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SUSTAINABLE CONSTRUCTION PLANNING AND REPORTING: A SCIENTOMETRIC REVIEW

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Abstract

The concept of sustainable construction planning and reporting influences global actions and decisions, and existing literature research is not able to systematically analyse and present global trends. A scientometric analysis of current literature, including 524 bibliographic records from the Web of Science (WOS) database published in 2016-2023, was used in this project. The results show that annual production will peak in 2022, with Thaheem, Muhammad Jamaluddin of the National University of Science and Technology, Pakistan, being the most prolific author. Due to collaboration between co-authorship networks, China, the United States and Malaysia are the top three productive countries, with Spain showing the highest increase in research output in 2016 and England showing the greatest centrality. Hong Kong Polytechnic University and the University of Tun Hussein Onn in Malaysia were recognized as the most productive institutions. The co-occurrence keywords were topped by performance, construction, and management. The authors identified new research cluster such as project success, sustainable development goals and mid-term assessment. This project will familiarize academics, policy makers and industry experts around the world, with existing trends and patterns in sustainable construction planning and reporting.

Keywords: Sustainability, Sustainable Infrastructure, Construction Planning, Sustainable Construction, Construction Reporting, Scientometric Analysis.

1. Introduction

Project-based organizations now consider the skill of incorporating sustainability concepts into project planning, design, construction, and management to be an essential social obligation. According to Awuzie and McDermott (2013), a high degree of asset specificity makes building projects complicated and uncertain because numerous requirements must be satisfied during the design and construction phases. The viability of traditional construction methods is under threat due to increased pressure to comply with global environmental standards while upholding social responsibility, so project-based organizations must look for ways to transition from traditional to sustainable construction methods that support the achievement of corporate goals and objectives without harming the environment (Oke et al., 2019).

In order for any sustainable solutions to be applied successfully, it is necessary for all parties involved to play their respective roles in a supply chain where their activities have an impact on the entire world, according to Xue et al. (2018). Therefore, it is anticipated that parties will come together and coordinate their efforts to create a circular economy where private contractors are typically encouraged by government regulators to implement sustainable production measures rather than simply considering business benefits (Johnsson et al., 2020).

It is widely known that the construction industry is prone to producing large amounts of garbage, which accounts for about 30% of the exploitation of natural resources and 25% of worldwide solid waste (Benachio et al., 2020). Despite the substantial waste, construction operations are typically held responsible for polluting water sources and causing long-term climate change. Such wastage poses considerable dangers to the accomplishment of environmental sustainability. Due to the labor-intensive nature of construction projects and the involvement of numerous stakeholders, there are significant sustainability risks associated with the use of materials like wood, limestone, and clay (Sunke and Schultmann, 2009). However, the scope of the influence extends beyond the ecological environment to include the society and economy as well.

Based on the European Union (2012) and the Europea Council for an Energy Efficient Economy (2013), the construction sector has the lowest productivity globally, with other industries, like production, recording an average growth of 100% since 1964, while the construction sector has dropped by 10% on average. The construction of buildings and the operation of occupation and habitation services, are major forms of consumption of energy resources and materials, notjust during the completion stage, but also during all periods of the existence of constructed infrastructure (otherwise known as construction life cycle) (Ellabban et al., 2014; Alwi et al., 2016). In like manner, Heede et al. (2012) highlights life-cycle phases of a construction project such as manufacturing of materials and building products, construction and utilization of buildings with respect to ecological, social and economicfactors.

1.2 Knowledge gap and research objectives.

Sustainable construction planning and reporting is quite broad and applies to different areas and sectors. Previous revisions of the concept of sustainability in the construction sector have not sufficiently considered sustainability aspects in construction planning. This article focuses on this vulnerability. Falkenbach et al. (2010) examined the drivers of sustainable construction by analyzing the perspectives of real estate market participants; Wong and Zhou (2015) studied the concepts of sustainability and BIM (Green Building Information Modeling) for different phases of building development.

Lele (1991) conducted a review of the concept of sustainable development, with discussions focusing on factors such as community participation, environmental degradation, economic growth, and internationalization. The research of Darko et al. (2017) helped to classify and categorize green building factors into several sub-levels, such as corporate-level drivers, external drivers, individual-level drivers, property-level drivers, and project-level drivers. Some studies have used systematic literature reviews to highlight practical sustainability strategies applicable to project organizations to increase project performance (Aarseth et al. 2016). In other cases, some researchers used Scopus, Wong and Zhou (2015) used 84 journal articles, while Darko et al. (2017) used 42 journal articles. In this study, we use a much older Web of Science (WoS) database with a relatively larger number of articles.

From the foregoing research gaps and identified limitations, this article provides a detailed overview of research on sustainable construction planning and reporting through a scientometric-based review. The proposed scientometric review addresses the limitations of traditional literature reviews, which according to Markoulli et al. (2017), lack consistency in some contexts. A scientometric analysis was performed to visualize the progress of ongoing research and to help identify influential thematic and strategic authors, journals, countries, and organizations/institutions, as well as to track groups of research keywords and their evolution. 524 articles published in the Web of Science (WoS) database were analyzed and the results of the cluster analysis identified research topics and keyword trends for future articles.

The issue of sustainable construction planning and reporting is a critical issue that has gained prominence in research, particularly in global policy frameworks and statements such as the United Nations Sustainable Development Goals (SDGs) 2015–2030. It becomes important to monitor and identify existing research trends and themes and to map the various connections, interrelationships, and linkages between researchers and research clusters, as very few studies are able to do, in studies related to sustainable construction planning and reporting.

The following section reviews the research methodology (Section 2), scientometric analysis (Section 3), identifying major networks, clusters, and themes, highlighting previous research on sustainable building design and reporting, and finally covering conclusions on future research directions (Section 5). Our presentation aims to enhance existing literature reviews by highlighting trends, clusters, and patterns, connecting networks of key researchers, institutions, and countries, and identifying new areas of interest for future research. , with direct implications for practitioners and policymakers.

2.0 Study Methodology

This article reviews the current literature using scientometric analysis. The authors aim to map scientific knowledge and to trace existing themes and trends that reflect the themes of previous research papers related to the subject of sustainable construction planning and reporting, and the setting and promulgation of the United Nations Sustainable Development Goals. (SDG) on December 25, 2015. The research design is presented in Figure 1

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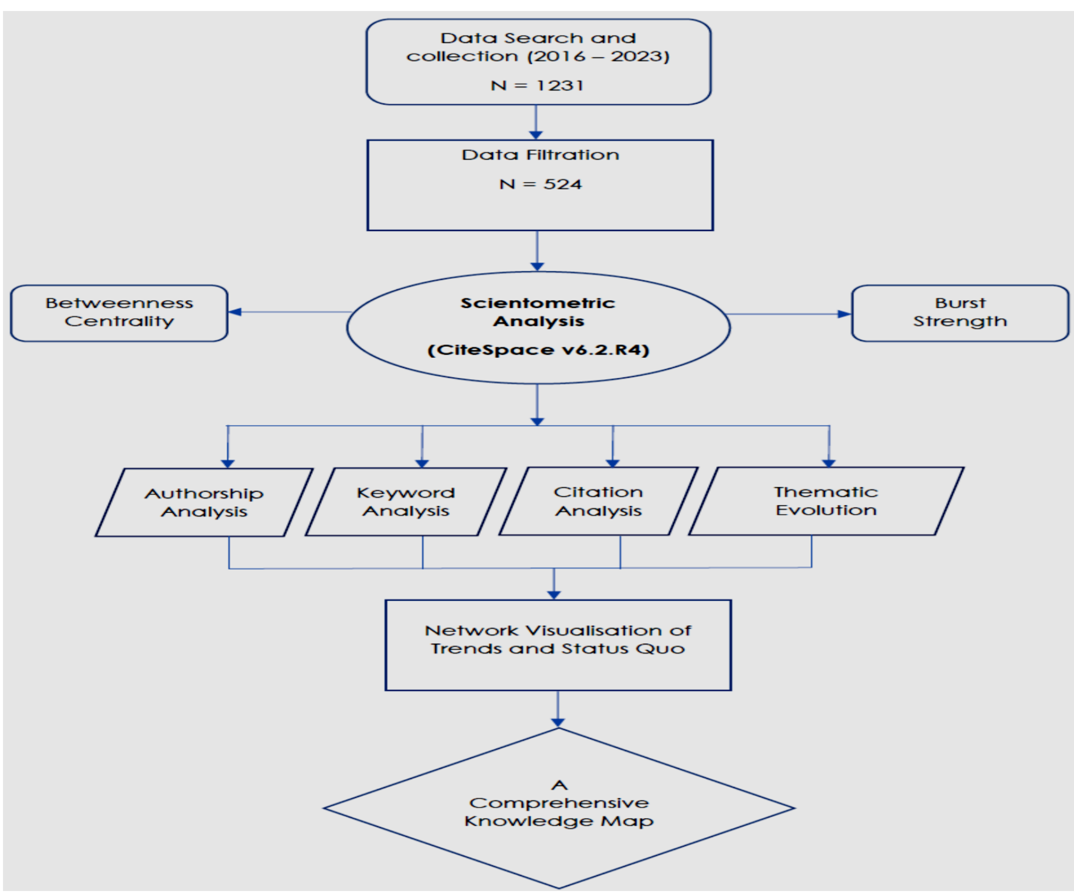

Fig. 1. Research design

2.1 Search Protocol &Data Collection

Most researchers use databases like Web of Science (WoS), Scopus, and Google Scholar to facilitate research, although some of these databases have known strengths and limitations. Orduna-Malea et al. (2017) found that while Google Scholar covers a very large scope of literature, the quality of the data it contains is not very reliable and researchers are sometimes dealing with duplicate data. Martin-Martin et al. (2018) argue that Scopus and Web of Science (WoS) are quite similar in terms of data coverage. For the purposes of this article, all publications were retrieved from the Web of Science (WoS) database, a citation database that has access to multiple databases and helps provide citation data and references in conference proceedings, scholarly journals, and articles from various scholarly disciplines. The core collection includes 1.5 billion reference articles from 1900, 74.8 million total records, 10.1 million total open access records, and over 21,100 unique publications worldwide, peer-reviewed and of high quality in 254 areas of scholarship, arts, humanities, and social sciences. Article types were limited to journals, conference proceedings, and reviews, while book reviews and editorial articles were omitted. The search protocol is presented in Fig. 2,as applied to the WoS database: *Sustainable Construction* Planning OR Sustainability Construction Planning OR Green Construction Planning OR Sustainable Construction Factors OR Sustainability Construction Factors OR Green Construction Factors OR Sustainable Construction Objectives OR Sustainability Construction Objectives OR Green Construction Objectives AND Sustainable Construction Reporting OR Sustainability Construction Reporting OR Green Construction Reporting. This applied search protocol ensured that related articles were only identified if keywords and terms were defined in their titles, keywords or abstracts.

To uniquely identify documents from this study period (2016-2023), the search protocol was modified to filter data within the period. 1,231 documents were identified. By further filtering the data with the ability to identify irrelevant documents outside the research area, the data was streamlined with WoS categories such as Green Sustainable Science Technology, Engineering Civil, Construction Building Technology, Engineering Environmental, Engineering Multidisciplinary, Operations Research Management Science, Transportation and Engineering Industrial, and delivered 524 results that served as input data for Cite Space v6.2. R4 for scientometric analysis.

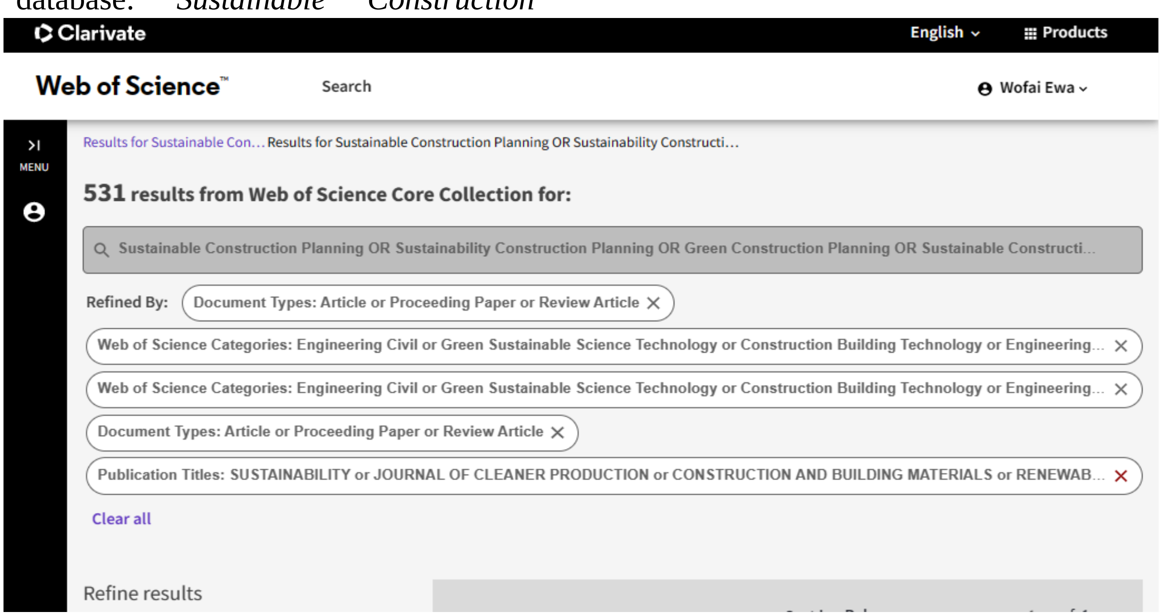

Fig. 2. Search protocol for the WoS database

The results of the above protocol do not guarantee the inclusion of all available articles on the subject. However, the research protocol ensures that the results identified are of high and reasonable quality and are able to represent the evolving trends and the status quo of the topic.

2.2 Scientometric Analysis

Mulchenko (1969) describes "scientometrics" as a quantitative method for examining trends in the development of science and as a technique for measuring the impact of research. Borner et al. (2003) emphasized the progress of science and extended the narrative to include understanding the citation process and mapping knowledge structures and evolutionary trends based on a credible example space of high-quality scientific datasets. Through the compilation of bibliometric datasets, scientometric analysis supports scholarly efforts toward systematic literary discovery by quantifying concepts in the existing literature that would otherwise be overlooked in qualitative literature reviews (Su & Lee, 2010).

Using text-mining techniques, scientometric analysis visually represents the bibliometric network of past research using various keywords and subheadings, allowing data miners and researchers to identify research fields in different areas and research gaps while reducing subjectivity (Salihu et al., 2022). A scientometric analysis is also considered a method of scientific knowledge mapping, where scientific mapping is a general process of analysis and visualization of research fields, aimed at discovering the intellectual structure of a scientific field (Chen 2017), useful for visualizing notable trends and patterns in a collection of literature and bibliographic data (Cobo et al. 2011).

2.3 Software Tool Selection

Cobo et al. (2011) believe that several software tools are available to aid in the scientific mapping of the extensive existing literature. Whilst some software tools are designed for scientific mapping in general, many others are specifically designed for specific applications within the scientific mapping philosophy and care should be taken in choosing the right software tool as the software tool chosen will be relevant to the mapping and scientific work of data visualization is crucial records. This is consistent with the argument by Van Eck and Waltman (2010) that software tools should be chosen based on their characteristics, strengths, limitations, and most importantly their relevance to the study being conducted, seeing that text-mining tools are developed to analyze and visualize bibliometric networks of existing literature in specific scientific domains (Van Eck and Waltman, 2014).

For this project, CiteSpace v6.2.R4 was used for scientometric analysis. The Cite Space software is a Java application for the analysis and visualisation of citation networks (Chen, 2004) and deals with the identification of all emerging trends and turning points in science (Chen, 2006) with unique advantages that analyze and visualize scientific literature. By systematically creating charts and grids, one can more easily understand existing research by helping uncover hidden patterns and implications in large amounts of information. For all networks and diagrams generated by Cite Space, there are two main quantifying measures for finding key nodes called ‘betweenness centrality’ and the ‘burst strength’. Equation 1 shows the formula for calculating centrality between nodes as Freeman (1977) notes that the value of betweenness centrality can be calculated from the "ratioof the shortest path between two nodes to the sum of all such shortest paths".

$$Centrality(nodei) = \sum_{i \neq j \neq k} \left(\frac{\mathrm{P}jk(i)}{\mathrm{P}jk} \right) \quad (1)$$

P_{jk} represents the number of shortest paths between node j and node k, while P_{jk} (i) represents the number of all paths passing through node i. Burst detection analysis uses an algorithm developed by Kleinberg (2003) to highlight abrupt changes in citations over time. Pathfinder is useful for cleaning up any diagram and network, removing all redundant connections between nodes while improving the readability of the diagram and network (Chen and Morris, 2003). Finally, thematic cluster analysis is used as a basis for critical examination and helps to identify research clusters and topics, since cluster analysis has been recognized as a common technique for analysing statistical data and discovering insights in science, and revealing the underlying semantic themes developed from aggregated data (Hossain, 2011).

After data search, collection, and processing, the final records of the 524 identified papers were entered into Cite Space as research data, using scientometric techniques, and generating information such as Annual Publication Output, Co-Authorship Network, Countries Network, Keyword Co-occurrence Network, Journal Co-Citation Network, Author Co-Citation Network, and Thematic Cluster Analysis. The cited articles are categorized according to different topics and groups and included in a literature review in order to identify research topics and corresponding trends.

3.0 Scientometric Analysis

This section provides details the annual publication output, co-author analysis, co-word analysis, cluster analysis, co-citation analysis, and the evolution of keywords and themes, using the Cite Space software.

With this study covering an eight-year period (2016-2023), the authors used a time-slicing function, a divide-and-conquer strategy that divides the study period into a number of larger time windows (Chen, 2005b). In this research, a slice of 1-year was adopted, with the pathfinder utility – regarded as the better choice (Chen, 2014) – used for the network-pruning process, by removing redundant links. Chen and Morris (2003) describe further details regarding network pruning.

3.1 Annual Publication

Figure 3 presents the yearly outlay of all 524 records from 2016 to 2023, with the highest peak point and most productive year identified in 2022. The research in 2022 primarily focused on fire resistance of geo-polymer concrete (Amran et al., 2022), Critical success factors for green building promotion (Chen *et al.*, 2022), What drives clients to purchase green building? The cybernetic fuzzy analytic hierarchy process approach (Durdyev et al., 2022), Stakeholder relationships in off-site construction (Nguyen et al., 2022).

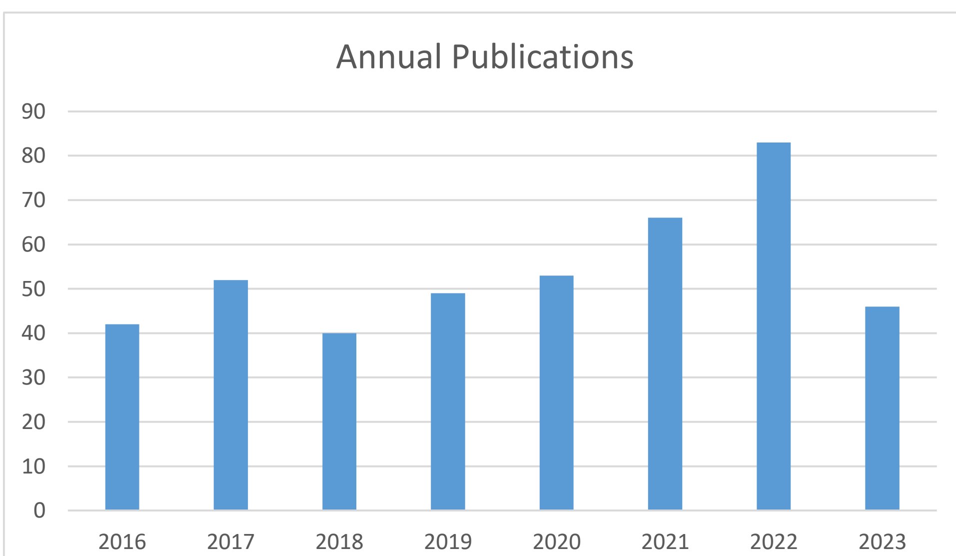

Fig. 3. Annual Publication Output

3.2 Co-Author Analysis

Using the data from the WoS, networks of co-authors, countries/regions and institutions can be generated.

3.2.1 Network of Co-Authorship

Having the author at the center of research and the subject of academic communication and correspondence, the co-authorship network represents the core basis for the analysis of various types of co-occurrence relationships. The top-ranked authors by citation counts are Thaheem (2017) with a citation count of 4, the second one being Maqsoom (2022) with a citation count of 2, while the third is Aibinu (2017) with a citation count of 2. Others are shown in Table 2.

Table 2: Top 10 Most Productive Authors

Citation Count	Author	Year
4	Thaheem, Muhammad Jamaluddin	2017
2	Maqsoom, Ahsen	2022
2	Aibinu, Ajibade	2017
2	Ahmad, Tayyab	2017
2	Bata, Antonella	2017
2	Mohandes, Saeed Reza	2022
2	Durdyev, Serdar	2022
2	Yang, Wu	2022
2	Ismail, Syuhaida	2022
2	Yan, Jun	2022

For this paper, the co-authorship network is as shown in Fig. 3, with each node representing a lead author, and the edges depicting collaborative links. This study contains 296 nodes and 1137 edges/links in the created co-authorship network, with node sizes representing publication count, while edge/link thicknesses indicate the levels of cooperative relationships per year. Figure 3 also reveals research communities, signifying strong author collaborations within these communities, and as in all such networks, the researcher’s influence relies on their connection to other researchers within the network.

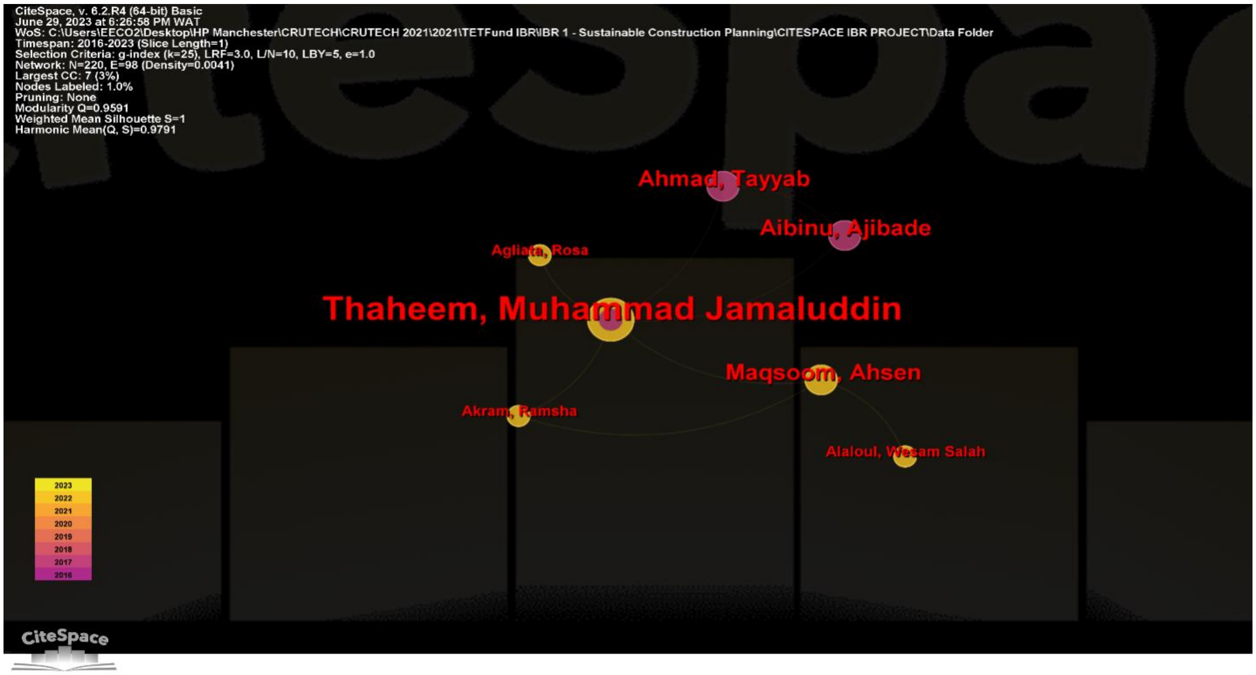

Fig. 3. Network of Co-Authorship

3.2.2 Network Co-Author's Countries/Region

The top-ranked countries/regions by citation counts are Peoples Republic of China with a citation count of 74. The second one is USA with a citation count of 53, while the third is Malaysia with a citation count of 49. Others are shown in Table 3.

Table 3: Top 10 Most Productive Countries/Regions

Citation Count	Country/Region	Year
74	PEOPLES R CHINA	2016
53	USA	2016
49	MALAYSIA	2016
47	AUSTRALIA	2016
42	ENGLAND	2016
24	ITALY	2017
17	CANADA	2016
16	PAKISTAN	2017
15	SOUTH KOREA	2016
14	SPAIN	2016

Fig. 4 presents the generated network for countries/regions, with nodal size representing article publications within the country from 2016 to 2023. A significant number of related articles in these countries/regions indicates maturity and high awareness in these countries/regions. Measured by the number of citations, the People's Republic of China has made the most eloquent contribution to the development of the research field, and on the basis of international cooperation, associated scholars in China are engaged in broader cooperation and communication with scholars from other regions.

Fig. 4.: Network Co-Author's Countries/Region

3.2.3 Network of Co-Author's Institutions

The top-ranked institution by citation counts are Hong Kong Polytechnic University with a citation count of 10. The second one is University of Tun Hussein Onn Malaysia with a citation count of 9, while the third is Egyptian Knowledge Bank (EKB) with a citation count of 8. Others are presented in Table 4.

Table 4: Top 10 Productive Institutions

Citation Count	Institution	Year
10	Hong Kong Polytechnic University	2016
9	University of Tun Hussein Onn Malaysia	2018
8	Egyptian Knowledge Bank (EKB)	2018
8	Arizona State University	2016
8	Arizona State University-Tempe	2016
7	University of New South Wales Sydney	2017
6	Deakin University	2021

6	Chinese Academy of Sciences	2017
6	Universiti Sains Malaysia	2016
6	Chongqing University	2017

Figure 5 shows the network generated for the institution, with the node size representing the total article count in the institution over the period 2016 – 2023. The analysis shows that the contribution of these institutions is more significant than the others. The document count from these institutions shows the maturity and progress in this area.

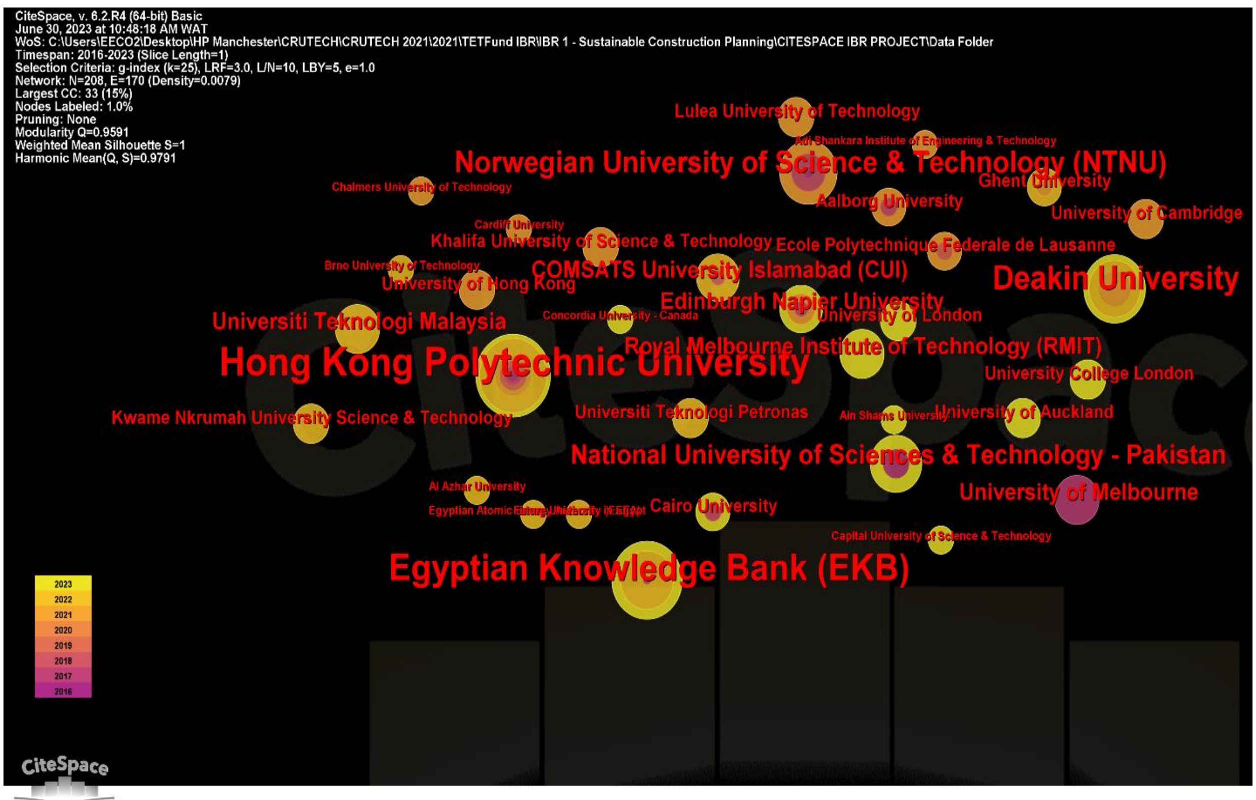

Fig.5. Network of Co-Author's Institutions

3.3 Co-Word analysis

3.3.1 Network of keyword o-occurrence

By analyzing the keyword recurrence network, the authors identified the dominant themes as the keywords are short descriptions representative of the content of the research supporting this study. While current themes can be easily identified on the knowledge map over a period of time, the evolutionary web helps uncover important changes in the field over the period considered in this study. Figure 6 shows the generated keyword co-occurrence network, where the size of the nodes is determined by the frequency of occurrence of the keyword in the bibliometric dataset. Popular ranking keywords are performance, construction, management, design, model, Life-cycle Assessment (LCA), etc.

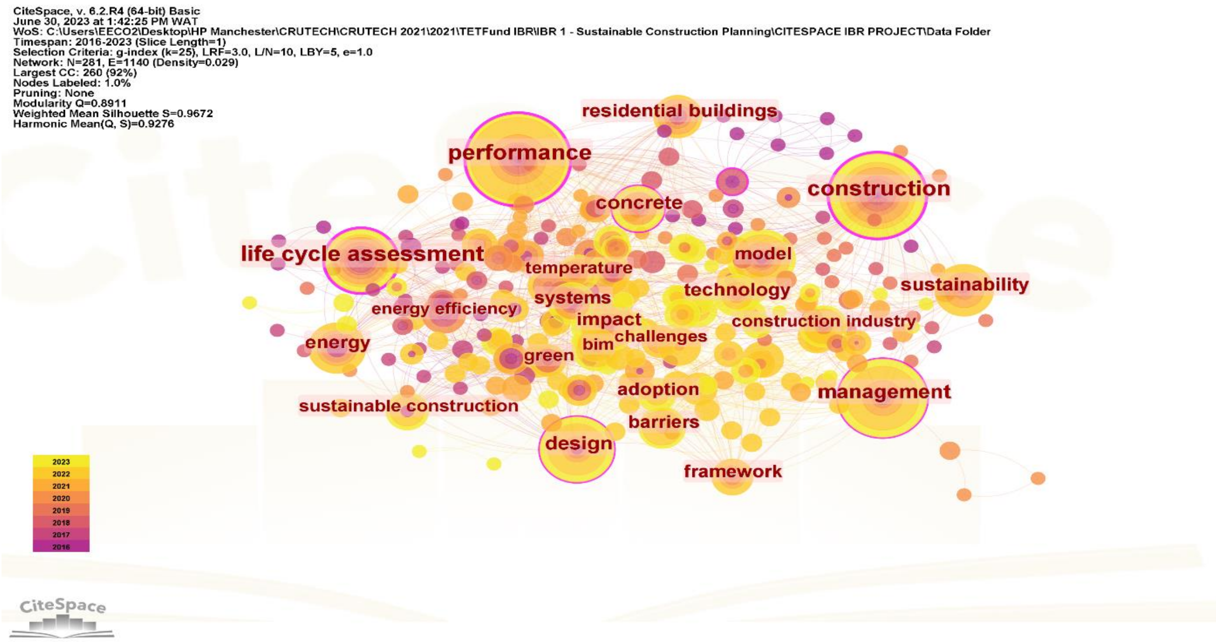

Fig. 6: Network of Keyword Co-occurrence

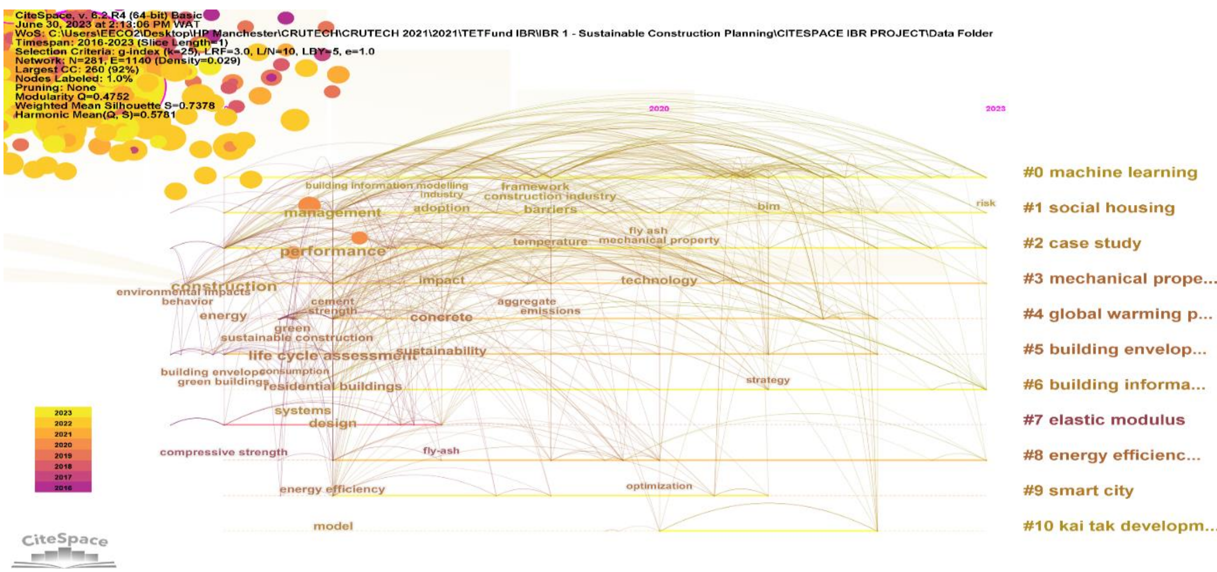

Fig. 7. A timeline view of the keyword co-occurrence network 2016 – 2023

3.3.2: Evolution of keywords

Keywords can also be viewed across time spans, through co-occurrence links, as shown in Fig. 7.

3.4 Co-Citation Analysis

3.4.1 Network of Journal Co-citation

Source journals for this project are shown in Table 5 and Figure8.The top-ranked journals by citation counts is Journal of Cleaner Production with a citation count of 172, the second one being SUSTAINABILITY-BASEL with a citation count of 142, while the third is Building and Environment with a citation count of 114. Others are as presented below.

The references cited by the 524 articles were analysed in Cite Space, with the network highlighting the most significantly cited journals.

As shown in Fig. 8, the size of a node represents a source journal's co-citation frequency, while the high frequency of co-citation of a journal depicts its influence on the subject matter.

Table 5: Journal Co-citation generated table

Citation Counts	References	Year
172	J CLEAN PROD	2016
142	SUSTAINABILITY-BASEL	2017
114	BUILD ENVIRON	2016
107	RENEW SUST ENERG REV	2016
101	J CONSTR ENG M	2016
88	CONSTR BUILD MATER	2016
88	ENERG BUILDINGS	2016
87	AUTOMAT CONSTR	2016
79	RESOUR CONSERV RECY	2016
76	PROCEDIA ENGINEER	2017

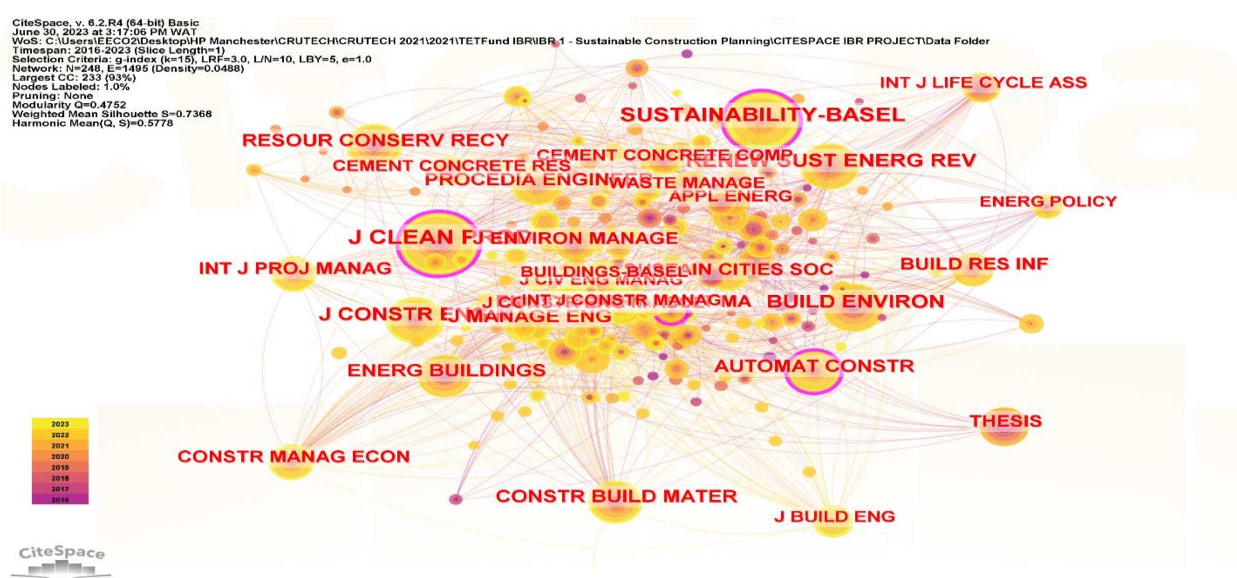

Fig. 8. Network of Journal Co-citation

3.4.2 Network of Author Co-citation

To explore, identify, and visualize the intellectual structure in this field, the authors used author co-citation analysis (Bayer et al., 1990), counting the number of times an author's work was shared with another author in the references to the cited documents could be cited. Table 6 and Figure 9 show the details of author's co-citations, with node sizes representing author's co-citations, while node-to-node links represent indirect collaborative relationships based on co-citations frequency. The highest-ranked co-citation authors by number of citations are UNKNOWN (2016) with a citation count of 141, second is ANONYMOUS (2016) with 137 citations and the third is EUROPEAN COMMISSION (2017) with 17 citations.

Table 6: Author Co-citation generated table

Citation Counts	References	Year
141	UNKNOWN	2016
137	ANONYMOUS	2016
17	EUROPEAN COMMISSION	2017
17	MOHER D	2021
14	HWANG BG	2016
12	CHEN C	2018
11	LIU Y	2017
11	CHAN APC	2017
11	IEA	2016
10	UNITED NATIONS	2019

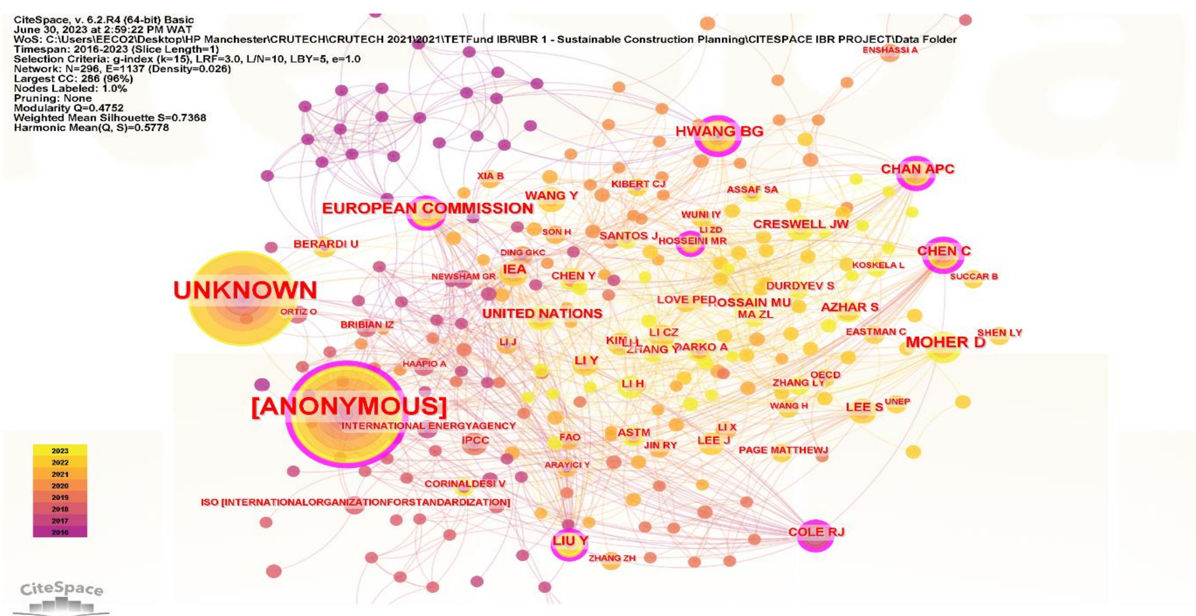

Fig. 9. Network of Author Co-citation

3.4.3 Network of Document Co-citation

A co-citation analysis is a useful approach for similarity analysis of documents (Luo et al. 2019), while the co-citation analysis of documents helps researchers to explore a co-cited references network. As Li et al. (2017)

argued that researchers should first analyze the cited references in the selected articles so that they have a solid knowledge base on each article. Taking into account the citation rate in WoS, the ten most cited works are listed in Table 7, led by Page Matthew J (2021), Xia B (2018) and Lin X (2019). These articles have been highly acclaimed by peers and have been of great value to the research work assessing the sustainable construction planning and reporting. Figure 10 shows the document co-citation network for this project.

Table 7: Top 10 cited articles among the 524 articles (2016-2023)

Freq	Burst	Degree	Centrality	Sigma	Document	First Author	Year	Source
5	2.19	0	0	1	Page Matthew J (2021)	Page Matthew J	2021	BMJ
3	1.53	5	0.01	1.02	Xia B (2018)	Xia B	2018	J CLEAN PROD
3	1.3	18	0.01	1.01	Lin X (2019)	Lin X	2019	J CLEAN PROD
3	1.3	18	0.01	1.01	Hosseini MR (2018)	Hosseini MR	2018	AUTOMAT CONSTR
3	1.3	6	0	1	Wuni IY (2020)	Wuni IY	2020	BUILD RES INF
2	1.24	2	0	1	Steffen W (2015)	Steffen W	2015	SCIENCE
2	1.24	2	0	1	Bostanci SC (2018)	Bostanci SC	2018	J CLEAN PROD
2	1.22	4	0	1	Schweber L (2013)	Schweber L	2013	BUILD RES INF
2	1.22	4	0	1	Alyami SH (2012)	Alyami SH	2012	SUSTAIN CITIES SOC
2	1.22	2	0	1	Basbagill J (2013)	Basbagill J	2013	BUILD ENVIRON

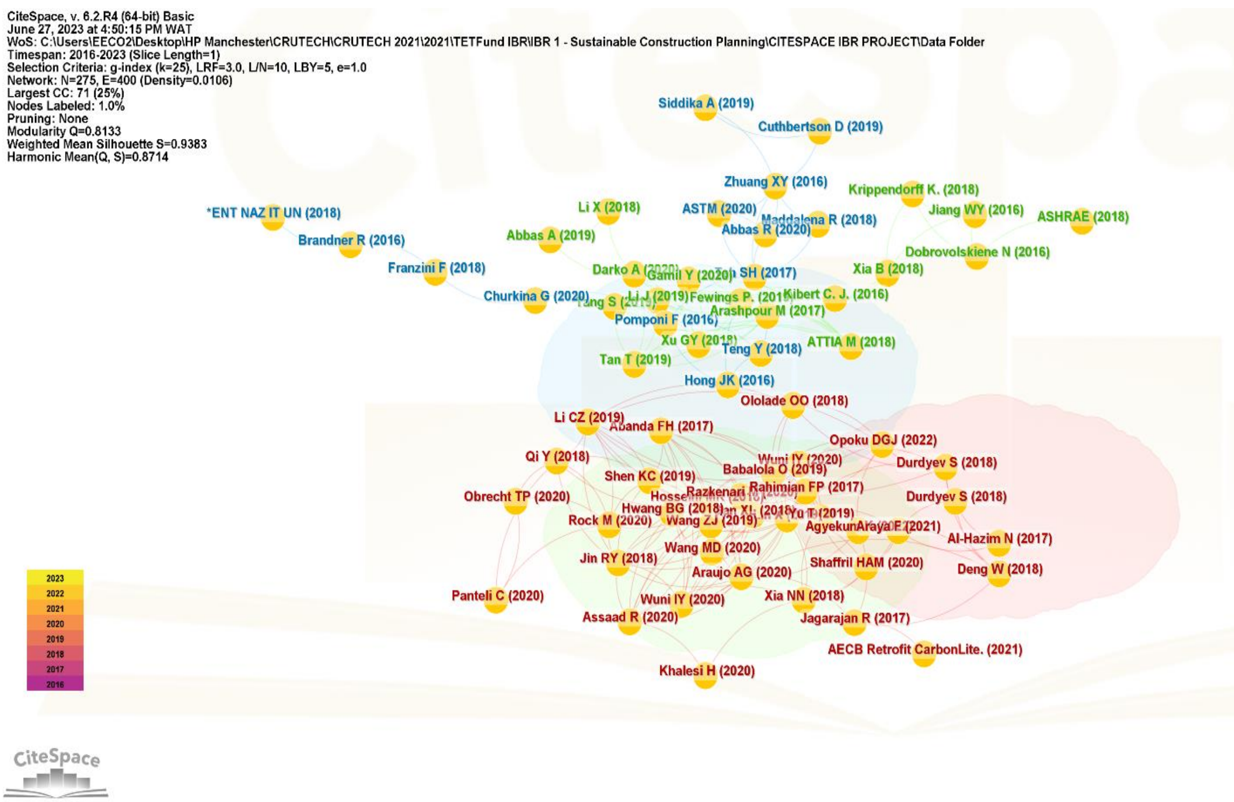

Fig. 10. Network of Document Co-citation

4.0 Thematic Analysis of Clusters

Cluster analysis refers to a technique that facilitates statistical data analysis and knowledge base discovery, and is then used to uncover and identify hidden themes and clusters in the data (Chen and Morris, 2003). Based on the relative correlation of search terms, the cluster analysis technique helps to classify large amounts of research data into manageable units, making it easier to identify hidden clusters of research topics, trends, and their interrelationships (Olawum& Chan, 2018). The software tool Cite Space uncovered the hidden structures and distributions of clusters and research topics over the years under review.

Clusters and subjects are classified discretely, and the clustering techniques used for classification are Latent Semantic Indexing (LSI), Log-Likelihood Ratio (LLR), and Mutual Information (MI), depending on the techniques of the ability to create high-quality clusters with high intra-class similarity and low similarity between classes. This means that the keywords and terms grouped in the group must be similar and interdependent, but different from the keywords in the other groups. The quality of the cluster labels depends on the variety, breadth and complexity of the keywords in the articles (Chen et al., 2010). The generated cluster labels are highlighted in the cluster analysis.

For our article, five distinct clusters of co-citation are observed, with the co-citation clusters listed in Table 8 labeled and sorted by size, with the cluster size representing the members of each cluster.

Table 8: Document Co-citation clustering of sustainability research (2016-2023)

Cluster ID	Size	Silhouette	Mean Year	LSI	LLR	MI
0	35	0.892	2019	project success; sustainable cities; construction projects; stakeholder management; stakeholder impact | off-site construction; stakeholder relationship; qualitative content analysis; research synthesis methods; scientometric analysis	nigeria (4.44, 0.05); construction industry (4.44, 0.05); benchmarking (2.2, 0.5); environmental management system (2.2, 0.5); building (2.2, 0.5)	benchmarking (0.89); environmental management syst
1	17	0.977	2018	sustainable development goals; augmented reality; literature review; swot analysis; mixed reality | project success; bibliometric analysis; construction projects; sustainable construction project; augmented reality	virtual reality (2.13, 0.5); sustainable development goals (2.13, 0.5); augmented reality (2.13, 0.5); bibliometric analysis (2.13, 0.5); swot analysis (2.13, 0.5)	virtual reality (0.94); sustainable development go

2	14	0.985	2017	midpoint assessment; industrial waste; mechanical properties; ordinary portland cement; to-grave approach | life cycle carbon; life cycle assessment; carbon emission; cement composites; midpoint assessment	cement composites (3.02, 0.1); sound (3.02, 0.1); simapro software (3.02, 0.1); absorb acoustic concrete (3.02, 0.1); industrial waste (3.02, 0.1)	cement composites (0.5); sound (0.5); simapro soft
19	3	1	2019	construction site; transportation activities; travelled distance; smartwatch	smartwatch (6.47, 0.05); transportation activities (6.47, 0.05); travelled distance (6.47, 0.05); construction site (6.47, 0.05); sustainability (0.28, 1.0)	smartwatch (0.07); transportation activities (0.07
42	2	1	2017	lidera; retail buildings; building sustainability assessment (bsa) methods; sustainable management	building sustainability assessment (bsa) methods (6.47, 0.05); lidera (6.47, 0.05); retail buildings (6.47, 0.05); sustainable management (6.47, 0.05); sustainability (0.28, 1.0)	building sustainability assessment (bsa) methods (

From Table 7, cluster #0 is the cluster ID with the largest cluster size with 35 members and cluster #42 is the smallest cluster size with 2 members. Because the analyzed cluster data comes from articles cited in 524 articles, it may contain articles that are not fully relevant to this area. Therefore, a manual review was required to remove unrelated clusters by manually reviewing the content of the articles in each cluster.

The silhouette score for all clusters ranges from 0.892 to 1, indicating some level of accuracy for members of each cluster who fit well into their respective groups, since silhouette scores measure and compare average homogeneity of clusters (Rousseeuw, 1987), while it is generally used for cluster validation. Annual averages indicate whether the clusters consist of current or obsolete items.

5.0 Conclusions and further work

The subject of sustainable construction planning and reporting has received increasing attention around the world since the United Nations Sustainable Development Goals were set in 2015, with governments, academia and industry professionals all being involved accordingly. This paper is a literature review on scholarly metrics and provides researchers and policymakers with a visualization method to analyze 524 bibliographic records in the Web of Science (WoS) database, using scienometric techniques such as co-author, co-word, clustering and a co-citation analysis, all helping to uncover research metrics and clusters/themes. This has helped provide an in-depth understanding of the status quo and trends in sustainable construction planning and reporting. From the WoS database, 524 bibliographic records published in the period 2016–2023 were extracted.

To identify the co-authors in this domain and the most influential researchers, co-authorship and the author co-citation analyses were performed. Additionally, among the countries identified in the network of countries with the highest contributors, China, the United States and Malaysia each topped the list, indicating the networking and collaborative research and studies between these countries and other countries.

keywords helped create a successful network highlighting popular words in the industry from 2016-2023. The most repeated keywords were performance, engineering, management, design, model and life cycle assessment.

In addition, the journal co-citation analysis identified important journals with notable published articles. The Journal of Cleaner Production, Sustainability-Basel, Building and Environment, Renewable and Sustainable Energy Reviews, and the Journal of Construction Engineering and Management had higher co-citation rates and were the most-produced journals over the past six years, suggesting that these journals have a greater impact on academic research in sustainable construction planning and reporting.

Based on the co-citations of documents, Page Matthew (2021), Xia (2018), Lin (2019) and Hosseini (2018) got the highest co-citations, thanks to the cluster analysis, three outstanding research groups were identified as project success, sustainable development goals, and midpoint assessment.

The study provides credible information for researchers, practitioners, as well as ministries, departments and agencies looking to study or implement activities in the study area. The research networks presented provide excellent insight and understanding of leading researchers, institutions, countries/regions, emerging trends and prominent issues, while helping to highlight key information and findings to drive improvements in research and practice towards the implementation of a holistic framework to support the achievement of sustainable construction and reporting.

This study recommends that researchers focus on emergent themes, while further research could focus on methods, frameworks and systems of interest to researchers.

The authors posit that these findings would interest: (a) academics, when collaborating with other researchers in their fields, (b) government departments, departments and agencies, and companies when formulating and advising policies, including development of partnerships with key institutions identified in our work, (c) Industries and sectors, such as Construction and Engineering Management, for example, in identifying and increasing their level of activities towards achieving sustainability in construction planning and reporting.

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