packed clusters that are homogenous, as shown in Figure 1. The nodes size represent corresponds to the number of publication of authors in the dataset, and authors such as Satish Nagarajaiah and Billie F. Spencer, Jr. are noticeable in the network. The top 5 productive authors in the network are shown in Table 1A. Most of the research clusters are smaller in size. They do not collaborate significantly with other clusters, which 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.

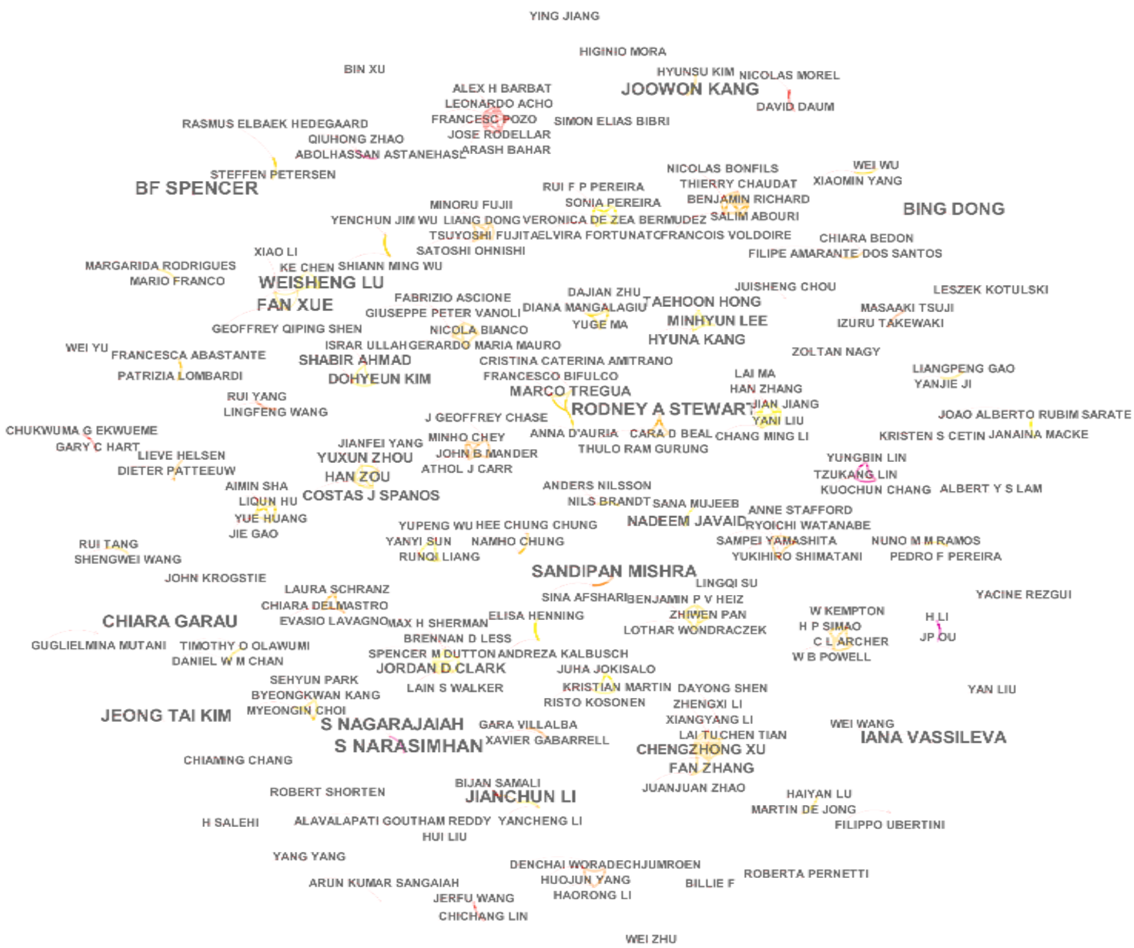

Figure 1: Co-author network

Table 1: Scientometric analysis for co-authors, keywords, and document co-citation network

1A – Top Authors		
Author	**Institution**	**Country (Counts)**
Satish Nagarajaiah	Rice University	USA (7)
Billie F. Spencer, Jr.	University of Illinois at Urbana-Champaign	USA (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

3.2 Analysis of co-occurring keywords

The network analysis of the co-occurring keywords, as shown in Figure 2, has 136 nodes and 388 links. According to Olawumi and Chan (2018), the keyword node sizes represent its frequency in the dataset. Also, the keyword analysis network 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 reveals some high-frequency keywords (Figure 2) in the research corpus which are “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 are analyzed using the betweenness centrality and citation burst. Also, the centrality scores are normalized between the interval of 0 and 1, and a node with a higher centrality scores links up two or more large clusters of nodes (Chen, 2014, Olawumi and Chan, 2018). Such nodes also help to pinpoint key and critical research publications.

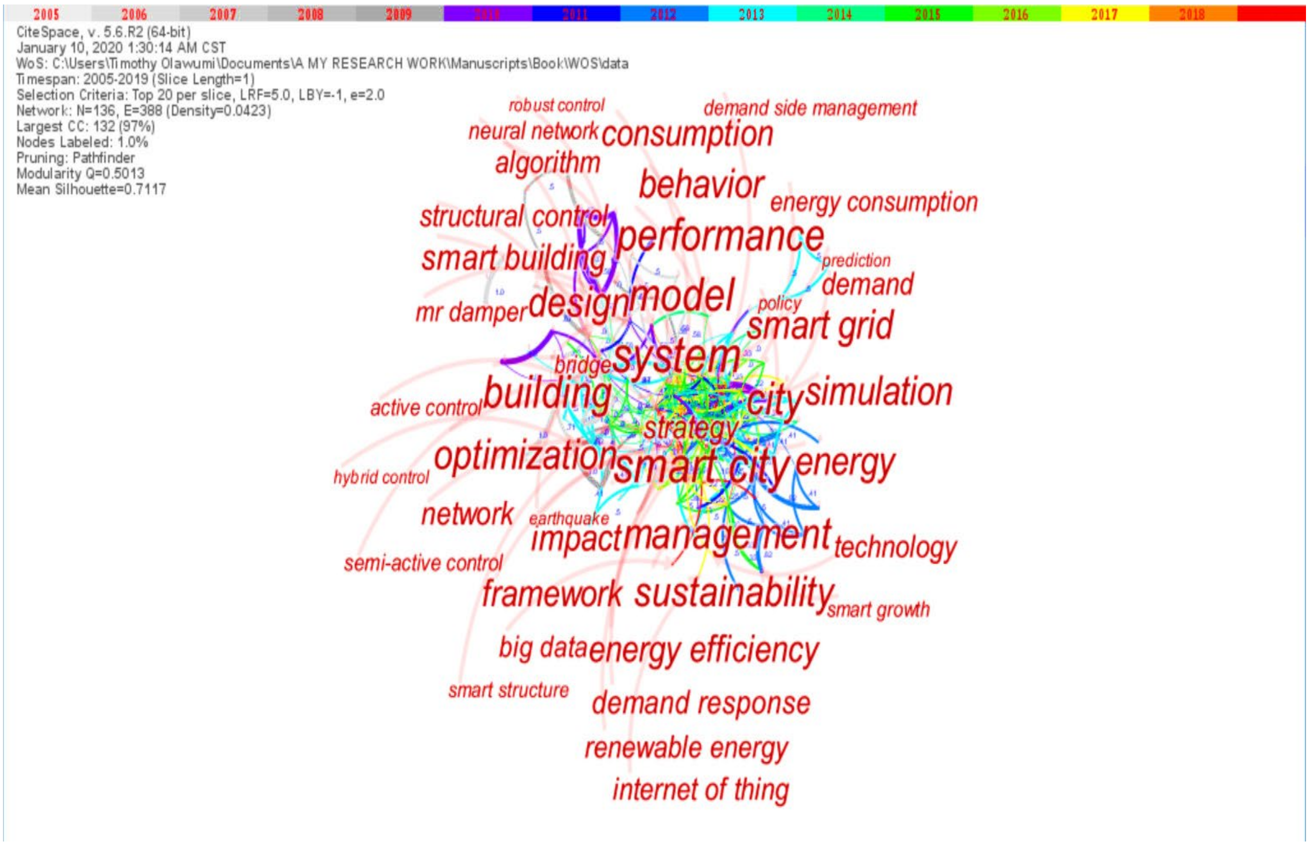

Figure 2: Network analysis of co-occurring keywords

Keyword nodes with betweenness centrality scores include “building” (centrality = 0.36), “system” (0.25),” performance” (0.25), “structural control” (0.21), “design” (0.19), “model” (0.17), “optimization” (0.17) among others. These keyword themes are shaping and connecting the emerging development of the concept of smart buildings and smart cities. For the co-occurring keywords citation burst, fourteen keywords were identified from the analysis network. These keywords, with citation burst, as shown in Table 1B, are the salient topics and themes in smart buildings and smart cities. An interesting finding is that keywords such as “structural control,” “demand response,” “technology,” “smart grid,” “internet of thing,” “energy consumption,” and “neural network” have both citation bursts and high frequencies. The results portend that these salient research themes are critical to achieving the smart building and cities within the built environment.

3.3 Analysis of Author co-citation network

The research corpus extracted from the WoS records forms the dataset for this author co-citation analysis, as shown in Figure 3, which has 299 nodes and 1142 links. The network, meanwhile, has modularity (Q= 0.7449) and a mean silhouette, S= 0.6089, which shows 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 cooperative alliance" between the authors using the metric of their co-citation frequency. Based on the network analysis (Figure 3), the ten highly cited authors were identified, of which two of the most cited authors are international organizations, which reflects the significant interest in the concept of smart buildings and cities worldwide. These highly cited authors are the European Commission (frequency, f= 74, Belgium*), Spencer Billie (f= 65, USA), Caragliu Andrea (f= 63, Italy), Giffinger Rudolf (f= 58, Austria), Yang Jann (f= 50, USA), the United Nations (f= 45, USA*), Batty Michael (f= 45, UK), Nagarajaiah Satish (f= 44, USA), Neirotti Paolo (f= 44, Italy), and Komninos Nicos (f=42, Greece). The diversity in the affiliation of the authors shows the growing interest and evolution of the research fields of smart buildings and cities.

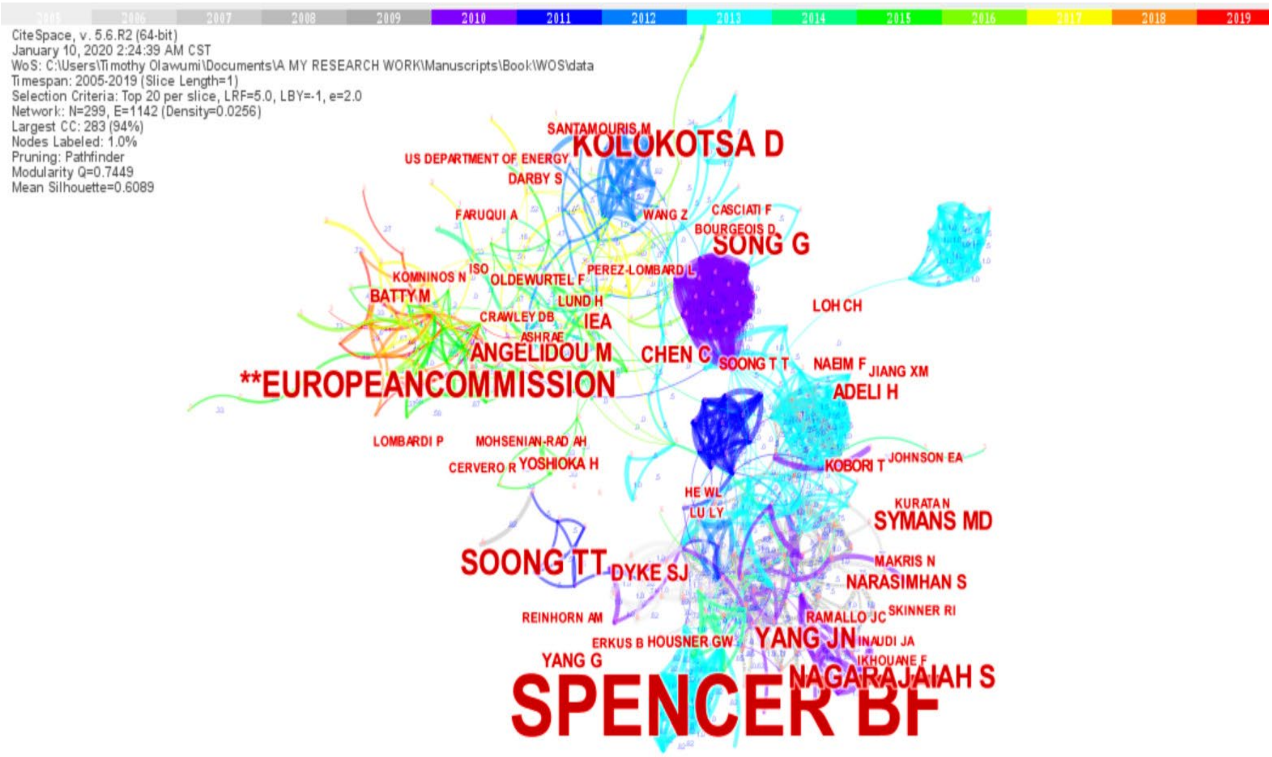

Figure 3: Network analysis of Authors co-citation

The authors, with high citation bursts within a short period, were identified from the analysis network (Figure 2). These authors include 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, research papers by these authors have shaped the concept and research field of smart buildings and smart cities. Hence, their works are worth following.

Meanwhile, nodes with betweenness centrality and their values were identified from the analysis network which are 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 have 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.

3.4 Document co-citation network

Figure 4 shows the document co-citation network with the modularity of 0.83 and a mean silhouette of 0.41, which depicts a loosely clustered network but less homogenous. Table 1C shows the list of the top 5 documents that are well cited in the dataset. These documents are well placed in the network, as shown in Figure 4. Notably, Neirotti et al. (2014) examined the concept of smart city and assessed the trend at a global level. It identified six categories, subcategories and defined the coverage index (CI). The study revealed the lack of a unified concept for smart cities and concluded that the concept is contextual. Similarly, Caragliu et al. (2011) and Albino et al. (2015) also examined the concept of a smart city. This suggests that the smart city concept is multifaceted and dynamic.

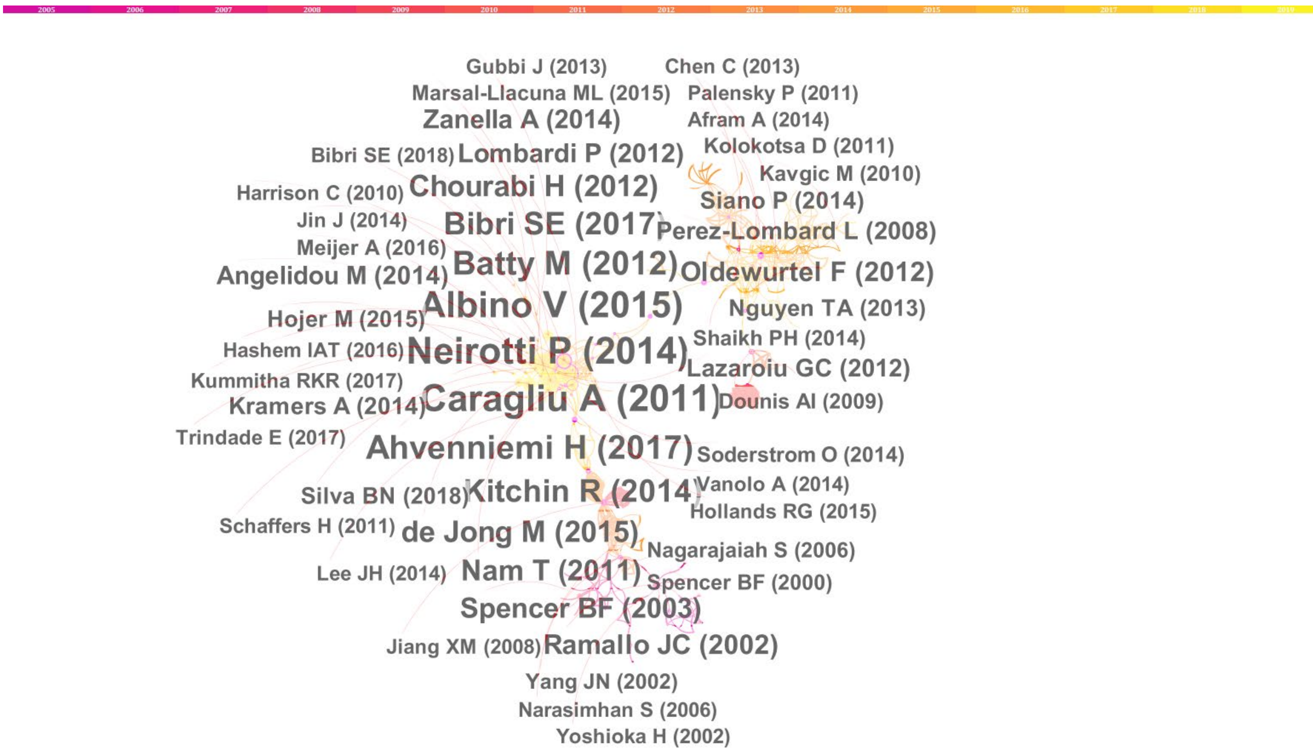

Figure 4: Document co-citation network

18 of the articles received citation burst and the top 5 includes: 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 bust includes 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 relate more to smart buildings, which include smart structures, while the latest articles with burst relate more to smart cities. It can be deduced that the concept of smart structures precedes the smart cities' concept, which has been gaining more attention in recent years.

4. Conclusions

The use of scientometric analysis has been gaining widespread usage because of the increase in research outputs. The use of scientometric analysis varies depending on the study's aim, which may 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. This chapter presents a simplified step of the analysis and adopts the research domain of smart buildings and smart cities as an example for further illustration. The method would continue to gain widespread usage in research because of its usefulness and the meteoric research outputs over the years.

Albeit scientometric analysis is easy to use and apply to the corpus of articles, however, it still requires a good understanding of the research domains. Also, the method can be used as a secondary research method in the built environment research because of its rigor and quantitative justifications. In this chapter, articles not written in English were not part of the analysed corpus, hence a limitation to the study. Also, researchers interested in the application of the scientometric review to analyse 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," "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, USA, Italy, Austria, the UK, 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.

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