



Sustainability in Construction Management Research: A Bibliometric Review

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Abstract— The growing field of sustainability is growing rapidly in the construction management research and little research has been done in the past on this field. A few published studies have been researching on environmental review methods, life-cycle assessment (LCA), sustainability, energy efficiency, and hazardous gas emissions, where there are close links to the issue of waste and construction materials. The extensive bibliometric and network analysis presented in this paper, which utilized the Web of Science database, offers novel and new understandings into the development of the construction management study field and its expanding reporting of sustainability-related subjects. The research field is identified using bibliometrics in the first step, which identifies 328 published studies. Network analysis is used in the second step to find significant publications, authors, and established research groups. Key research areas, the degree to which sustainability is taken into consideration, interrelations, and patterns of collaboration in the field are all identified via a more extensive content analysis. Data mapping techniques use visual representations to show how publications have changed over time and to pinpoint areas of future research interest, namely in sustainability.

Index Terms—*Bibliometric; Construction Management; Literature Review; Sustainability*

I. INTRODUCTION

Sustainability can be defined as improving social, economic, and environmental conditions for both the current and future generations, as well as boosting people's capacity to live in a healthy environment. Since the World Commission on Environment and Development's report, "Our Common Future" (WCED) in 1987, which called for a strategy that united development and the environment, sustainable development has received considerable attention across all countries [1]. The report also made a declaration that fulfilling current demands without sacrificing the ability of future generations to meet their own needs is the definition of sustainable development. According to Sachs and Warner [2], sustainable development will be the biggest problem of the twenty-first century. According to Vollenbroek [3], sustainable development requires a balance between the technology at hand, innovative growth plans, and governmental policies.

In recent years, Since resource preservation has been globally driving a rapid development of sustainable construction, the construction industry faced numerous operative, tactical, and managerial challenges. Additionally, the building sector makes a substantial contribution to meeting societal needs by raising quality of life. [4-6]. However, 45%-65% of the waste disposed in landfills and 35% of global CO₂ emissions are attributable to this industry. [7]. Furthermore, a significant number of hazardous pollutants are produced by the construction industry and its related activities. Particularly, activities associated with the

construction process contribute to the production of 30% of the planet's greenhouse gas emissions, with the transport and dispensation of construction resources accounting for 18% of CO₂ emissions. [8].

In this light, it is clear how important it is to study sustainability in the civil construction industry, Corporations are gradually becoming more concerned that keeping a competitive edge requires more than just offering clients high-quality products and services at reasonable rates. Customers assume corporations to uphold moral standards, be ethical, and display social responsibility. [9].

In the construction industry, sustainability may help reach the requirements of both the current and future generations by preserving energy, freshwater, and natural resources through reuse, recycling, continuous innovation, and reducing waste and pollution. Aigbavboa, Ohiomah [10] report that Proactive measures are taken to lessen or eliminate the negative environmental effects of construction activity.

According to Lima, Trindade [7], few scholars has conducted a literature review related to Sustainability in construction Management literature. Despite the rich knowledge that these works have contributed, we contend that further examination of this literature utilizing unbiased bibliometric approaches and network analysis potentialities can offer further insights that were not fully appreciated in earlier research. Bibliometric tools provide an alternate viewpoint about Sustainability by utilizing the most recent scientometric, informetric, and bibliometric methodologies and procedures. Fahimnia, Sarkis [11] emphasize that bibliometric methods can be particularly effective in network

analysis for detecting both established and developing theme topics. Additionally, it can be used to pinpoint research groups and scholars who have demonstrated how different schools of thought may have developed in response to author and institutional traits. By capturing the more current themes that these academics have studied, identifying the more significant researchers inside the clusters creates the framework for identifying additional emergent study fields.

By providing a thorough analysis of the Construction Management's (CM) rapidly expanding topic, this work adds to the body of literature on the subject. To provide a more thorough and comprehensive view of the subject, the study particularly examines the traits and connections among all the papers that have been produced in the field of CM over a given period of time. Therefore, it goes beyond simple literature reviews, which may not be exhaustive enough, or meta-analyses, which may not emphasize the connections between the papers in the subject as well. As a result, the paper gives the reader a thorough overview of the topic by utilizing the potent network analysis and bibliometric tools with machine learning skills. The research ends with a pool of 328 published papers and narrows it down to the researchers and publications with the most influence. A thorough network analysis is then finished, resulting in the identification of key clusters. These clusters are then used to categorize published works according to topic, identify potential research areas and systems of thought, and analyze the clusters' temporal development (i.e., from 2018 to 2022). These findings provide new information about the areas of current research as well as the position of the study of sustainability within the field of CM. The debate also offers some directions for additional study.

II. RESEARCH METHODOLOGY

This section describes the methodology used to conduct this bibliometric analysis on sustainability in the CM literature. The analysis was based on Seuring and Müller [12] quantitative technique, which includes the four processes of gathering, describing analysis, choosing categories, and material assessment. This kind of review uses reproducible techniques to find, pick, and assess publications in the literature on the topic of the research being looked at.

A. Initial Search Results

Following the procedures of Lima, Trindade [7], In the Web of Science's main collection, we looked for primary research using a variety of key terms that the authors came up with during a brainstorming session. These included a collection of words linked to sustainability; a set of words connected to CM; and a list of search phrases that were deemed necessary for this study to gather the most information possible while adhering to the defined scope. It's crucial to remember that these search terms were connected using the Boolean "and" logic while considering publications on this subject between January 2018 and September 2022. To cover all the data in the database on this subject, The title, abstract, and keywords of each article were all searched for

under each topic.

8560 items were returned by this search. Only content from linked fields was considered. To focus the results, exclusion criteria were created and used. 328 articles were acquired for analysis after exclusion criteria filters were applied.

B. Initial Data Statistics

The number of papers published between 2018 and 2022 about Sustainability in CM is depicted in Fig. 1. The elbow in 2020 does not suggest that the pace of publications is slowing down. The publications published in that year were affected by the COVID-19 outbreak. These preliminary findings indicate that the area will continue to draw a lot more attention for research because it has not yet reached a mature stage.

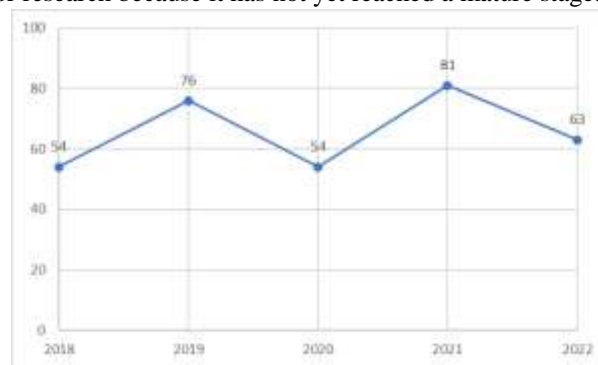


Fig. 1. increase over time in the quantity of sources.

If only journals and conference proceedings are taken into account, it appears that 116 studies, or 35% of all the publications under consideration, have been published in 6 journals/repositories. Table 1 below lists the journals and conference repositories that published these publications. Because the results we would have gotten for each outlet individually would have been very little or many times zero, we present the results as a whole rather than on an ongoing basis.

Table 1

The top 6 publications influencing the study field

Source	Record Count	% of 328
SUSTAINABILITY	63	19.21%
JOURNAL OF CLEANER PRODUCTION	26	7.93%
INTERNATIONAL JOURNAL OF CONSTRUCTION MANAGEMENT	9	2.74%
BUILDINGS	6	1.83%
ENVIRONMENT DEVELOPMENT AND SUSTAINABILITY	6	1.83%
SMART AND SUSTAINABLE BUILT ENVIRONMENT	6	1.83%

III. DATA ANALYSIS

A. Bibliometric Analysis

For the bibliometric analysis, we employ several software programs. Due to its ability to evaluate a variety of datasets, including Web of Science, BibExcel was chosen [11]. Furthermore, we both use VOSviewer [13], a network analysis program that BibExcel is compatible with. As suggested by Fahimnia, Sarkis [11], we first conduct bibliometric analyses using BibExcel, but we also utilize Excel and Notepad.

B. Affiliation Statistics

The organizations', contributing to the research sample, geographical locations were revealed by an initial examination (see Table 2). Despite the fact that Malaysia, which continues to be a significant market for publication, was the source of the first articles on 2018 [14], 17.5% of the relevant research is conducted in China.

Table 2
Geographical locations of the contributing organizations.

Field:	Record Count	% of 328
Countries/Regions		
PEOPLES R CHINA	58	17.68%
AUSTRALIA	35	10.67%
BRAZIL	24	7.32%
SPAIN	22	6.71%
ENGLAND	21	6.40%
MALAYSIA	21	6.40%
USA	17	5.18%
INDIA	15	4.57%
IRAN	14	4.27%
GERMANY	12	3.66%

Table 3
Top 10 contributing organizations

Field:	Record Count	% of 328
Affiliations		
HONG KONG POLYTECHNIC UNIVERSITY	11	3.35%
DEAKIN UNIVERSITY	7	2.13%
TECHNICAL UNIVERSITY KOSICE	7	2.13%
EGYPTIAN KNOWLEDGE BANK EKB	6	1.83%
INDIAN INSTITUTE OF TECHNOLOGY SYSTEM IIT SYSTEM	6	1.83%
IRAN UNIVERSITY SCIENCE TECHNOLOGY	6	1.83%
KWAME NKRUMAH UNIVERSITY SCIENCE TECHNOLOGY	6	1.83%
NATL INST CONSTRUCT MANAGEMENT RES	6	1.83%
UNIVERSITY OF NEW SOUTH WALES SYDNEY	6	1.83%
CITY UNIVERSITY OF HONG KONG	5	1.52%

The top 10 contributing organizations are included in Table 3 along with the total number of publications they have contributed thus far.

C. Keyword Statistics

The 328 papers were used to create a pool of 1603 keywords. The minimum number of instances for a keyword was set by default in VOSviewer at 5, and the 83 keywords that were found met that requirement. The top keywords are constantly depicted in Tables 4

Table 4
The 10 terms that appear most frequently in publication titles.

Keyword	Occurrences
Sustainability	103
Management	37
Performance	37
Framework	35
Design	34
Social sustainability	26
Construction	25
Sustainable construction	25
Buildings	21
Construction industry	21

IV. NETWORK ANALYSIS OF PUBLICATIONS

We employ the two-step network analysis proposed by Fahimnia, Sarkis [11].

First, a co-citation analysis identifies the most significant authors and their local relationships to one another within our dataset.

Next, we gauge the strength of the links between articles using citation-based metrics.

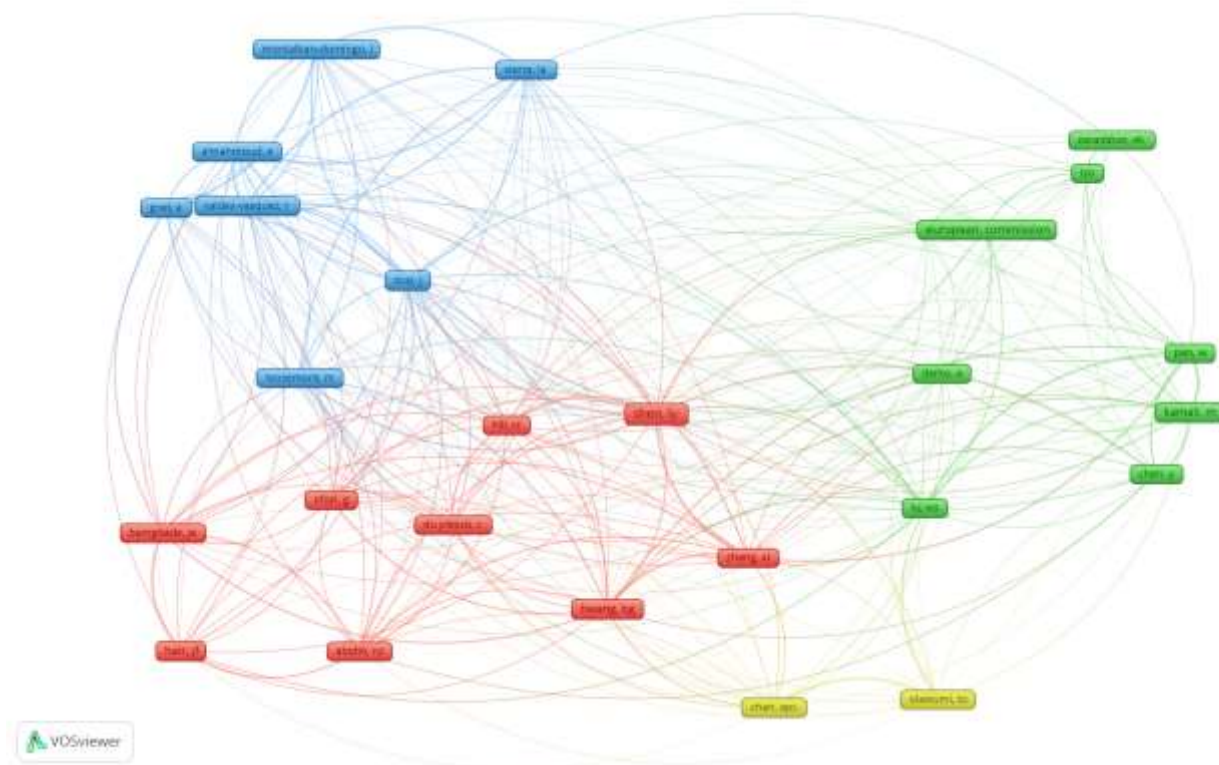
A. Author visualization

By establishing a cutoff point of a specific number of citations per author, we combed through the authors to discover those who had the most influence [15]. The researcher has significant flexibility over the citation levels above which papers will be retrieved when choosing the clustering technique [16].

The formal considerations that promote meaningful interpretation "may alter the threshold for citation and co-citation [17]. If the threshold is set too low, we can end up with a "huge component," as Small [18] refers to it, in which practically every document is interconnected. Although a big cluster of this size demonstrates the individuality of each document, we are unable to observe and analyze the differences among them (as was the case with our low cutoff). However, a threshold that is set too high could lead to

distortion and break important links [17]. Given that the majority of published co-citation analyses used distinct samples, it seemed questionable to apply or advise a specific criterion based on prior studies (e.g., number of documents, their connection together, and the nature of the same subject). Because we needed both rigor and parsimony in the results, we decided on a rigorous cut-off value of 20 local citations as a pertinent trade-off for the author visualization and 10 for literature classification.

The networks of co-citation relationships for writers as generated by VOSviewer are depicted graphically in Fig. 2a. A publication is more likely to cite authors of the same color in tandem. The density of cocitation for authors is displayed in Fig. 2b; the larger the label size, the more frequently the author is mentioned.



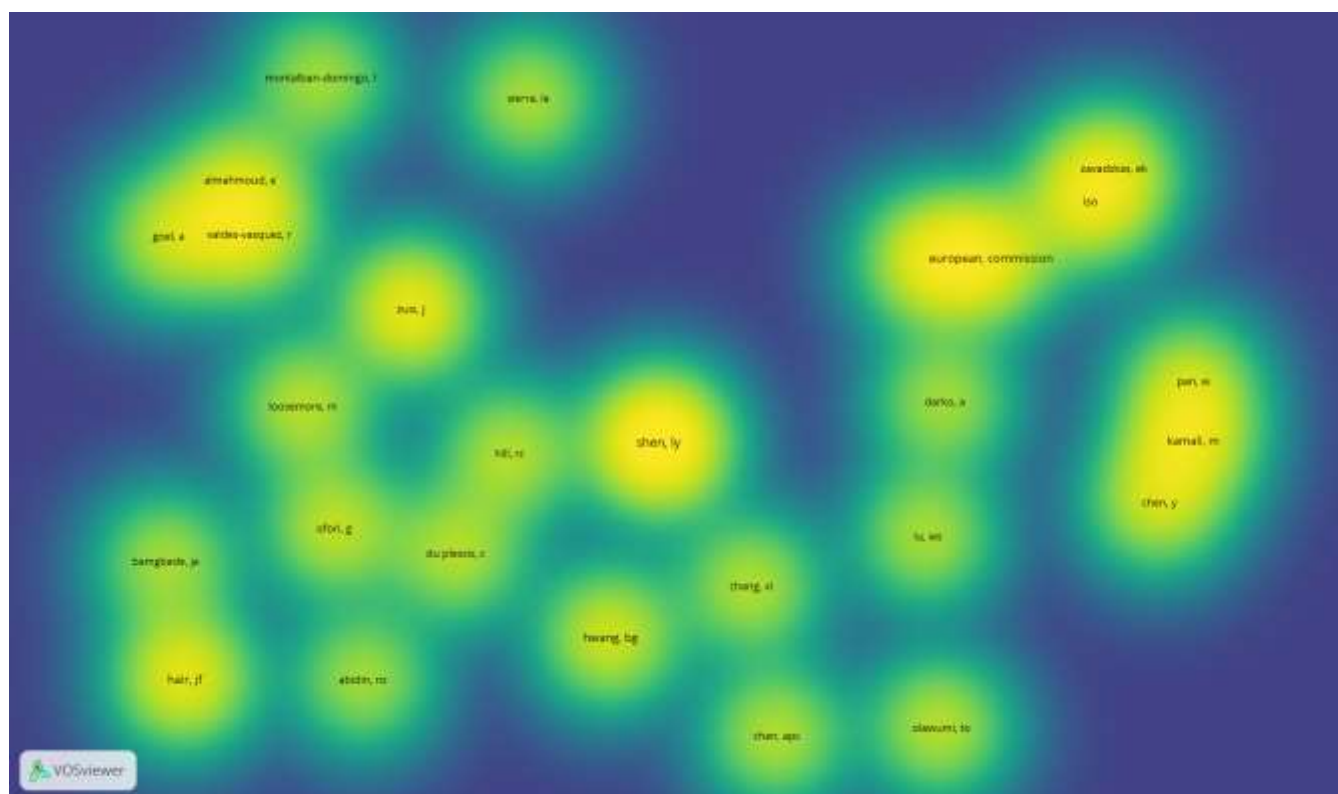


Fig. 2. a). Illustration of authors networks. **b).** Illustration of the density of authors.

According to the amount of local citations, or the number of citations inside the 328 papers inside our dataset, Table 5 lists the top 10 most significant authors.

Table 5

The 10 authors with the highest citation scores.

Author	Citations
Shen, Ly	49
Zuo, J	34
Hair, Jf	32
European, Commission	29
United, Nations	28
Hwang, Bg	27
Kamali, M	25

Valdes-Vasquez, R	24
Ofori, G	24
Chen, Y	24

B. Data clustering:

This procedure was used on the publishing network. We set the requirement for membership into a particular cluster at 10 local citations per article in accordance with McCain [16] criteria. Four significant clusters were established as a result of the investigation.

In cluster 1, there were 9 publications; in cluster 4, there were 2 publications. Fig. 3 shows the clusters in visual form.

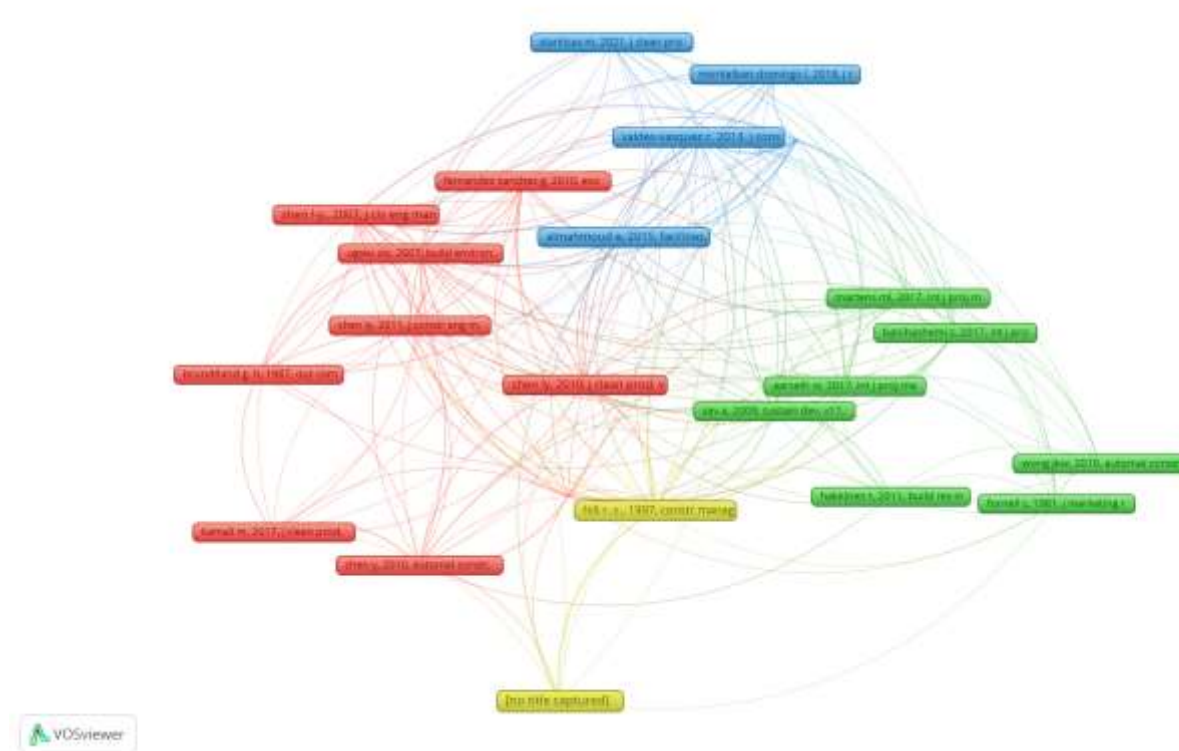


Fig. 3. Study of co-citations by publication names.

We base our study on the presumption that articles within a cluster have strong cocitation relationships and that publications that are more frequently co-cited are more likely to present related subject areas [19]. This leads to the conclusion that "careful analysis of publications of one cluster can define the area of research concentration of that cluster" [11]. According to the number of local citations, we rated the top papers in each cluster.

V. DISCUSSION

A. Key research topics

According to Fig3, main research topic in the area of sustainability in CM literature are 4-fold and follow one another in a logical sequence. The first cluster (red) contains 9 works related to the Sustainable Performance. The second cluster (green) contains 7 works related to barriers and drivers for sustainable building. The Third cluster (blue) contains 5 works related to social sustainability in construction. Finally, the yellow cluster related to Sustainable construction frameworks.

B. Field relationships and patterns of cooperation

The citation and co-citation studies additional presented that influential work of authors such as Shen Ly [20-23] relating to performance indicators of sustainability in construction were in the center of the network. In addition, the work of Zou j [24] relating to green buildings was cited 34 times. Zhang, Wu [25] paper for assessing sustainability in construction projects also have a strong total link strength with other works.

CONCLUSION

The aim of this study was to suggest a structured representation of Sustainability in research CM field. Numerous publications have been made recently, although despite several hesitant analyses of the CM literature, no bibliometric study including a network analysis was conducted. This initial study makes use of both approaches' strong structuring and representational capabilities (i.e., network analysis and bibliometric study) to fairly present the most significant figures in the field as well as the newest areas of study, with a focus on the sustainability.

The findings imply that older papers have greater sway. A co-citation analysis, however, introduces some bias into the circumstance. Although this kind of analysis is excellent at examining the historical intellectual influences or the body of knowledge in a field of study, it falls short when describing the most recent publications because older publications had the chance to accumulate citations over time, whereas more recent ones did not. Another type of study, called a bibliographic coupling frequency (BCF), can be performed to at least somewhat offset this. Since BCF analysis only finds prominent authors and articles that are still a small portion of the core set, it is more suitable for investigating recent publications [26].

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