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## RESEARCH TREND ON COST ANALYSIS IN BUILDING CONSTRUCTION

Diana Suita<sup>1</sup>, Afizah Ayob<sup>1,2\*</sup>, Victor G. Sinaga<sup>3</sup>, Nik Zainab Nik Azizan<sup>4</sup>, Norazrin Ramli<sup>5</sup>, Hamizah Mokhtar<sup>6</sup>, Senja Rum Harnaeni<sup>7</sup>, Mustaqqim Abdul Rahim<sup>8</sup> and Mustafa Zainal<sup>9</sup>

<sup>1</sup>Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis, 02600 Arau, Perlis

✉ [dns1301@gmail.com](mailto:dns1301@gmail.com)

ORCID <https://orcid.org/0009-0006-8530-6712>

<sup>2</sup>Centre of Excellent, Water Research and Environmental Sustainability Growth (WAREG), Universiti Malaysia Perlis, 02600 Arau, Perlis, MALAYSIA

✉ [afizah@unimap.edu.my](mailto:afizah@unimap.edu.my)

ORCID <https://orcid.org/0000-0003-2802-1316>

<sup>3</sup>BPJN II Medan Direktorat Jenderal Bina Marga, Medan Indonesia

✉ [victorsinaga2411@gmail.com](mailto:victorsinaga2411@gmail.com)

ORCID <https://orcid.org/0009-0005-7122-3863>

<sup>4</sup>Fakulti Kejuruteraan Awam, Universiti Teknologi Malaysia

✉ [nikzainab@unimap.edu.my](mailto:nikzainab@unimap.edu.my)

ORCID <https://orcid.org/0000-0001-7153-4913>

<sup>5</sup>Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis, 02600 Arau, Perlis

✉ [norazrin@unimap.edu.my](mailto:norazrin@unimap.edu.my)

ORCID <https://orcid.org/0000-0001-6398-6709>

<sup>6</sup>College of Engineering, Universiti Teknologi MARA Pahang Jengka Campus, 26400 Bandar Tun Razak Jengka, Pahang

✉ [hamizah1161@uitm.edu.my](mailto:hamizah1161@uitm.edu.my)

ORCID <https://orcid.org/0000-0001-6361-8797>

<sup>7</sup>Department of Civil Engineering, Faculty of Engineering, Universitas Muhammadiyah Surakarta, 57102 Surakarta, Indonesia

✉ [srh289@ums.ac.id](mailto:srh289@ums.ac.id)

ORCID <https://orcid.org/0000-0003-3081-2942>

<sup>8</sup>Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis, 02600 Arau, Perlis

✉ [mustaqqim@unimap.edu.my](mailto:mustaqqim@unimap.edu.my)

ORCID <https://orcid.org/0000-0003-0040-135X>

<sup>9</sup>Faculty of Civil Engineering & Technology, Universiti Malaysia Perlis, 02600 Arau, Perlis

✉ [mustaffazainal@gmail.com](mailto:mustaffazainal@gmail.com)

ORCID <https://orcid.org/0000-0001-8681-1645>

\*Corresponding Author

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### Abstract:

The study titled “Cost Analysis in Building Construction: Life-Cycle, Digital, and Managerial Perspective” presents a systematic literature review aimed at synthesizing current research trends, analytical methods, and cost management strategies in the construction sector. The construction industry faces ongoing challenges in achieving cost efficiency while balancing sustainability, digital transformation, and

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managerial optimization. Despite the growing volume of research, a comprehensive synthesis that integrates these perspectives remains limited. To address this gap, the review applied the PRISMA protocol to ensure transparency and rigor in the selection process. Searches were conducted across two major databases, Scopus and Web of Science, yielding 36 primary studies that met the inclusion criteria. The selected articles were analyzed and categorized into three dominant themes: (1) Life-Cycle Costing & Environmental Performance, focusing on the integration of life-cycle assessment and cost modeling to evaluate sustainability and long-term financial feasibility; (2) Cost Estimation, Optimization & Digital Analytical Methods, emphasizing the application of digital tools such as Building Information Modeling (BIM), machine learning, and optimization algorithms for accurate cost prediction and project efficiency; and (3) Construction Management, Procurement, Renovation & Site Prefabrication Economics, addressing the influence of managerial frameworks, procurement policies, and prefabrication systems on project cost performance. The synthesis of findings indicates a clear transition toward data-driven, environmentally conscious, and policy-aligned cost analysis frameworks in modern construction. The study concludes that integrating life-cycle perspectives, digital analytics, and management innovation is essential to achieving cost-effective and sustainable outcomes in the building industry. The review contributes a structured understanding of emerging methodologies and provides valuable insights for researchers and practitioners seeking to enhance cost analysis practices across diverse construction contexts.

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**Keyword:**

Building Construction; Cost Analysis; Digital; Lifecycle; Managerial



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**Introduction**

Cost analysis in building construction is a critical aspect that significantly influences the success and feasibility of construction projects. Accurate cost estimation and effective cost management are essential for ensuring that projects are completed within budget and on time. The complexity of construction projects, coupled with the dynamic nature of the industry, necessitates the use of advanced methodologies and tools to enhance the accuracy and reliability of cost estimates. This paper aims to explore the various methods and factors involved in cost analysis in building construction, highlighting the importance of accurate cost estimation and the challenges faced in the process. The literature on cost analysis in building construction reveals a variety of methods and approaches used to estimate and manage costs.

One of the primary methods discussed is the parametric cost estimating model, which involves identifying significant cost drivers and developing mathematical models to define cost estimating relationships. Multiple regression analysis is often used to establish these relationships between building parameters and construction costs (Phaobunjong & Popescu, 2003). This method provides a systematic approach to cost estimation, allowing for more accurate predictions based on historical data and project-specific variables.

Another approach to cost estimation involves the use of fuzzy mathematics and neural network models. These models are particularly useful in handling the uncertainties and complexities associated with construction cost estimation. By combining fuzzy mathematics with neural networks, researchers have been able to develop models that can estimate the cost of building and installation works with a higher degree of accuracy (Y. Li & Ma, 2018). Similarly, machine learning methods, such as supporting vector regression, have been employed to enhance the predictability of conceptual cost estimates for residential buildings (Juszczak, 2018). The use of innovative construction materials and methods also plays a significant role in cost analysis. For instance, the application of new concrete types and the evaluation of their cost-benefit ratios have been explored to determine the profitability and efficiency of construction projects (Yudenko et al., 2019). Additionally, the selection of appropriate cost estimation models is crucial for accurate cost predictions. Models based on the cost estimate of work, such as those used in the analysis of office-residential buildings in Zagreb, provide valuable insights into the cost structure of construction projects (Martinec et al., 2010).

Predictive models for estimating structural construction costs have also been developed using design information available in the early stages of residential building projects. These models, which integrate advanced methods such as the Storey Enclosure Method (SEM) and principal component analysis, offer robust predictability and help in establishing range estimates and confidence intervals for cost predictions Dang & Le-Hoi, (2018) such models are essential for making informed management decisions during the early stages of construction projects. The importance of accurate cost estimation is further emphasized by the challenges faced in the construction industry. Factors such as limited time for analysis, lack of required knowledge, and unorganized information often hinder the effectiveness of cost breakdown analysis (CA). To address these issues, frameworks based on ontological modelling have been proposed to systematically organize and retrieve cost analysis knowledge, thereby improving the accuracy and efficiency of cost estimation (Wang et al., 2025).

In addition to traditional methods, the geometric shape of a building has been identified as a significant factor influencing construction costs. Studies have shown that the base area and the area of external walls are key parameters that determine the amount of materials needed for construction, which in turn affects the overall cost. Optimizing the shape of a building at the initial design stage can lead to significant cost savings and reduced energy consumption (Kozniowski & Banaszak, 2020). The success of construction projects is heavily dependent on the accuracy of cost estimates, which influence various aspects of project feasibility and profitability. Essential factors related to cost estimation include the location of the project, political situation, financial status of the owner, and the cost of construction materials. These factors must be carefully considered to ensure accurate and reliable cost predictions (Enshassi et al., 2007). The integration of Building Information Modeling (BIM) technology has also been highlighted as a promising approach for enhancing cost management in construction

projects. BIM enables digital representation of a project, facilitating cost estimation, tracking, and analysis throughout the project lifecycle (Matejka & Vitasek, 2018).

The literature on cost analysis in building construction underscores the importance of accurate cost estimation and effective cost management. Various methods and approaches, ranging from parametric models to advanced machine learning techniques, have been developed to address the complexities and uncertainties associated with construction cost estimation. By leveraging these methods and considering the key factors influencing costs, construction professionals can improve the accuracy and reliability of their cost estimates, ultimately enhancing the success and feasibility of construction projects.

### ***Research Question***

This study was guided by five key research questions designed to explore the intellectual structure and development of research on cost analysis in building construction. RQ1 examines the publication trend over the years to understand how scholarly interest in this field has evolved and fluctuated over time. RQ2 identifies the top ten most productive authors who have significantly contributed to advancing knowledge and shaping the direction of this research area. RQ3 focuses on the ten most frequently cited articles to highlight influential works that have made substantial academic and practical impact. RQ4 analyzes the top ten countries based on the number of publications, providing insights into global research distribution and the region's most actively engaged in construction cost analysis. Finally, RQ5 investigates the most frequently used keywords to reveal the major themes, concepts, and emerging topics that define the current research landscape in this domain.

RQ1: What is the publication trend of research in this field over the years?

RQ2: Which authors are identified as the top ten contributors to this topic?

RQ3: Which studies represent the ten most frequently cited articles?

RQ4: Which countries rank among the top ten based on their number of publications? RQ5: Which keywords are most frequently associated with research in this area?

### **Methodology**

Bibliometric analysis refers to the process of collecting, structuring, and interpreting bibliographic information derived from scientific literature (Alves et al., 2021; Assyakur & Rosa, 2022; Verbeek et al., 2002). Rather than focusing solely on descriptive statistics such as determining the distribution of journals, publication periods, or key contributing authors (Wu & Wu, 2017), this method also incorporates advanced analytical approaches like document co-citation mapping. Performing an effective literature review requires a systematic and repetitive procedure that involves identifying appropriate search terms, exploring relevant sources, and conducting a detailed evaluation of the findings. This systematic approach assists researchers in developing a complete reference list and obtaining credible analytical outcomes (Fahimnia et al., 2015). In this context, the present study emphasized high impact journal papers, as these works often reflect strong theoretical contributions that shape scholarly discourse. To maintain precision in data retrieval, SCOPUS was chosen as the main database for gathering bibliographic records (Al-Khoury et al., 2022; di Stefano et al., 2010; Khiste & Paithankar, 2017). Furthermore, to ensure the inclusion of reliable and validated sources, only peer-reviewed journal articles were selected, while other document types such as books and lecture notes were intentionally omitted (Gu et al., 2019). The dataset was extracted from Elsevier's

Scopus database, which offers extensive coverage, and included publications from 2015 up to October 2025 for further examination.

### **Data Search Strategy**

The initial data collection was conducted using the Scopus database to ensure the inclusion of high-quality and peer-reviewed studies. The search process applied two main keywords, namely “Cost Analysis” and “Building Construction,” which yielded a total of 197 related documents. To refine the selection and maintain consistency, several exclusion criteria were applied. Articles written in non-English language, published before 2015, and document types such as conference papers, book chapters, review papers, and items still listed as “In Press” were removed from consideration (Table 1). After applying these filters, 117 eligible journal articles remained for further analysis. The complete formulation of the search query used in Scopus is presented in Table 2.

**Table 1: The Selection Criterion Is Searching**

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2015 – 2025	< 2015
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press

**Table 2: The Search String.**

Database	Search String
Scopus	TITLE-ABS-KEY ( ( "Cost Analy*is" OR "Financial Analy*is" OR "Budget Analy*is" ) AND ( "Build* Construc*" OR "Facility Construc*" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( PUBYEAR , 2015 ) OR LIMIT-TO ( PUBYEAR , 2016 ) OR LIMIT-TO ( PUBYEAR , 2017 ) OR LIMIT-TO ( PUBYEAR , 2018 ) OR LIMIT-TO ( PUBYEAR , 2019 ) OR LIMIT-TO ( PUBYEAR , 2020 ) OR LIMIT-TO ( PUBYEAR , 2021 ) OR LIMIT-TO ( PUBYEAR , 2022 ) OR LIMIT-TO ( PUBYEAR , 2023 ) OR LIMIT-TO ( PUBYEAR , 2024 ) OR LIMIT-TO ( PUBYEAR , 2025 ) )  Date of excess: January 2026

### **Data Analysis**

VOSviewer is an accessible bibliometric analysis software created by Nees Jan van Eck and Ludo Waltman at Leiden University in the Netherlands (van Eck & Waltman, 2010, 2017). It has become one of the most widely applied tools for mapping and analyzing scientific literature, particularly due to its strength in producing clear and interactive visual representations of bibliometric networks. The software is capable of clustering related elements and generating density visualizations that highlight patterns in the data. Its flexible functions support the analysis of co-authorship links, co-citation relationships, and keyword co-

occurrence structures, allowing researchers to gain a comprehensive view of the research landscape. The interactive interface and continuous software improvements make it convenient for users to navigate, modify, and interpret extensive datasets efficiently. Moreover, VOSviewer's ability to perform metric calculations, adjust visualization parameters, and integrate multiple bibliometric data formats renders it a powerful and reliable instrument for academic studies within complex research domains. A distinct advantage of VOSviewer lies in its functionality converting large and intricate bibliometric datasets into easily interpretable visual forms such as maps and graphs. By emphasizing network visualization, the program effectively identifies clusters of related terms, tracks patterns of keyword cooccurrence, and produces detailed density diagrams. Because of its simple design, the software is suitable for both beginners and experienced users, enabling effective exploration of bibliometric data. Through regular updates and development, VOSviewer continues to remain relevant for modern bibliometric investigations, offering enhanced analytical features through metrics evaluation and adjustable visualization tools. Its compatibility with various data formats, including co-authorship and citation datasets, establishes its reputation as an adaptable and essential application for researchers seeking structured and meaningful insights into scientific domains.

This study, datasets including information such as publication year, article title, author name, journal source, citation count, and associated keywords were downloaded in plain text format from the Scopus database, covering publications from 2015 until October 2025. These data were processed using VOSviewer version 1.6.19. By employing VOS-based clustering and mapping algorithms, the software generated structured bibliometric maps for deeper interpretation. As an alternative to the Multidimensional Scaling (MDS) method, VOSviewer arranges data items in a low-dimensional space where the relative distance between two nodes represents their level of similarity or relatedness (van Eck & Waltman, 2010). In this sense, the technique bears conceptual resemblance to MDS (Appio et al., 2014). However, unlike MDS, which depends mainly on similarity indices such as cosine or Jaccard coefficients, the VOS method applies a distinct normalization technique called association strength ( $AS_{ij}$ ), computed as (Van Eck & Waltman, 2007):

$$AS_{ij} = \frac{C_{ij}}{w_i w_j}$$

This measure is “proportional to the ratio between observed number of cooccurrences of  $i$  and  $j$ . On the other hand, the expected number of co-occurrences of  $i$  and  $j$  under the assumption that co-occurrences of  $i$  and  $j$  are statistically independent” (Van Eck & Waltman, 2007).

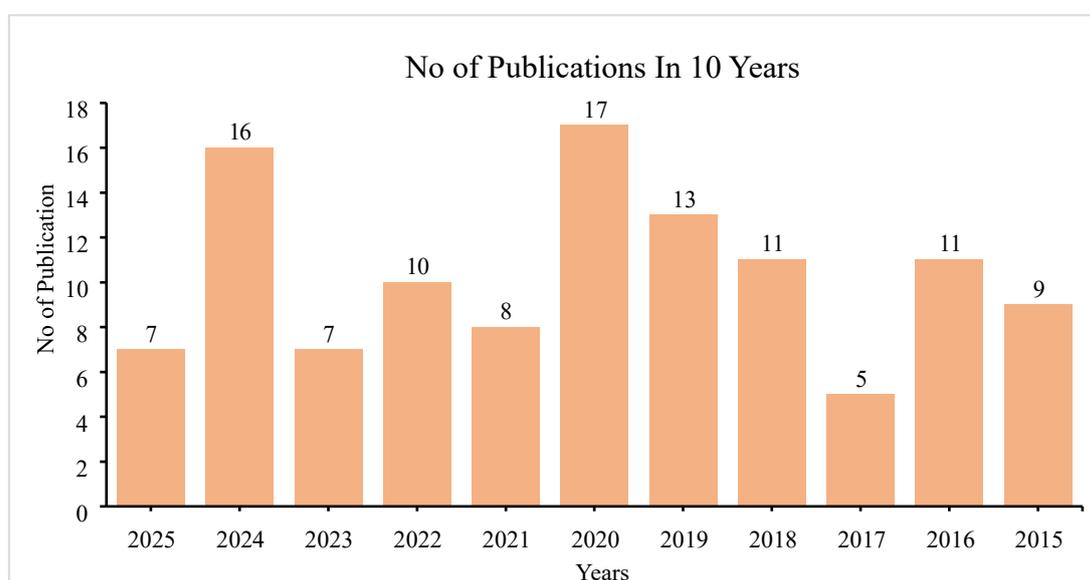
## Findings

### *What Is the Publication Trend of Research in This Field Over the Years?*

Figure 1 shows the trend of research in cost analysis in building construction. The publication trend on Cost Analysis in Building Construction from 2015 to 2025 demonstrates fluctuating yet progressively increasing research attention, particularly after 2018. The number of publications began moderately in 2015 (9 papers) and showed a slight increase until 2016, followed by a temporary drop in 2017. From 2018 onward, a notable upward trend emerged, peaking in 2020 with 17 documents, representing the highest productivity (14.91%). This peak coincides with a global shift toward cost optimization and digital transformation in the

construction sector, particularly during the COVID-19 pandemic, which pushed researchers and industry practitioners to explore cost-effective and sustainable construction strategies under resource and workforce constraints.

After 2020, the publication trend shows a mild decline, with some fluctuations between 2021 and 2024. The number of documents decreased slightly in 2021 but remained stable overall, suggesting that interest in cost analysis remained relevant though more specialized. The moderate growth again in 2024 indicates renewed focus likely driven by integration of Building Information Modeling (BIM), life-cycle cost analysis, and sustainability frameworks in construction research. The 2025 data, though incomplete, still reflects ongoing scholarly engagement in the topic. Overall, the trend suggests that cost analysis research in construction evolves alongside global economic pressures, technological innovations, and sustainability demands, indicating its continuing importance in managing construction efficiency and economic performance.



**Figure 1: Trend Of Research in Cost Analysis in Building Construction.**

### *Which Authors Are Identified as The Top Ten Contributors to This Topic?*

Table 3 and Figure 2 show 10 top authors on research. The authorship distribution indicates that research on Cost Analysis in Building Construction is relatively dispersed, with only a few authors contributing multiple papers. The most productive authors are Ferrando, D.G. and Fregonara, E., each with four publications (2.27%), followed by Di Ludovico, M. and Prota, A. with three documents (1.70%) each. This pattern suggests a limited concentration of expertise, where a small number of researchers consistently contribute to advancing the topic, possibly focusing on specialized subfields such as life-cycle costing, sustainability assessment, and construction economics. These authors, particularly from European institutions, are likely engaged in collaborative networks addressing cost management in energy-efficient or seismic resistant construction, explaining their repeated contributions within this research niche.

The relatively low publication percentages across most authors (1.14 - 2.27%) highlight a fragmented research community, where many contributors publish occasionally rather than maintain continuous engagement. This dispersion may reflect the interdisciplinary nature of cost analysis in construction, involving economists, civil engineers, and sustainability experts who integrate cost considerations within broader studies. The modest author productivity also indicates that the field is still developing and lacks a dominant research cluster. However, the presence of recurring authors implies the emergence of thought leaders shaping methodological frameworks and influencing future research directions in construction cost optimization and sustainable building practices.

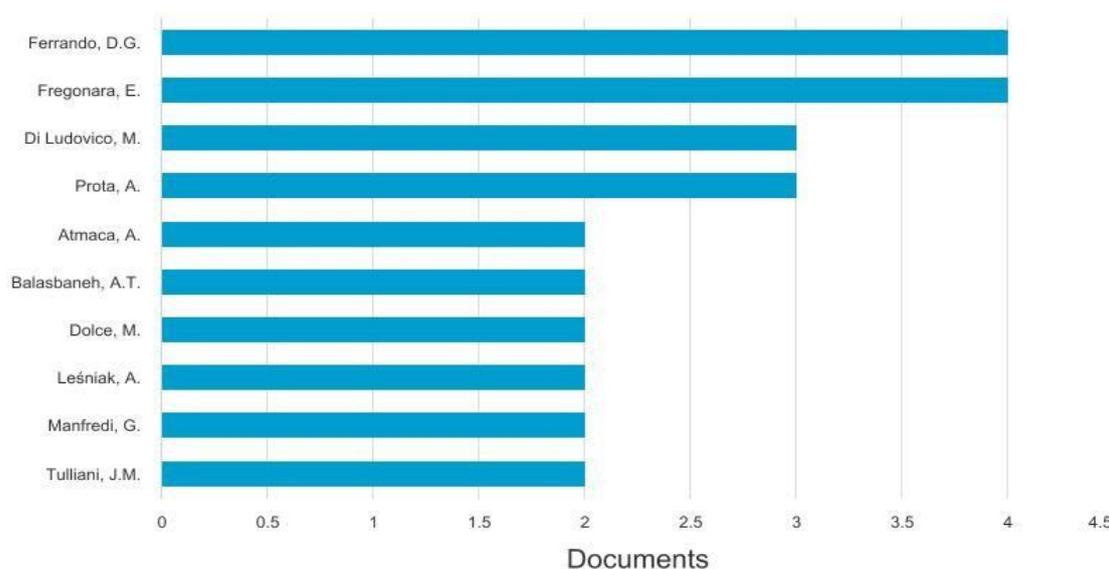
**Table 3: 10 Top Authors**

Authors Name	No of documents	Percentage (%)
Ferrando, D.G.	4	2.27
Fregonara, E.	4	2.27
Di Ludovico, M.	3	1.70
Prota, A.	3	1.70
Atmaca, A.	2	1.14
Balasbaneh, A.T.	2	1.14
Dolce, M.	2	1.14
Leśniak, A.	2	1.14
Manfredi, G.	2	1.14
Tulliani, J.M.	2	1.14

## Documents by author

Compare the document counts for up to 15 authors.

Scopus



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**Figure 2: 10 Top Authors**

### ***Which Studies Represent the Ten Most Frequently Cited Articles?***

The citation analysis reveals that Abanda and Byers (2016) stand out as the most influential authors, with 326 citations, far surpassing others in the field. Their paper, published in *Energy*, explored the impact of building orientation on energy consumption using Building Information Modelling (BIM), a topic that bridges cost analysis, sustainability, and digital innovation are three major themes driving construction research today. High citation counts for studies by Ludovico et al. (2017) and Chou and Yeh (2015) further demonstrate that widely cited works often link cost analysis with environmental performance and resilience, such as earthquake reconstruction and carbon emissions assessment. This indicates that research integrating cost with sustainability, life-cycle assessment, or disaster recovery garners more academic attention due to its broader applicability and policy relevance. Table 4 shows the most cited authors.

The variation in citation numbers also reflects differences in publication venues, research impact, and thematic scope. Highly cited articles were mostly published in top-tier journals like *Energy*, *Journal of Cleaner Production*, and *Journal of Environmental Management*, which attract wider readership and cross-disciplinary citations. Conversely, more recent studies (2020–2021) show lower citation counts, not due to lesser quality but limited time for academic dissemination. The dominance of environmentally oriented cost studies signifies a global shift toward sustainable construction practices, where cost optimization is analyzed alongside energy efficiency and carbon reduction. Hence, citation performance aligns closely with global sustainability agendas and technological integration in construction economics research.

**Table 4: Most Cited Authors**

No	Authors	Title	Year	Source title	Cited
1	(Abanda & Byers, 2016)	An investigation of the impact of building orientation on energy consumption in a domestic building using emerging BIM (Building Information Modelling)	2016	Energy	326
2	(Ludovico et al., 2017)	Reconstruction process of damaged residential buildings outside historical centres after the L'Aquila earthquake: part I—"light damage" reconstruction	2017	Bulletin of Earthquake Engineering	146
3	(Chou & Yeh, 2015)	Life cycle carbon dioxide emissions simulation and environmental cost analysis for building construction	2015	Journal of Cleaner Production	123
4	(Fernando et al., 2021)	Life cycle assessment and cost analysis of fly ash–rice husk ash blended alkali activated concrete	2021	Journal of Environmental Management	121
5	(Qerimi et al., 2020)	Modeling of the solar thermal energy use in urban areas	2020	Civil Engineering Journal (Iran)	121

6	(Lešniak & Zima, 2018)	Cost calculation of construction projects including sustainability factors using the Case Based Reasoning (CBR) method	2018	Sustainability (Switzerland)	103
7	(Gürcanli et al., 2015)	Activity based risk assessment and safety cost estimation for residential building construction projects	2015	Safety Science	98
8	(X. Li & Malkawi, 2016)	Multi-objective optimization for thermal mass model predictive control in small and medium size commercial buildings under summer weather conditions	2016	Energy	97
9	(Ibrahim et al., 2015)	Building envelope with a new aerogel based insulating rendering: Experimental and numerical study, cost analysis, and thickness optimization	2015	Applied Energy	92
10	(Ji et al., 2021)	Building life-span prediction for life cycle assessment and life cycle cost using machine learning: A big data approach	2021	Building and Environment	81

### ***Which Countries Rank Among the Top Ten Based on Their Number of Publications?***

The distribution of publications by country shows that China leads with the highest contribution (17 documents, 11.97%), followed by Italy and South Korea (each 8.45%), and the United States (7.75%). This dominance by China reflects its rapid growth in construction activity, urbanization, and governmental emphasis on cost efficiency and sustainability within the built environment. China's significant research funding and academic interest in cost management, coupled with widespread adoption of BIM and life-cycle cost analysis, have positioned it as a global leader in construction economics research. Similarly, Italy's and South Korea's strong research output is linked to national priorities in energy efficiency, seismic risk mitigation, and digital construction technologies, which align with cost analysis as a core research component.

The moderate contributions from the United Kingdom, Australia, Malaysia, and Turkey (around 3 - 4%) suggest active but regionally focused research communities. These countries are increasingly integrating sustainability frameworks and cost-benefit analyses into construction practices, driven by environmental policies and the need for resource optimization. Emerging contributions from Brazil and New Zealand (2.82%) highlight growing awareness of sustainable construction economics in developing and mid-sized economies. Overall, geographical distribution indicates that cost analysis in building construction has gained global relevance, with stronger participation from nations advancing digitalization, green building initiatives, and post-disaster reconstruction key areas where economic assessment plays a decisive role in sustainable infrastructure development. Table 5 and Figure 3 show the documents by countries.

**Table 5: Documents By Countries**

Countries	No of Documents	Percentages (%)
China	17	11.97
Italy	12	8.45
South Korea	12	8.45
United States	11	7.75
United Kingdom	6	4.23
Australia	5	3.52
Malaysia	5	3.52
Turkey	5	3.52
Brazil	4	2.82
New Zealand	4	2.82



**Figure 3: Documents by Countries**

***Which Keywords Are Most Frequently Associated with Research in This Area?***

The co-occurrence analysis of author keywords using VOSviewer identifies how frequently specific terms appear together within the same set of publications, illustrating thematic relationships and research structures within a field. In this study, the *full counting method* was applied, where each keyword occurrence contributes equally to the total count. A threshold of a minimum of 10 occurrences was set, resulting in 19 keywords out of 1322 being mapped into three distinct clusters. This approach helps visualize the intellectual structure and dominant themes related to *Cost Analysis in Building Construction*, revealing how keywords are interconnected based on authors shared focus areas. High-occurrence terms such as “cost analysis” (81) and “building construction” (68) show central importance in the network, forming the core of the research landscape. Figure 4 shows network visualization map of keywords’ co-occurrence.



sustainable design. China, Italy, and South Korea were identified as leading contributors, reflecting strong national investments in sustainable construction technologies and digital cost management practices. Keyword analysis further highlighted the prominence of themes such as sustainability, life-cycle cost, and optimization, confirming the interdisciplinary nature of cost analysis research.

This study contributes to the existing body of knowledge by mapping the intellectual structure and global research landscape of cost analysis in building construction, emphasizing the convergence of economic, environmental, and technological considerations. The results suggest that cost analysis has evolved beyond traditional budgeting approaches to encompass sustainability and data-driven decision-making frameworks. These insights have practical implications for policymakers, engineers, and construction managers, providing evidence-based directions for enhancing efficiency, sustainability, and cost control in future projects. However, the study is limited by its reliance on a single database (Scopus) and the exclusion of non-English sources, which may restrict the diversity of findings. Future research could expand the analysis using multiple databases, longitudinal citation tracking, and thematic evolution mapping to capture a broader scope of knowledge development. Overall, the bibliometric approach offers a valuable framework for understanding the dynamics of construction cost analysis research and its role in promoting sustainable and efficient building practices.

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**Author Contribution Statement:** All authors contributed significantly to the development of this manuscript. All authors read and approved the final version of the manuscript prior to submission.

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