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## A systematic literature review on knowledge management for project risk management in construction

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## ABSTRACT

The need for urbanisation, smart cities and high-rise buildings globally has increased the volume of projects carried out in the Architecture, Engineering and Construction (AEC) industry. These buildings are designed under tight schedules, tight contracts, huge budgets, and highly performance-driven construction managers. Thus, this article presents a systematic literature review (SLR) on knowledge management for project risk management in construction. Using the SLR, two academic databases were utilised, namely Dimensions and Scopus for publications from 2000 to 2025. The knowledge acquired from the research was examined by classifying the areas on Project Risk Management (PRM), construction processes and knowledge management associated with construction. The keyword search utilised for this study was conducted in Google Scholar database. The search on this SLR considered three main areas namely project management (PM), knowledge management (KM) and risk management (RM). However, related search was conducted on other aspects like quantitative risk management (QRA). The findings include the development of knowledge maps on publication trends. Findings on the publication trends reflect steady growth in publications, with peaks and dips due to global events (like, COVID-19 pandemic in 2020/2021). Regarding the subject areas, Engineering is the dominant subject area (39 %), followed by Business and Computer Science, then others. Also, the leading countries include USA, China, UK, Australia, Malaysia, then others. The implications of the study reflect knowledge-based learning on construction management. The study found various innovative

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technologies that are adapted in construction through knowledge management. This SLR shows emerging trends, applications and research collaborations in the construction industry.

#### List of Abbreviations:

Abbreviations	Definition	Abbreviations	Definition
5W's	What, when, why, which, and where	ICT	Information and Communication Technology
AEC	Architecture, Engineering and Construction	ICPR	International Construction Project Risk
AI	Artificial Intelligence	JV	Joint Venture
ALARP	As Low As Reasonably Practicable	K2	Knowledge Infrastructure for Construction
AR	Augmented Reality	KB	Knowledge-Based
AMV	Autonomous Maritime Vessel	KM	Knowledge Management
AM	Additive Manufacturing	KM1-KM17	Knowledge Management Variables, from Variable 1 to Variable 17
BBN	Bayesian Belief Network	KBDSS-SRA	Knowledge-Based Decision-Support System for Safety Risk Assessment
BCIS	Building Cost Information Service	LHCS	Latin Hypercube Simulation
BIM	Building Information Modelling	MCS	Monte Carlo Simulation
BN	Bayesian Network	MOU	Memorandum of Understanding
CBR	Case-Based Reasoning	MS-Excel	Microsoft Excel
CDE	Common Data Environment	PC	Project Coordinator
CFA	Confirmatory Factor Analysis	PM	Project Management
CK	Constructing Knowledge	PMBOK	Project Management Body Of Knowledge
CPD	Continuing Professional Development	PMI	Project Management Institute
CSF	Critical Success Factor	PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
DSS	Decision-Support System	PRM	Project Risk Management
EFA	Exploratory Factor Analysis	QRA	Quantitative Risk Analysis
EIA	Environmental Impact Assessment	RBM	Risk-Based Management
ET	Event Tree	RBS	Risk Breakdown Structure
EVA	Earned Value Analysis	RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
FCEM-AHP	Fuzzy comprehensive evaluation method-analytical hierarchy process	RII	Relative Importance Index
FMEA	Failure Mode and Effects Analysis	RM	Risk Management
FRAM	Functional Resonance Analysis Method	RBM	Risk-Based Management
FSE	Fuzzy Synthetic Evaluation	ROI	Return on Investment
FT	Fault Tree	SLR	Systematic Literature Review
FTOPSIS	Fuzzy Technique for Order Preference by Similarity to Ideal Solution	SNA	Social Network Analysis
GDP	Gross Domestic Produce	SNS	Social Networking Services
GenAI	Generative Artificial Intelligence	SPSS	Statistical Package for Social Sciences
GSAI	Graphical Safety Assessment Interface	SRs	Safety Risks
GT	Grounded Theory	STAMP	Systems Theoretic Accident Model and Processes
HAZOP	Hazard and Operability Studies	STPA	Systems Theoretic Process Analysis
HVAC	Heating, Ventilation and Air Conditioning	VR	Virtual Reality
ICE	International Construction Enterprises	WEF	World Economic Forum

## 1. Introduction

The need for urbanisation, smart cities and high-rise buildings globally has increased the volume of projects carried out in the Architecture, Engineering and Construction (AEC) industry [1–4]. Thus, these construction works are designed under tight schedules, huge budgets, highly performance-driven construction managers, and tight contracts, among other risks that are considered [5–8]. To ensure the project success, good planning is first handled, best practices are practiced, and good control measures are put in place following the risk assessment conducted [7,9–12]. Construction projects are frequently considered to be difficult and high-risk ventures, as such some projects have cost overruns [13–17]. Additionally, construction projects are susceptible to external factors along with the risk of uncertainties associated with these projects [18–21]. To identify various factors related to project risks in construction, systematic reviews have been conducted by various authors [22–25].

Earlier systematic reviews related to construction management, risk management, knowledge management and construction projects have been conducted [23,26–29]. However, these studies have presented various knowledge maps on the subject. An earlier work by Wei et al. [23] presented a bibliometric analysis on project risk in construction but did not consider knowledge management. Khodabakhshian et al. [28] conducted a systematic literature review on risk management for construction projects using probabilistic and deterministic approaches but did not consider knowledge management. Similarly, Ghaleb et al. [30] studied the complexity of construction projects by conducting the systematic literature review alongside bibliometric analysis but did not consider knowledge management. Xia et al. [31] conducted a systematic literature review on risk management through the integration of stakeholder management and construction risk management but did neither consider knowledge management nor project risk management. In

another study, Isah & Kim [32] proposed a framework to develop a digital tool called ConRisk, which is risk knowledge graph (RiskKG) that applies knowledge-based risk management systems (KBRMS) for construction. Yuzui & Kaneko [33] conducted a systematic review on risk analysis approaches, and classified various tools from the search keywords from 47 papers related to autonomous maritime vessel (AMV), namely Failure Mode and Effects Analysis (FMEA), Systems Theoretic Accident Model and Processes (STAMP)/Systems Theoretic Process Analysis (STPA), Bayesian Network (BN), Fault Tree (FT) and Event Tree (ET), but excluded other tools like Hazard and Operability Studies (HAZOP) and Functional Resonance Analysis Method (FRAM), considering that they are not used significantly in maritime industry as much as they are used in the construction industry. However, these approaches of risk analysis have also been applied on construction industry research by different authors [8,34–37].

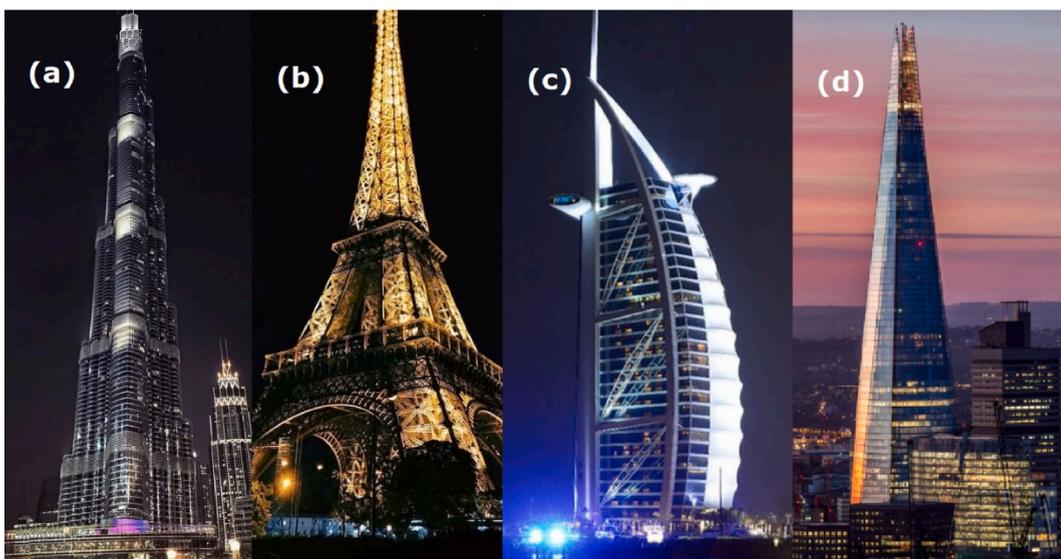
Due to the scale of some construction projects, there are increased project risks seen in various classes of risks [8,22,32,38]. It is important to add that one of the most impressive examples of human innovations is found within the construction sector, which is responsible for creating skyline buildings, creating green cities and giving a sense of life to architectural designs [39–43]. However, concealed beneath the towering steel and dazzling glass of most skyline buildings currently, is a reality that is not readily apparent, that various risks were considered [2,29,44,45]. Examples of notable structures are the Burj Al Arab Hotel in Dubai, the Eiffel Tower in Paris, Burj Khalifa in Dubai, the Shard in London, etc. (see Fig. 1). However, each of these construction projects presented various risk levels.

Howbeit, other studies within the AEC industry have been carried out considering knowledge management on construction and related risks [9,11,46,47]. Some lessons highlighted from these studies include that the construction industry regulates the activities of each firm towards safeguarding the employees as well as the overall safety of construction sites. Another area found by several authors are range of tools for RM like Quantitative risk analysis (QRA) [33,48–51]. Thus, it is noteworthy that the effective completion of projects is vital to keep up with the growing number of improvements in the built environment. Okudan et al. [9] developed a tool for risk analysis called CBRisk that utilizes CBR, but the tool had some limitations in its adaptability in the scale of construction projects. This literature review also found that technology enhances various construction firms involved in project planning, costing, estimating and execution to succeed in every project, such as RM tools RM [22,23]. In addition, good practices on risk management (RM) are necessary because RM is a critical component of achieving the project's success [18,19,35].

Thus, this article presents a systematic literature review on knowledge management (KM) for project risk management in construction. The findings include the development of publication trend charts as knowledge maps based on literature study for project risk management in construction alongside a KM framework. The study also presents lessons learned, emerging trends, and opportunities from this knowledge-based learning on construction management. The arrangement for the current study is as follows: the introduction of the research is presented in the 1st section of the article. The presentation of the research background is presented in the 2nd section. The methodology including its content analysis and presentation is given in the 3rd section. The results and discussion are reported in the 4th section. The opportunities and recommendations are reported in the 5th section. The conclusions are drawn in the 6th section.

## 2. Research background

In this section, the background on the research will be presented.



**Fig. 1.** An image collage of towering steel and glass structures that have made marks in construction, namely (a) the Burj Khalifa Hotel in Dubai, (b) the Eiffel Tower in Paris, (c) the Burj Al Arab in Dubai, and (d) the Shard in London. (Images are not on same zoom scale).

### 2.1. Publication synthesis by SLR

The use of content analysis further complements the SLR by enabling a deep dive into qualitative aspects, making it possible to assess the influence of project risk, risk assessment frameworks, knowledge management and risk management strategies. This study's methodology identifies and synthesizes key research contributions. In addition, it provides actionable insights into KM applications for PRM in construction. Also, it enhances the data analysis for the project's life cycle [52–54].

By leveraging content analysis and knowledge mapping, the study bridges the gap between academic research and practical application, offering a novel approach to tackling project risks and improving risk management strategies in the sector. Several studies on the application of technology including BIM, ontology, scientometrics, bibliometrics, SNS, SNA, AR, VR, etc., in construction's project risk management were found from the literature review [23,29,41,42,55,56]. These sources validate the use of this SLR method in the research as summarised in Table 1.

### 2.2. Study's Justification

In order to successfully implement the review of knowledge management on construction projects, the data extracted from Dimensions and Scopus were presented. One of the problems identified from this literature review is the need for the development of more KM models to enhance the culture of knowledge capture and knowledge application in the construction sector. Using the data, different network maps and charts can be developed, like risk maps. The choice of the systematic literature review (SLR) approach is informed by its successful application in previous KM and PRM research [22,23]. Studies have demonstrated the effectiveness of systematic literature reviews in uncovering patterns, trends, and gaps in research domains [9,62–64].

Another source of validation was comparative result of various risks earlier identified, which have been uncovered in recent studies to also impact upon project risks [7,11,65]. In the later source, WEF [65] report by the World Economic Forum (WEF), the network of various areas of risks were shown to have impact towards predictions made upon global development within the next 10 years, as seen in Fig. 2.

### 2.3. Research questions

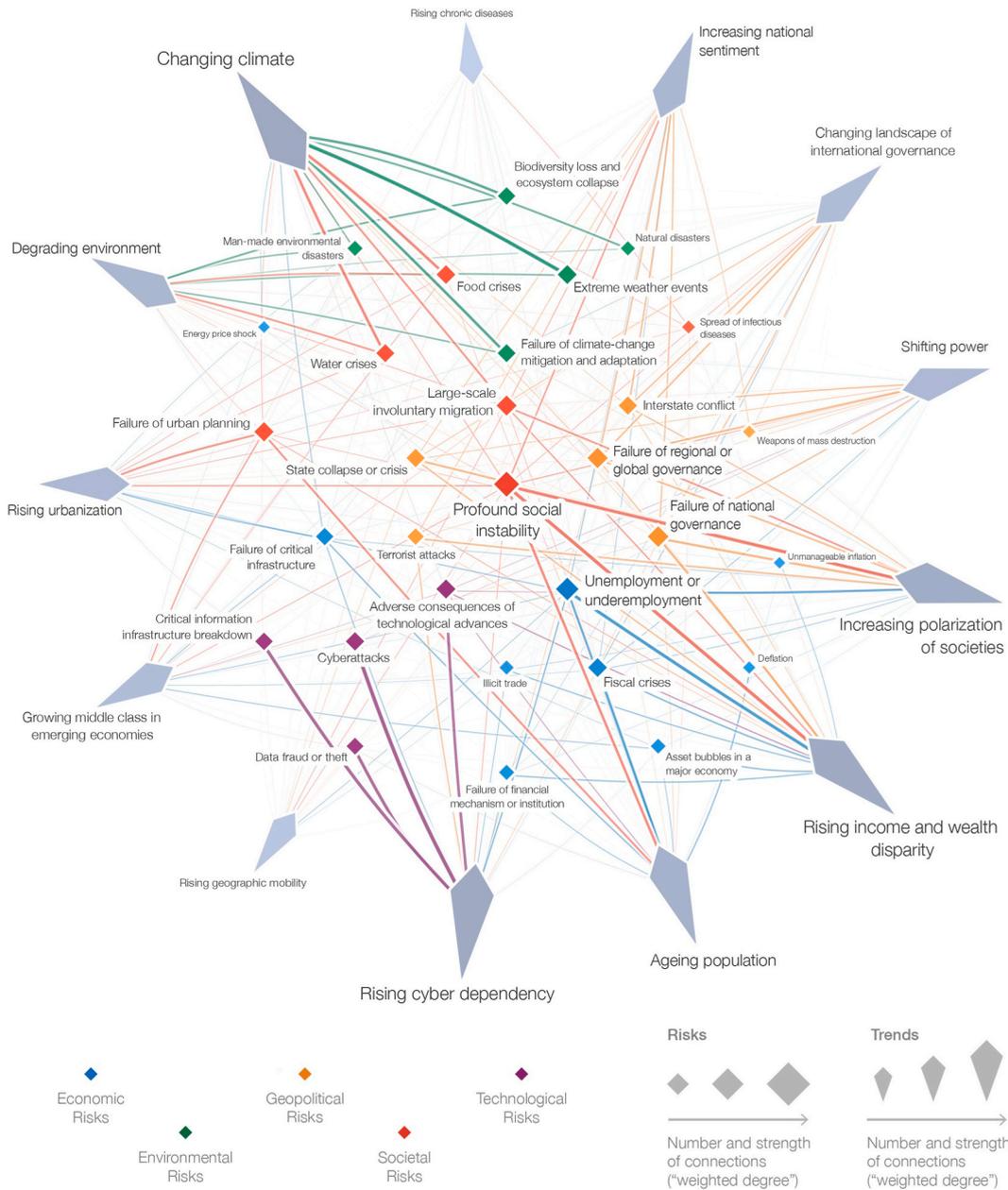
The following research questions are considered.

1. Using the systematic literature review, what trends reflect knowledge-based learning on risk management in construction projects, with respect to research and sustainability?
2. Which are the most important journals, most cited authors, most productive authors and publication trends on risk management in construction projects?
3. What opportunities and emerging trends in construction are found on knowledge-based learning on risk management in construction projects?
4. What lessons are learned from the systematic review that support knowledge management on risk management in construction projects?

**Table 1**

List of some bibliometric works on knowledge-based RM in construction.

S/N	Sources	Topical Keywords	Method used
1	[46]	KM, construction	Knowledge-based approach
2	[57]	KM, construction	Bibliometric analysis, quantitative data analysis
3	[47]	KM, AEC, ICT, construction	Ontology, semantic network to knowledge graph, systematic review
4	[58]	KM, construction, project delivery	Quantitative data analysis, factor analysis, RII
5	[23]	Construction, PRM, RM	Bibliometric analysis, quantitative data analysis
6	[7]	Construction, PRM, RM	Quantitative data analysis, factor analysis
7	[54]	Construction delay, RM	Factor analysis, FCEM-AHP, RII
8	[11]	Construction, PRM, RM	Quantitative data analysis, factor analysis
9	[9]	KM, RM, construction,	Case-based reasoning (CBR), CBRisk, black-box testing
10	[28]	RM, construction	Comparative analysis, systematic literature review
11	[31]	construction, RM, stakeholder management,	Systematic literature review
12	[27]	RM, construction	Systematic literature review
13	[26]	RM, construction	Systematic literature review
14	[22]	RM, construction	Systematic literature review
15	[42]	KM, ontology, construction	Systematic literature review, ontological
16	[5]	RM, construction	Systematic literature review
17	[30]	RM, construction	Systematic literature review, scientometric analysis
18	[59]	RM, construction	Systematic literature review
19	[60]	RM, construction	Systematic literature review, content analysis
20	[61]	Marine Structures, design, composites	Bibliometric analysis, quantitative data analysis
21	[33]	RM, maritime autonomous vessel	Systematic literature review, Quantitative Risk analysis, Qualitative risk analysis



**Fig. 2.** The interconnection map of trends on risks with most global impact in the next 10 years. Respondents to the survey were asked to rank the three trends that will have the biggest impact on world development over the next 10 years. Respondents were also asked to choose the risks that are most significantly influenced by each of the three trends that were found. Permission was obtained from WEF to use the image. Copyright year: 2018. Publisher: WEF. (Source: World Economic Forum Global Risks Perception Survey 2017–2018, [65]).

### 3. Methodology

In this section, the methodology is presented on this study.

#### 3.1. Research design

Scientometric analysis is a scientific approach that was considered in the research design. With scientometric analysis, the data for the research trend can be systematically explored. Scientometric analysis is used to reveal how journal publishers, researchers, research organisations and publications have affected a subject area and the body of knowledge in general. It also presents knowledge maps in accordance with the accepted interpretation of the terms. Scientometrics encompasses not only the quantitative analysis of

scientific phenomena but also the study of scientific policy and the dissemination of scientific findings [22,23,61].

The methodology considered for this investigation includes the assessing the context of knowledge map on the topic, developing the search query and carrying out the content evaluation on the subject area. The use of research methodology has been considered in previous studies as useful tool in carrying our typical research on knowledge management [9,62–64]. The writers looked at exploring the publication data on the subject area from recent and extant literature. Thus, this study also considered academic and industry aspects of project risk management. A systematic review with text mining was conducted to improve the bibliometric analysis in this paper. Systematic analysis can be used to obtain a comprehensive understanding on this research area, although this approach involves bias and subjective interpretation issues.

### 3.2. Research approach

The methodology for this study adopts a systematic literature review (SLR) approach, grounded in established frameworks. The framework considered is called PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). This approach ensures a structured and comprehensive exploration of knowledge management (KM) as applied to project risk management (PRM) in construction. The SLR method was chosen for its ability to synthesize fragmented research and provide a holistic view of the field, drawing from both academic and industry literature. The SLR approach was conducted in two academic databases, namely Dimensions and SCOPUS, using publication data from 2000 to 2025. The first search query used on SCOPUS is ‘knowledge management’ AND ‘project risk management’ AND ‘construction’. The second search query used was ‘knowledge management’ AND ‘risk’ AND ‘construction project’. However, both searches gave the same number of publications using the timeline from 2000 to 2025 which had 1660 publications. However, the first query was used on another academic database called Dimensions, and it found 1247 publications using the same timeline from 2000 to 2025. These searches were achieved using the title and abstract.

However, the keyword search utilised for this study was carried out in Google Scholar database. The keyword search did not consider the history of project risk management research, but keyword analysis was conducted because this is the very peculiar scientific analysis. However, future research can consider including a timeline of keyword co-occurrence network, as conducted by Wei et al. [23]. The method of content analysis has been selected as the best approach to elaborate on the current study emphasis from three various points of view, namely the influence of project risk, risk assessment, and risk management strategies. This is because the content analysis method is the most appropriate approach. This review is intended to provide some options for tackling the project risk that may be present on construction projects. The highlights extracted are used in knowledge mapping techniques that include both graphical recognition and semantic analysis. The methodology followed for this investigation is represented in Fig. 3.

### 3.3. Search criteria

The exclusion criteria were first considered in the search by using neither the publication’s DOI nor the full content. The full content was only checked during the screening process. The screening approach considered was that the paper had to be related to construction. In addition, the selected publications had to be in English Language. The search also excluded patents, thesis and pre-prints. Details on the search criteria are presented in Table 2.

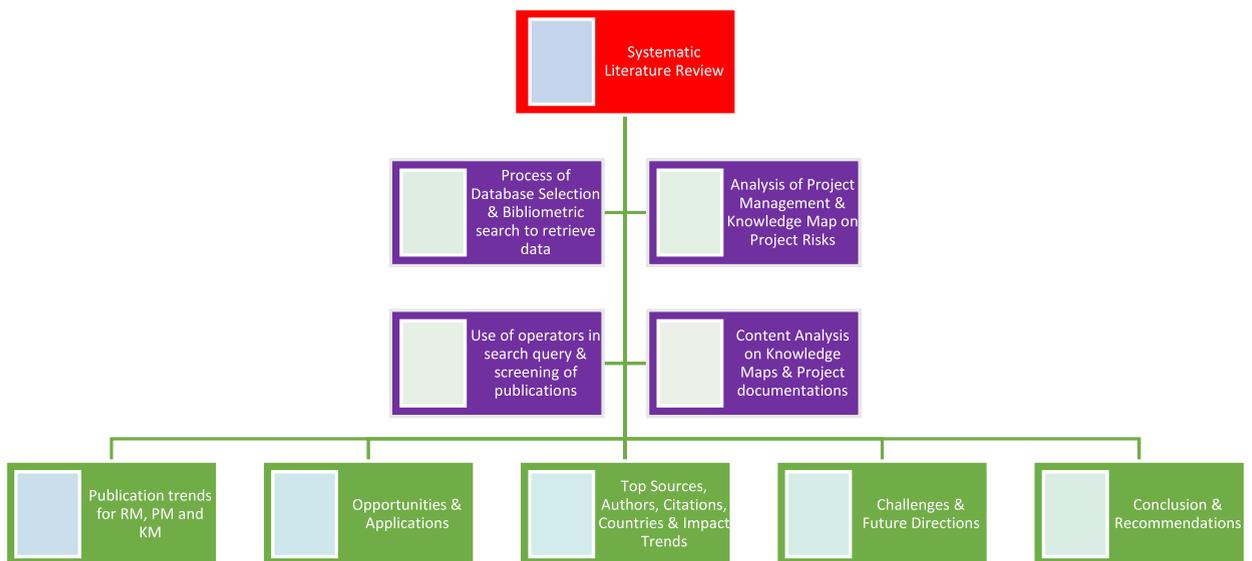


Fig. 3. The methodology used for this investigation.

**Table 2**

The search criteria table considered for the SLR.

S/N	Component	Content and Limit Criteria	Status (Yes/No)
<b>Limit Criteria</b>			
1		The papers assessed were limited to commentaries and editorials	No
2		The papers assessed were limited to state-of-the-art works	Yes
3		The papers assessed were limited to original practical research	Yes
4		The papers assessed were limited to theoretical research	Yes
<b>Exclusion Criteria</b>			
1		The publications assessed excluded unpublished research and non-peer reviewed research	Yes
2		The publications assessed excluded datasets and encyclopaedia inputs	Yes
3		The publications assessed excluded thesis and dissertations	Yes
4		The publications assessed excluded patents and pre-prints	Yes
<b>Inclusion criteria</b>			
1		The articles assessed must be peer reviewed	Yes
2		The articles accessed must not have a DOI	Yes
3		The articles accessed must not be only open access	Yes
4		The articles accessed must have high citations	No
<b>Content Criteria</b>			
1		The papers assessed had to have a commentary or discussion and a reference to its constraints	Yes
2		The papers assessed had to have detailed outcomes	Yes
3		The papers assessed had to have well-stated methodology	Yes
4		The papers assessed had to have a supplementary data	No

## 4. Results and discussion

In this section, the results and discussion are presented on this study.

### 4.1. Publication data by year

The first part of the systematic literature review (SLR) is the extrapolation of the publication data by year. The chart on the publications by year from 2000 to 2025 for the searched area is given in Fig. 4. From Fig. 4, there is an increased number of publications each year, but some drops were found in some other years. Also, it is evident that the Scopus data is higher than the Dimensions data except the publications found in 2024. Also, the publications found from the study identified key areas on KM, construction and risk management. Another finding from this study is the need towards the development of a culture of knowledge as well as its application within the construction sector. The drops found in some years like 2020 and 2021 are due to the economic downturns, COVID19 pandemic and varied projects conducted. Though, various competency levels are required by project managers in the industry to successfully complete projects, lessons learned can be used to implement policies for knowledge management.

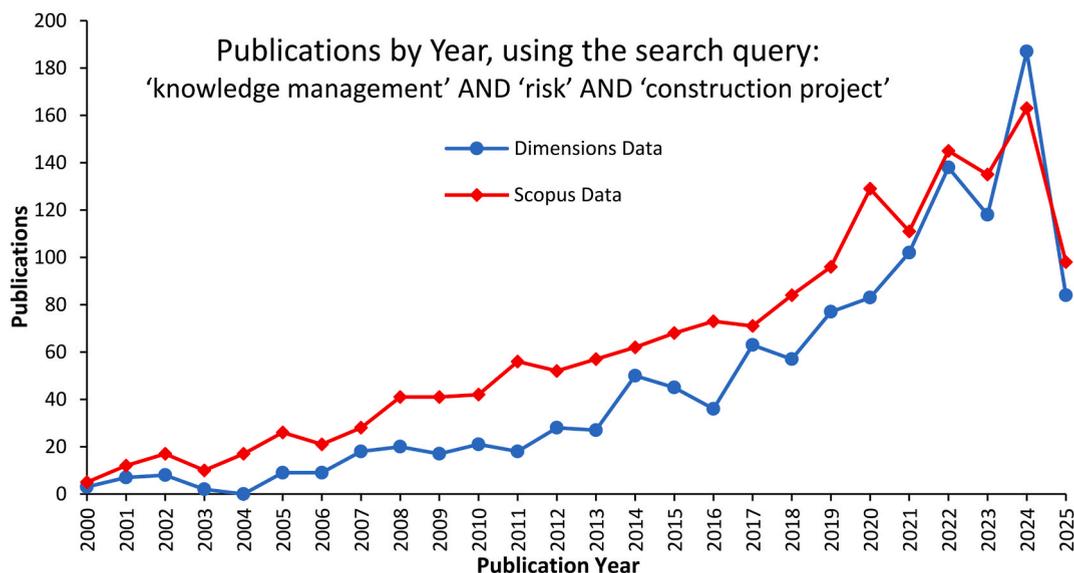


Fig. 4. Publications by year for search from 2001 to 2025 using data from Dimensions and Scopus databases. Data retrieved on 23rd July 2025.

#### 4.2. Publication data by subject area

The second part of the SLR is the extrapolation of the publication data by subject area. The chart on the publications by subject area from 2000 to 2025 for the searched area is given in Fig. 5. From Fig. 5, it is evident that various subjects were found, with the highest area being Engineering with 39.0 %. It was followed by Business Management with 16.1 %, then Computer Sciences with 9.3 %. It was followed by Social Sciences with 7.2 %, then Environmental Sciences with 5.6 %. It was followed by Energy with 3.8 %, then Earth and Planetary with 3.2 %. It was followed by Decision Sciences with 3.1 % then Medicine with 2.3 %. It was followed by Mathematics with 2.2 %, while others were 8.2 %. This result shows that there is high interest in carrying out original research for engineering works.

#### 4.3. Publication data by subject types

The third part of the SLR is the extrapolation of the publication data by subject types. The chart on the publications by subject area from 2000 to 2025 for the searched area is given in Fig. 6. From Fig. 6, it is evident that various subjects were found, with the highest area being articles with 55.5 %. It was followed by conference papers with 32.8 %, then review papers with 4.7 %. It was followed by conference review with 3.7 %, then book chapters with 2.2 %. It was followed by books with 0.8 %, then editorials with 0.1 %. It was followed by erratum with 0.1 %, then letters with 0.1 %. This result shows that there is high interest in original research works as published articles.

#### 4.4. Publication data by sources

The fourth part of the SLR is the extrapolation of the publication data by sources. The chart on the publications by sources from 2000 to 2025 for the top 6 journals in the searched area is given in Fig. 7. From Fig. 7, it is evident the highest journal is Journal of Construction Engineering and Management with 105 publications. It was followed by Engineering, Construction and Architectural Management with 75 publications, then Buildings with 41 publications. It was followed by Sustainability with 39 publications, then Safety Science with 29 publications. Then, there came Journal of Management in Engineering with 27 publications. From these sources, some of the top journals were in existence since 2000s while others were in existence since 2010s. Also, the peak part of the chart was found from the Engineering, Construction and Architectural Management with 14 publications in 2024.

#### 4.5. Publication data by funding sponsors

The fifth part of the SLR is the extrapolation of the publication data by funding sponsors. The chart on the publications by funding sponsors from 2000 to 2025 for the top 15 funders from the searched area is given in Fig. 8. From Fig. 8, it is evident that various funders were found, with the highest funder being National Natural Science Foundation of China with 68 publications. It was followed by National Research Foundation of Korea with 13 publications, then Fundamental Research Funds for the Central Universities with 11 publications and National Science Foundation of China with 11 publications. It was followed by UK Research and Innovation Council with 10 publications. Then Australian Research Council was next with 9 publications as well as Universiti Teknologi Malaysia with 9 publications too. It was followed by the European Commission with 8 publications, then Natural Sciences and Engineering Research Council with 8 publications. It was followed by Engineering and Physical Sciences Research Council with 7 publications and Hong

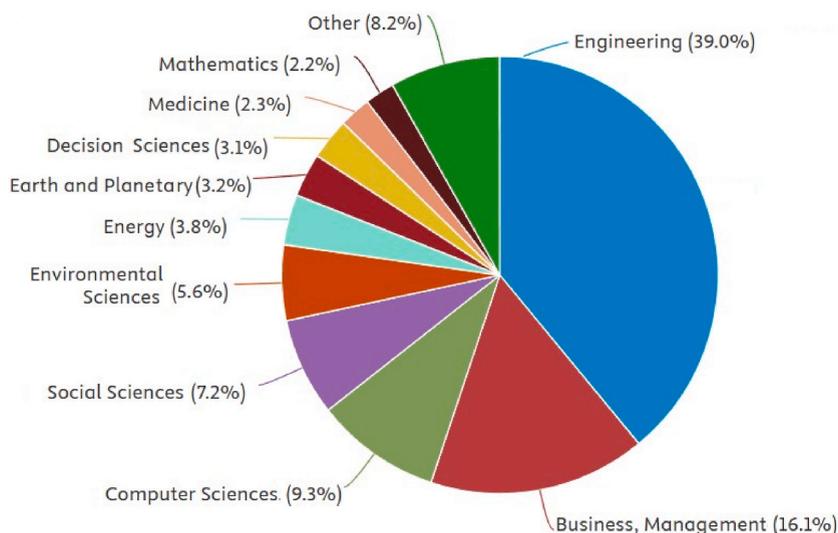


Fig. 5. Publications by subject areas.

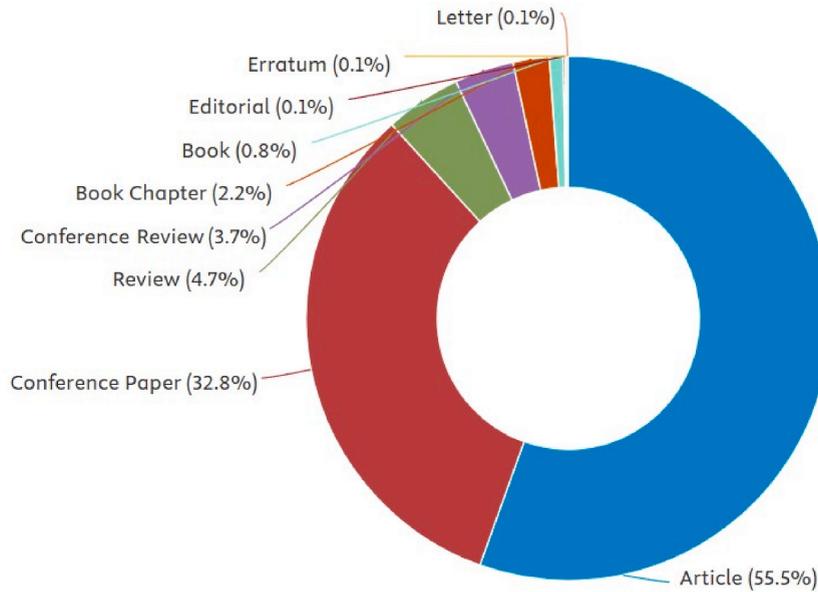


Fig. 6. Publications by subject types.

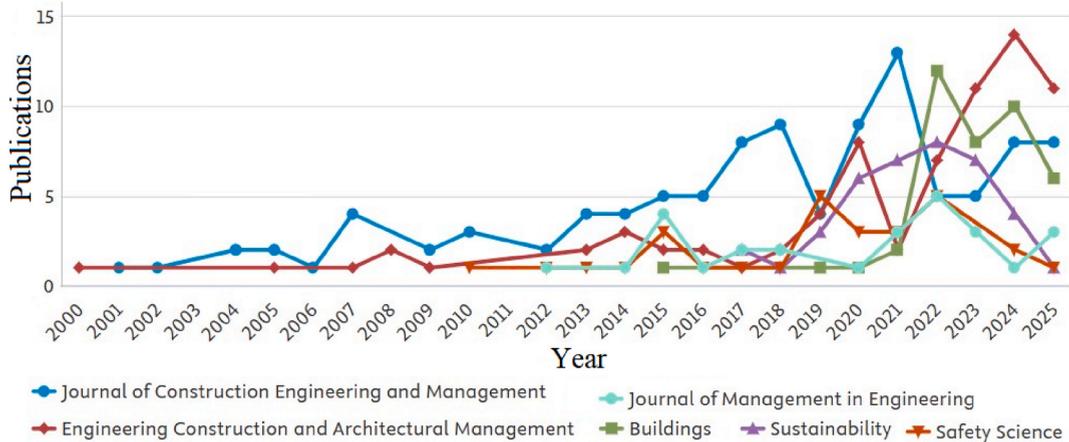


Fig. 7. Publications per year by sources for top 6 journals.

Kong Polytechnic University with 7 publications. It was followed by China Scholarship Council with 6 publications and National Key Research and Development Council with 6 publications. It was then followed by the Ministry of Education with 4 publications and the Ministry of Higher Education, Malaysia with 4 publications.

4.6. Publication data by authors

The sixth part of the SLR is the extrapolation of the publication data by authors. The chart on the publications by authors from 2000 to 2025 for the top 15 authors in this searched area is given in Fig. 9. From Fig. 9, it is evident that various authors were found, as the author with the highest publication found was El-Adaway, I.H. with 16 publications. It was followed by Hwang, B.G. with 10 publications, then Chan, A.P.C. with 9 publications. Three other authors had 9 publications too, namely Chileshe, N., Gunduz, M., and Zhao, X. The next set of authors had 8 publications each, namely Abdul Nabi, M., El Asmar, M., and Tran, D.Q. They were followed by the next set of authors with 7 publications each, namely Choi, B., Li, H., Liao, P.C., Love, P.E.D., and Smith, S.D. The 15th author on the chart was Deng, X. with 6 publications in this searched area.

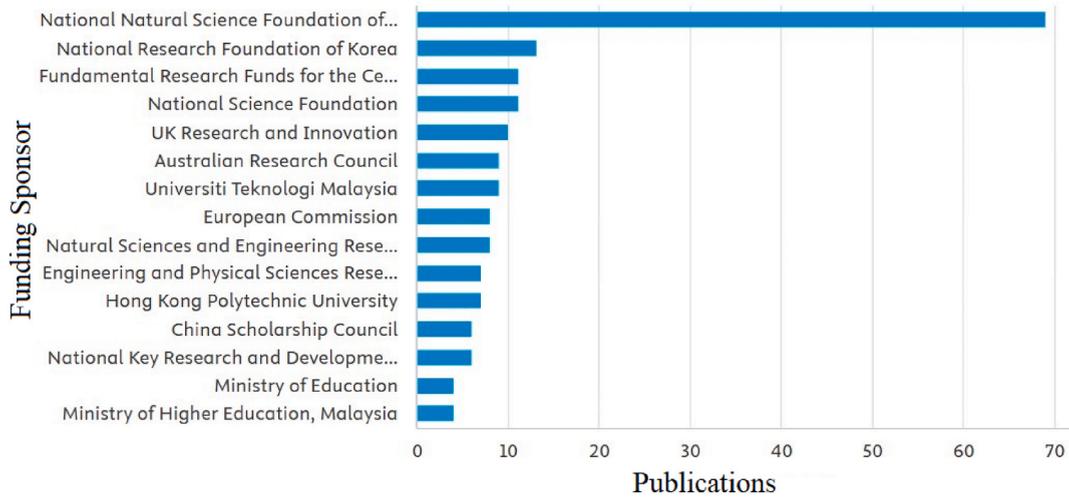


Fig. 8. Publications by funding sponsors for top 15 sponsors.

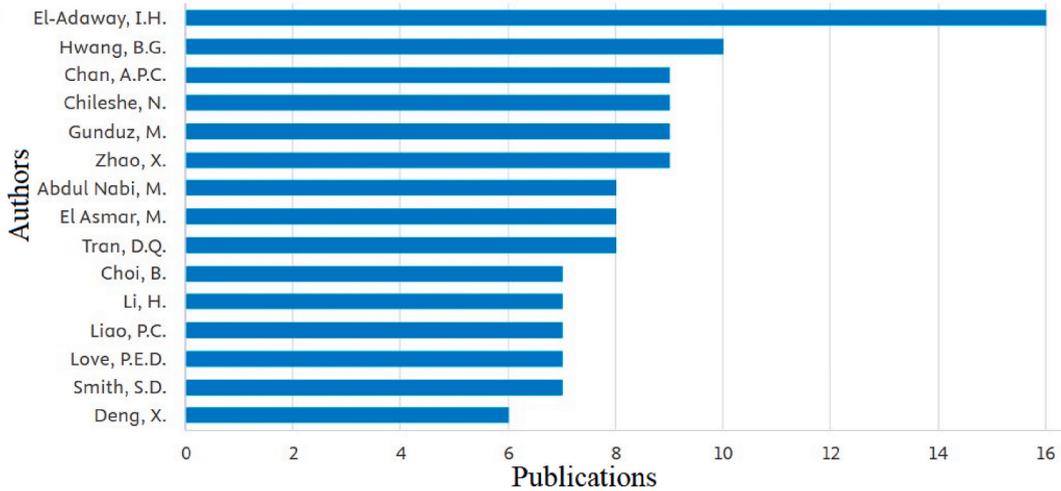


Fig. 9. Publications by authors for top 15 authors.

4.7. Publication data by country

The seventh part of the SLR is the extrapolation of the publication data by geographical locations. The chart on the publications by countries from 2000 to 2025 for the top 15 countries from the searched area is given in Fig. 10. From Fig. 10, it is evident that various authors were found, with the country with the highest publications in this area being United States with 317 publications. It was followed by China with 236 publications, then United Kingdom with 215 publications. The next was Australia with 165 publications, then Malaysia with 73 publications. It was followed by Canada with 64 publications, then Iran with 55 publications. The next was Hong Kong with 54 publications, then India with 53 publications. It was followed by South Korea with 39 publications, then Italy with 37 publications. The next one was Italy with 37 publications, then Egypt with 34 publications. The next set had 33 publications, namely France and South Africa, while the 15th country was Germany with 32 publications.

4.8. Publication data by affiliations

The eighth part of the SLR is the extrapolation of the publication data by affiliations. The chart on the publications by affiliations from 2000 to 2025 for the top 15 affiliations from the searched area is given in Fig. 11. From Fig. 11, it is evident that various affiliations were found, with the highest affiliation being Hong Kong Polytechnic University with 38 publications. It was followed by RMIT University with 31 publications, then National University of Singapore with 26 publications. The next is UNSW Sydney with 24 publications, then Tsinghua University with 22 publications. It was followed by University of Colorado Boulder with 20 publications, then Missouri University of Science and Technology with 20 publications. It was followed by Universiti Teknologi Malaysia with 17

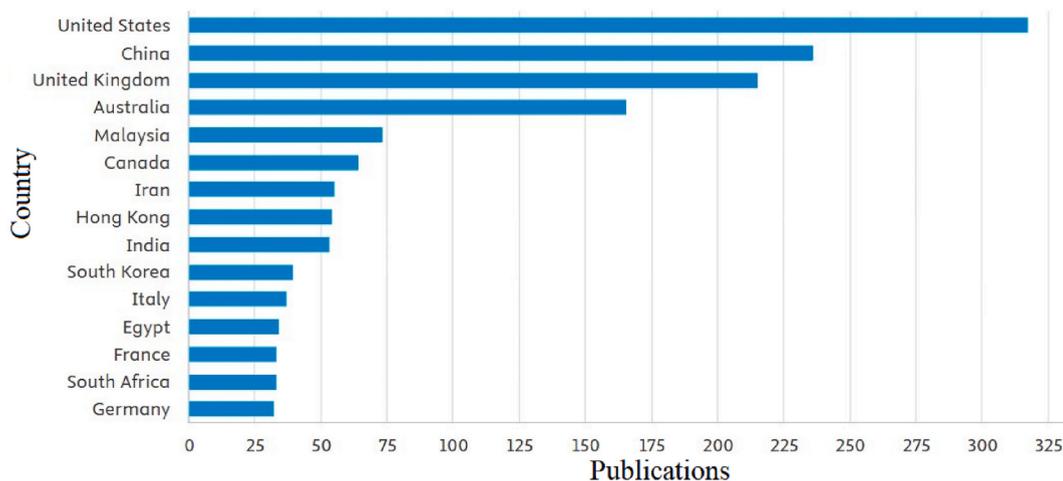


Fig. 10. Documents by country for top 15 countries.

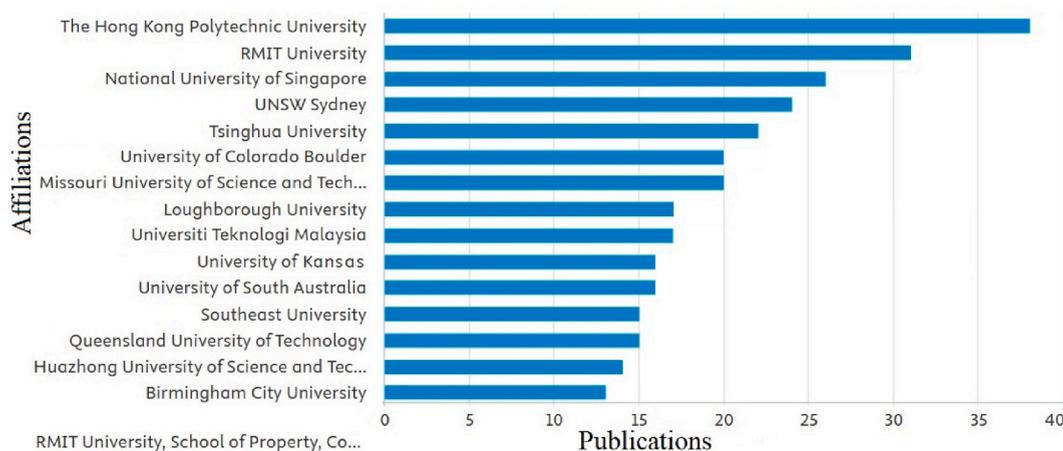


Fig. 11. Documents by affiliations for top 15 affiliations.

publications, then University of Kansas with 16 publications. The next was University of South Australia with 16 publications. It was followed by Southeast University with 15 publications, while the next was Queensland University of Technology with 15 publications. It was followed by Huazhong University of Science and Technology with 14 publications, while the last was Birmingham City University of Technology with 13 publications.

#### 4.9. Publication data by sustainability impact

The ninth part of the SLR is the extrapolation of the publication data by sustainability impact using Sustainable Development Goals (SDG). The chart on the publications by SDGs from 2000 to 2025 for the searched area is given in Fig. 12. From Fig. 12, it is evident that various goals were found, with the highest goal being Sustainable Cities and Communities (SDG11) with 103 publications. It was followed by Good health and Well being (SDG3) with 45 publications, then Industry, Innovation and Infrastructure (SDG9) with 40 publications. It was followed by Climate Action (SDG13) with 38 publications, then Affordable and Clean Energy (SDG7) with 33 publications. It was followed by Decent Work and Economic Growth (SDG8) with 29 publications, then Responsible Consumption and Production (SDG12) with 25 publications. It was followed by Life on Land (SDG15) with 23 publications, then Quality Education (SDG4) with 22 publications. The next was Peace, Justice and Strong Institutions (SDG16) with 18 publications. It was followed by Partnerships for the Goals (SDG17) with 8 publications, then Zero Hunger (SDG2) with 5 publications. It was also followed by Life below Water (SDG14) with 5 publications, then Gender Equality (SDG5) with 2 publications. It was lastly followed by No Poverty (SDG1) with 1 publication, then Clean Water and Sanitation (SDG6) with 1 publication. An important finding of this study is the use of publication data to identify the sustainability impact by classifying the SDGs.

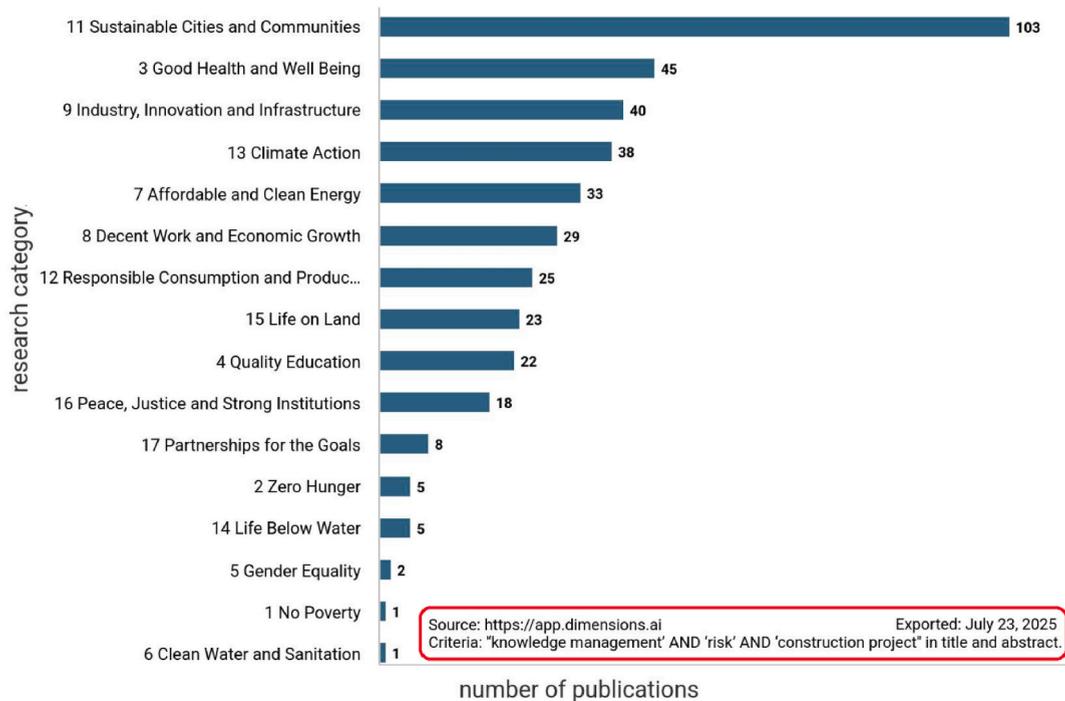


Fig. 12. Classifying by sustainable development goals (SDG).

#### 4.10. Publication data by research impact

The tenth part of the SLR is the extrapolation of the publication data by research impact. The chart on the publications by research impact from 2000 to 2025 for the searched area is given in Fig. 13. From Fig. 13, it is evident that various subjects were found using field of research (FoR), with the highest area being Built Environment and Design (FoR33) with 819 publications. It was followed by Engineering (FoR40) with 731 publications, then Commerce, Management and Tourism (FoR35) with 529 publications. It was followed by Information and Computing Sciences (FoR46) with 103 publications, then Human Society (FoR44) with 49 publications. Next, it was followed by Earth Sciences (FoR37) with 46 publications, then Environmental Sciences (FoR41) with 44 publications. There were other research areas as the least research area was Physical Sciences (FoR51) with 2 publications. The use of publication data to identify the research impact classified using the FoR (ANZSRC 2020). The study showed that publications in the area.

#### 4.11. Publication data by Co-authorships

This part covers the bibliometric analysis of co-authorships in publications. The co-authorships of articles are another important factor to consider in this field. Co-authorships have an effect on the number of citations this study area received as well. Co-authorship trends were employed to assess the scientific value of publications in the field, the impact of the papers on the field overall, and its significance regarding this study area. By eliminating publications with more than 25 authors, the co-authorship study that was carried out made use of the largest set of links leveraging the Dimensions database along with VOSviewer. The citation analysis has a network map, as evidenced by the data in Fig. 14. Fig. 14(a) displays data from the Dimensions database for 100 researchers, while Fig. 14(b) displays data from 500 researchers. It shows that a variety of authors with a high citation count are represented among the researchers from both sides. Both results highlight some co-authors with strong links, such as Hwang, B.-G., Zhao, X., Deng, X.-P., and Skitmore, M. R. Also, each of these authors were identified to have high h-index, high citations as well as related publications in this area. These authors also have recent publications in this area which reflect high significance in this area.

#### 4.12. Publication data by citations

Citations can be employed to assess the impact of the articles on the field altogether, or selectively. Citations also portray the scientific value of the publications within the field, as well as the prominence of a study area. By excluding publications with more than 25 authors, the citation analysis performed utilising VOSviewer along with the Dimensions database utilised the largest set of connections. The citation analysis has a network map, as evidenced by the data in Fig. 15. Fig. 15(a) displays the data from the Dimensions database for 100 researchers, whereas Fig. 15(b) displays the data for 500 researchers. It shows that a variety of authors with a high citation count are represented among the researchers from both boundaries. Both results highlight some co-authors with strong links,

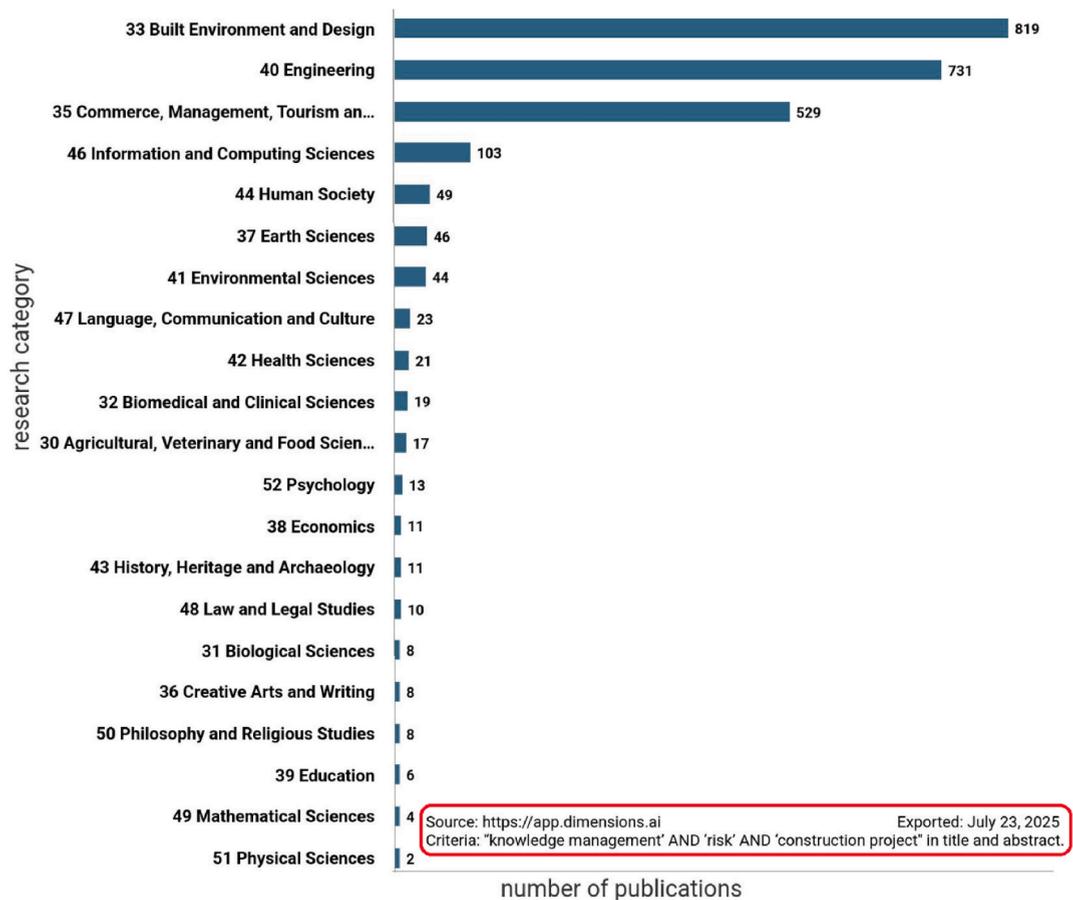


Fig. 13. Classifying by fields of research (ANZSRC 2020).

such as Hwang, B.-G., Zhao, X., Deng, X.-P., El-Adaway, I.H., Aigbavboa, C.O., Nabawy, M., and Skitmore, M.R. Also, each of these authors were identified to have high h-index, high citations as well as related publications in this area. These authors also have recent publications in this area which reflect high significance in this area.

#### 4.13. Publication data by keywords

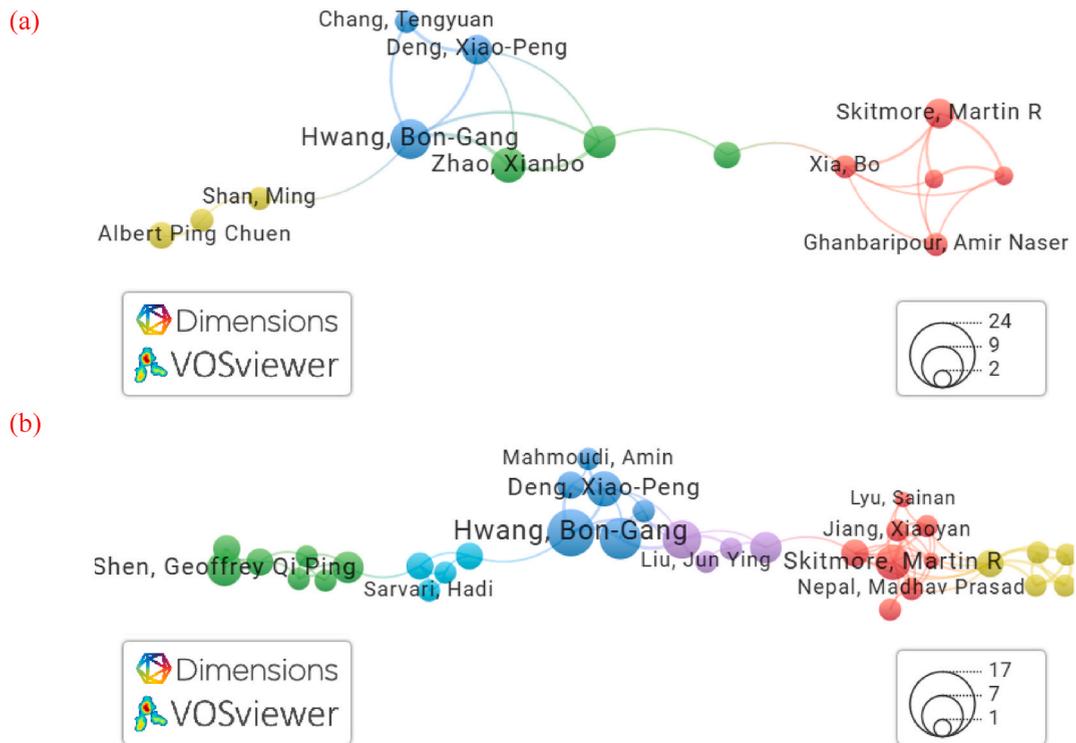
The bibliometric analysis of the publishing keywords and search terms used in this study were also investigated. The main keywords identified in this study were analysed using word clouds, and the results showed that some keywords had higher densities than others, as seen in Fig. 16. The terms with the highest density are expressed in the word cloud by using larger font sizes as well as unique font colours. A free online word cloud generator was utilised with condensed keywords extracted in a notepad file from Google Scholar database, in order to determine the effect of keyword analysis, as seen in Fig. 16. The keywords are shown from most to least bold when utilising an online word cloud generator. From the study, the main keywords highlighted include project, management, risk, knowledge, modelling, evaluation, among others.

## 5. Opportunities and recommendations

In this section, the opportunities and recommendations are presented on this study.

### 5.1. Opportunities and challenges via risk based structure

The need for urbanisation, smart cities and high-rise buildings globally has increased the volume of projects carried out in the Architecture, Engineering and Construction (AEC) industry. These buildings are designed under tight schedules, tight contracts, huge budgets, and highly performance-driven construction managers, thus increased the related risks. In the same vein, it necessitates the classification of the risk factors. Also, every project should have reliable documentation of the risk assessments completed by each construction worker. In project management, risk assessment has been recognised as a crucial tool [18–21]. Hence, the classification



**Fig. 14.** Map of co-authorship analysis on publications from 2000 to 2025 for this research, showing data obtained in Dimensions database, using (a) 100 researchers and (b) 500 researchers.

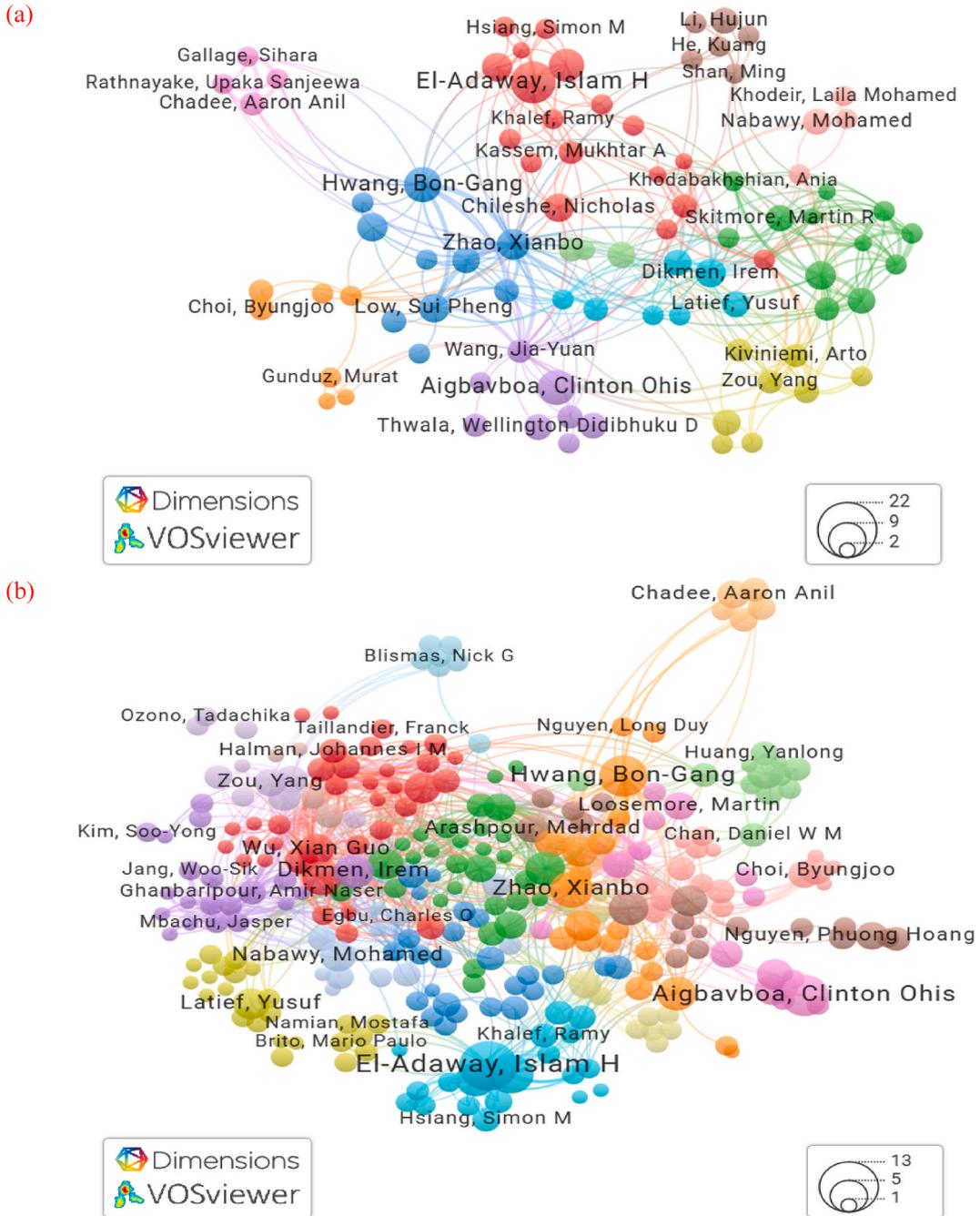
based on the knowledge of project risk factors in construction is conducted using a project management tool called risk-based structure (RBS).

Based on the need to have a safe construction workplace, the use of risk-based structure (RBS) has been a useful tool in monitoring the progress of the project. Risk-Based Structure (RBS) is an important tool that can be utilised to enhance the delivery of any project, from small scale to large scale projects. Recent studies have identified various project risk factors that impact on the management of construction projects [19,48,66–68]. The risk factors were classified using a structure called RBS for International Construction Enterprises (ICEs). This has been used in identifying the opportunities and challenges involved in ICE projects called international construction projects risk (ICPR). RBS is a useful KM tool for considering various risk factors that might inhibit the successful completion of the contract. Though, this review found that there are various opportunities and challenges that were identified in construction projects [59]. Summary on the studies that were based on the systematic literature review are presented in Table 3. Fig. 17 shows the ICE's RBS for construction industry opportunities and challenges obtained from the systematic review.

## 5.2. Emerging trends in risk knowledge management

The domain of risk knowledge management is not a static one; rather, it is continuously evolving in tandem with the progression of technology and the increasing complexity of projects [13,14,53,70]. The building and construction sector is currently at a critical crossroads as various project risks are identified; new techniques are proposed, and new materials are being developed but each of these require more benchmarking guidance. Though, the future is being constructed, brick by brick, the knowledge of ancient times till modern times has improved. As the level of competition increases and the complexity of the project increases, the adoption of good knowledge management strategies becomes necessary. With the rising interest in emerging technology within the construction sector, there is commensurate recognition of knowledge as a strategic asset, as it is geared towards increased productivity, enhanced innovation, and sustained growth. Though, both knowledge storage and knowledge dissemination are supported by the use of cloud, BIM and SNS in the construction sector [125,126], some intriguing trends that are on the horizon include:

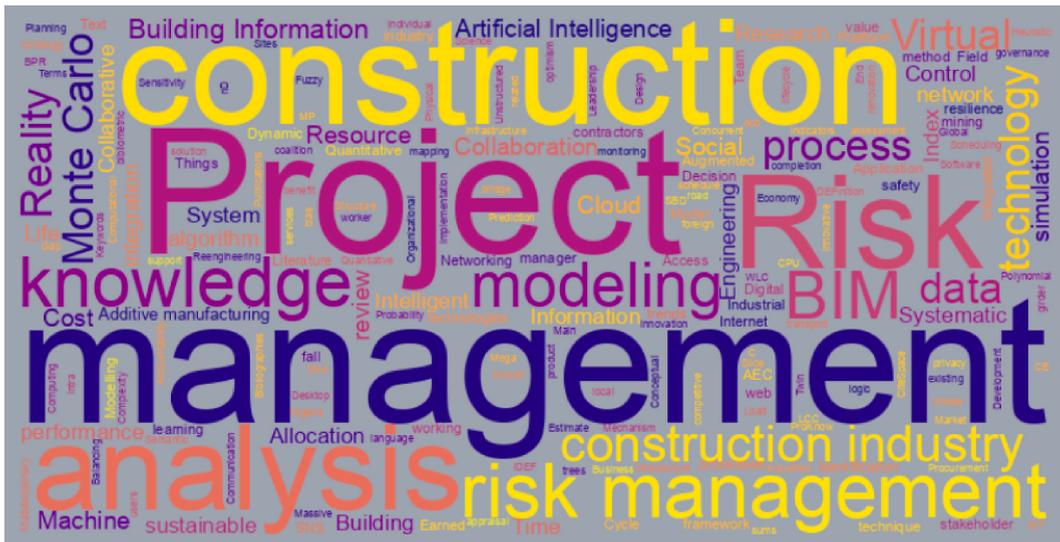
- **Artificial Intelligence (AI) and Big Data:** With AI-powered systems analysing enormous project data sets to forecast possible problems with stunning accuracy, it also prompts preventative measures before they materialise. This is a significant advancement in the field of artificial intelligence. This trend promises to bring about levels of risk forecasting and mitigation that have never been seen before, including GenAI tools for construction.
- **Virtual Reality (VR) and Augmented Reality (AR):** With AR/VR tools, simulating potential risk scenarios in immersive VR environments is possible. These tools enable teams to test mitigation techniques and perfect their response plans in a scenario that is



**Fig. 15.** Map of citation analysis on publications from 2000 to 2025 for this research, showing data obtained in Dimensions database, using (a) 100 researchers and (b) 500 researchers.

both safe and under control. The implementation of this novel strategy is expected to result in a substantial enhancement of risk preparedness, as industry users are still evolving in its adaptation.

- **Blockchain Technology:** With a safe and open-source digital platform that allows for the storage and dissemination of risk information across a wide range of organisations and sectors, more data is processed through blockchain technology. The blockchain technology has the potential to revolutionise the way in which people collaborate and share information, so promoting more extensive learning and improved risk management methods across a variety of industries, including the construction industry.
- **Building Information Modelling (BIM):** The use of BIM in the design and construction of buildings and other structures are increasing. BIM has made it possible to adapt technology into Computer-Aided Design (CAD) and other construction-related digital platforms that allows for the better collaboration, data storage and information dissemination [44,124,126,132].



**Fig. 16.** Word cloud of identified keywords. It reflects areas of knowledge-based learning in construction and SDGs are met in this research area. These keywords were obtained from Google Scholar Database using the search query. Source: Author's own image.

### 5.3. Lessons learned and insights

This study presents some lessons learned on knowledge mapping on project risk management and some recommendations that are made. Several important insights for researchers and practitioners may be learnt from the systematic review of knowledge management (KM) techniques applied to project risk management (PRM) in the construction industry. These observations demonstrate how knowledge management (KM) can promote organisational learning and resilience within complex construction instances in addition to reducing risk.

#### 5.3.1. Gaps in empirical application and metrics

Despite conceptual advancements, the literature reveals limited empirical validation of KM frameworks for PRM. Quantifiable metrics for evaluating KM effectiveness in risk reduction are often missing, thus the need for studies on knowledge mapping [7,23]. This underscores the need for longitudinal studies and project-based evidence to assess performance outcomes.

#### 5.3.2. Quantitative risk analysis (QRA) integration

The integration of KM with QRA techniques like Latin Hypercube Sampling and Monte Carlo Simulation enhances the accuracy of risk assessments [5,33,49,71]. This synergy supports data-driven decision-making and strengthens the reliability of risk mitigation strategies.

#### 5.3.3. Educational and training implications

The construction sector gains advantages from KM through consultancies, educational institutions and training facilities. One of the approaches is the use of specialist tools and construction-based databases, like the Building Cost Information Service (BCIS) database [72,73]. (see Fig. 18).

#### 5.3.4. Integration of KM and PRM enhances proactive risk handling

A key lesson is that integrating KM principles with risk management frameworks enables more proactive identification and treatment of risks. Organisations that institutionalize processes for capturing, sharing, and reusing risk-related knowledge—especially lessons from past projects—tend to demonstrate improved risk foresight and mitigation capacity. However, integration is often hindered by fragmented processes, lack of centralized repositories, and low stakeholder participation.

#### 5.3.5. Codification and balanced personalization

The literature confirms that both codified knowledge (e.g., databases, risk logs) and personalized knowledge (e.g., expert consultations, workshops) are essential. Codification supports scalability and transferability, while personalization fosters contextualized understanding of complex risk factors. Successful organisations maintain a hybrid approach, balancing formal documentation with informal knowledge exchanges.

#### 5.3.6. Lessons from Co-authorship and collaboration networks

Bibliometric analysis revealed that highly cited authors often engage in collaborative research, suggesting that co-authorship

**Table 3**  
Summary of some studies that were based on the systematic literature review.

Reference	Method	Tool	Summary
[24]	Systematic review on 148 publications found, filtered 13 publications, used content analysis	PRISMA tool, academic database	SLR on studies for risk control using Digital tools via design application. Safety initiative called Prevention through Design (PtD)
[32]	Developed a RM model from project risk register. Proposed a RisKG for KM for construction projects using Construction risk dashboard (ConRisk Dashboard).	ConRisk and Risk Knowledge Graph (RiskG)	It conducts frameworks for data retrieval model on intelligent tools facilitating digital collaboration in project stakeholders, project coordinators (PCs), and integrated risk management for informed decision-making on construction projects. It is for knowledge-based risk management systems (KBRMS).
[38]	Survey approach, quantitative analysis, qualitative analysis, Likert scale, mixed approach, semi-structured interviews, open-ended questions and perception analysis	Questionnaire and semi-structured interviews with 30 PCs	Considered the Ghanaian construction projects for identifying and classifying various construction-risk factors. Looks at organisational structures in international projects affect PC's perceptions of communication risks. their capacity to provide consistent information delivery. The study highlights how crucial skilled coordinators are to coordinating stakeholder objectives and making efficient use of available resources.
[25]	Structural equation modelling, content analysis, systematic approach adoption, and text-mining, perception analysis, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), deductive analysis, and quantitative analysis.	158 engineers, 166 quantity surveyors, 49 architects, 89 contractors, Questionnaire, Likert scale, focus group.	Three important elements are highlighted in this study's paths to identifying and classifying crucial construction-risk factors influencing projects in Ghana. These include efficient resource planning and control, prompt dispute resolution, and familiarity with emerging technological requirements. The study created a model to comprehend these risks using a survey of 462 professionals and suggests that a dispute resolution board be made obligatory for project success.
[69]	Snowball sampling, data saturation, content analysis, word frequency analysis, keywords-in-context method, coding process, semi-structured interviews, focus group study,	Questionnaire and semi-structured interviews, NVivo 12 platform, Whiteboard (an auxiliary tool embedded in Teams)	This study identifies 13 important elements, 7 of which are considered crucial, and examines the subjective factors influencing cost estimators' assessments of cost contingencies in highway construction projects in the UK. 12 semi-structured interviews with seasoned cost estimators employed by general contractors in the UK construction sector were carried out. Then a follow-up focus group study was likewise carried out with 7 seasoned cost estimators from the UK construction sector. With the ultimate goal of lowering cost overruns in building projects, the results emphasise the significance of both expertise-related and individual aspects in enhancing the accuracy of cost estimators' assessments.
[34]	BIM approach, interview coding, qualitative analysis, inferential - structural modeling (ISM) approach	Inferential - Structural Modeling (ISM) in MICMAC software,	Risk identification and classification using preventable safety risk mitigation factors. Using a BIM approach, the study attempts to discover and categorise preventable risk mitigation variables in mass housing projects. Out of 12 identified-as-significant variables, certain factors, such management commitment as well as employee empowerment, are found to be critical in improving safety and lowering occupational accidents of construction projects through interviews and analysis using ISM and MICMAC software. For organisations and safety decision-makers concerned with enhancing safety in mass housing building, the study offers insightful information.
[35]	Likert scale, Interview surveys, quantitative analysis, KBDSS-SRA and GSAI to evaluate SRs based on the FTOPSIS method. 24 specialists working in 7 construction projects in Hong Kong were interviewed onto the development of the DSS.	MATLAB, GSAI, and KBDSS-SRA	The study looks at having safer tower crane operations. By identifying and assessing critical safety risks (SRs), the study proposes a KBDSS-SRA with the goal of enhancing safety in tower crane operations. By automating the risk assessment process, the technology helps safety management staff make well-informed decisions to improve worker safety on building sites. Nevertheless, during the creation of KB and DSS, 15 of those with more years of experience were regarded as senior

(continued on next page)

Table 3 (continued)

Reference	Method	Tool	Summary
[36]	Questionnaire, detailed literature review, structured interviews, hypothesis test, partial least-squares structural equation modelling,	Questionnaire and semi-structured interviews	specialists and interviewed as such. It culminates into "As Low As Reasonably Practicable" (ALARP) The purpose of this study is to determine the major factors that influence health climate in building construction projects. Based on a detailed literature study and organised interviews with seasoned professionals, a hypothesis was developed to accomplish this purpose on the relationship between practitioners' assessments of the health climate and their current state of health. The results show that practitioners' health condition and health climate are favourably connected. The study offers important insights to enhance health via construction practices by highlighting employment involvement as the most important determinant, thereafter management commitment alongside a supportive environment.
[37]	Knowledge graph, automated analysis approach, case-based reasoning (CBR). Utilising developments in computer science along with artificial intelligence, the method incorporates case representation and case retrieval.	Knowledge graphs,	In order to overcome issues with case representation and retrieval, this study suggests an automated analysis method for bridge operating incidents that makes use of a knowledge graph and case-based reasoning (CBR). The methodology offers useful tools for risk management in bridge operations and possibly other infrastructures by improving retrieval efficiency using a multi-circle layer strategy and proving its validity with specific situations. The case representation in the suggested method uses a knowledge graph to build multi-dimensional networks. The knowledge graph provides a thorough depiction of accidents domain knowledge by capturing the connections between different elements and entities.
[8]	Fuzzy Synthetic Evaluation (FSE), Factor Analysis, Critical Success Factors (CSFs),	Closed-ended questionnaire, Likert scale,	The critical success factors (CSFs) required to advance sustainable health and safety practices in Malaysia's construction sector were examined in this study. Techniques. A thorough literature review served as the foundation for the development of a closed-ended questionnaire that was verified by professionals. 158 valid replies were obtained from the survey, which was given to construction industry experts in Malaysia. FSE was used to rank the significance of each factor in the data. Stakeholder involvement, efficient waste management, and the use of environmentally friendly products to improve operational resilience and worker well-being. The results show that combining these approaches can have major positive effects on safety and the economy.

networks play a significant role in advancing knowledge in this domain. Encouraging interdisciplinary and cross-institutional collaboration can accelerate innovation in KM and PRM. Table 4 shows the bibliometric data on knowledge management in construction from the systematic literature review using the research keywords.

#### 5.4. Frameworks on knowledge management and recommendations

This study presents some opportunities that knowledge mapping creates alongside recommendations made. Howbeit, there are some important takeaways that knowledge brings towards illuminating the future. Hence the framework proposed for classifying KM is seen in Fig. 19.

##### 5.4.1. Knowledge sharing

Although the issue of project risks may have many classifications, its influence can be seen in various aspects when confronted with any risk likelihood that is targeted and illuminated. Project teams can leverage their shared understanding of past experiences, emerging trends, and cutting-edge technology by adopting a culture of knowledge management [19,66–68]. This allows them to shed light on the route that lies ahead in the construction by good understanding of the project risks.

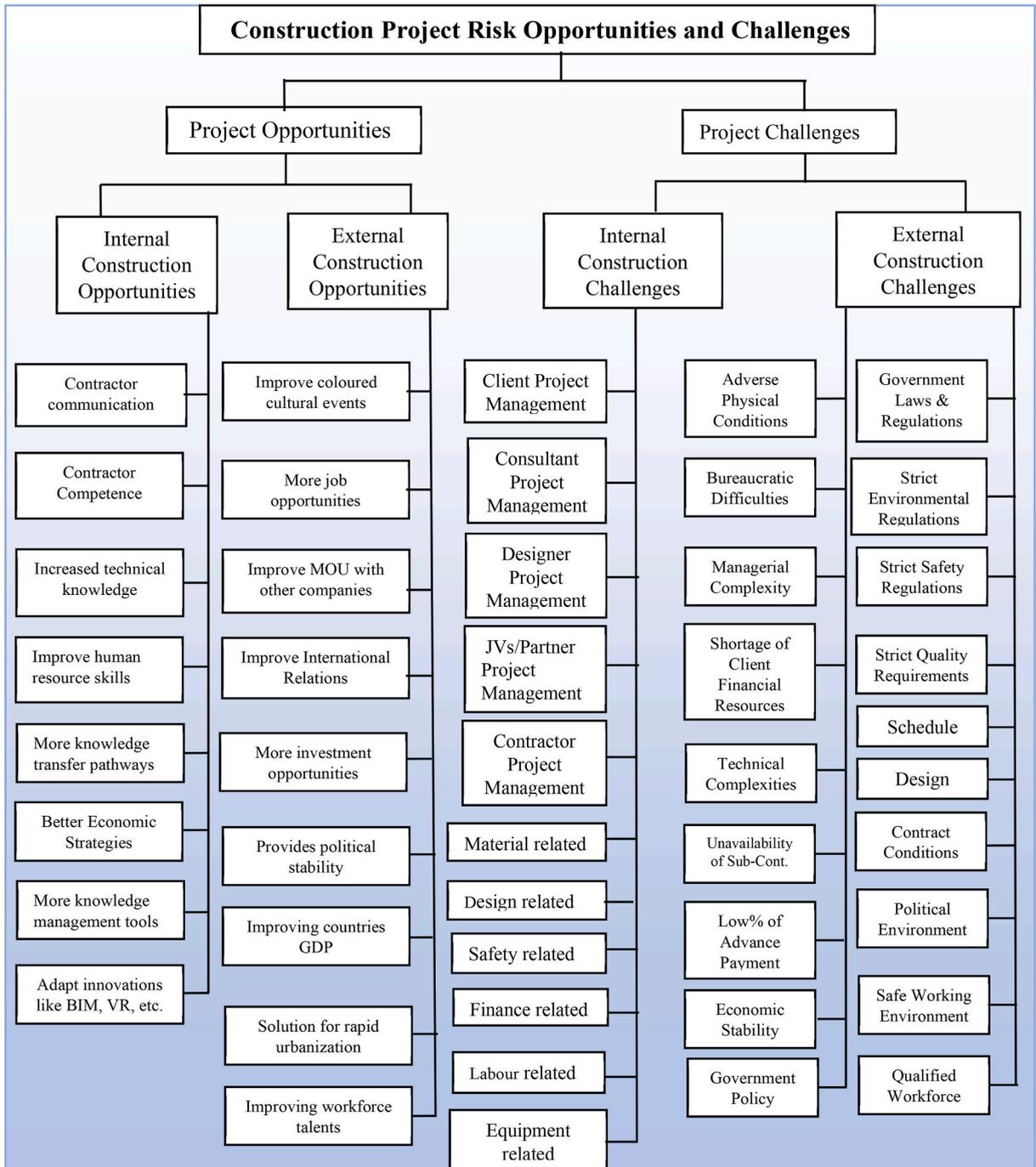


Fig. 17. The risk factors for construction project opportunities and challenges obtained from the systematic review.

5.4.2. Knowledge mapping

Also, effective knowledge management provides businesses with a valuable knowledge asset, which enhances their capacity to react to shifting market conditions and produce improved project outputs. This has the potential to provide businesses with a competitive advantage and raise their profitability. Due to this, they can improve their competitive edge, which ultimately results in increased profitability. Knowledge mapping enables quick access to best practices and lessons learned, hence reducing the amount of rework that is required and expediting decision-making [57,58,61,62].

The screenshot shows the BCIS Online search results page. The main content area displays the project title '23 Flats and 3 Detached Houses, Brownlow Road - #34694' and a 'SUMMARY' table with the following details:

SUMMARY	
Project title:	23 Flats and 3 Detached Houses, Brownlow Road
Location:	Haringey, London N11
Date:	Jan-2022
Building cost:	£6,987,500
Cost/m <sup>2</sup> :	£3,088
Floor area:	2,263m <sup>2</sup>
Main construction:	Brick construction

**Fig. 18.** Search output on construction database called BCIS Online showing a search interface for finding UK-based residential houses recently constructed in 2022 (Link: <https://online.bcis.co.uk/Analyses/AnalysesDetail/33696?returnUrl=%2FAnalyses%2FAnalysesResults%3ForiginatingPage%3DBasicParameters%26analysesType%3DAll&returnText=Go%20back%20to%20analyses%20results&Section=Analyses>). Data retrieved on 25th July 2025. Source: BCIS Online database).

**Table 4**

The bibliometric data on knowledge management in construction from the systematic literature review using the research keywords.

S/N	Research Keywords	Sources
1	Risk Management	[9,10,22,33,62–64,70,74–78,123,129–131]
2	Knowledge Management (KM)	[2,29,44,45,79]
3	Systematic literature review (SLR)	[22,26–28,31,80–82]
4	Bibliometric/Scientometric	[22,23,41,42,42,57,83]
5	International Construction	[7,11,22,54,127,128]
6	Political risk management	[7,9,11–14,18–22,46,47,85,88,128]
7	Quantitative risk analysis (QRA)	[33,48–51,71,77,90–97]
8	Stakeholder risk management	[1–4]
9	Project management	[13,14,98–105]
10	Construction management	[3,13,14,41,43,45,98,100,102,103,106,107]
11	Building Cost Information Service (BCIS)	[72,73,108,109]
12	Construction delay	[54,110]
13	Building information modelling (BIM)	[1,44,111,111,115,124,126,132]
14	Cost Overrun	[13,14,53]
15	Risk assessment/risk identification/risk mitigation	[5–7,10,14,22,46,60,112–114]
16	AEC industry/construction industry	[1,1–3,8,41,42,81,98,103,125]
17	Green construction	[3,66,67,84]
18	Ontology	[40–43,45,101,115]
19	Monte Carlo Simulation (MCS)	[48,50,51,71,92]
20	Augmented Reality (AR)	[102,106,107,116]
21	Virtual Reality (VR)	[80,102,117]
22	Social Networking Service (SNS)	[55,103,111,111,125,126]
23	Information and Communication Technology (ICT)	[40,43,44,47,81,115,116]
24	Project risk management (PRM)	[7,11,12,84,86–89]
25	Semantic web technology	[43,82,115]
26	Project success	[11,19,44,66–68,101]
27	Social Network Analysis (SNA)	[55,56,118,119]
28	Smart buildings	[4,80,120]
29	Sustainable construction	[3,4,66,67,84,98,98,120]
30	Cost estimation	[39,40,72,72–74,108,109,127]

#### 5.4.3. Knowledge storage

Furthermore, cloud-based platforms provide for real-time access to project information and knowledge repositories. Thus, the cloud-based platforms eliminate geographical barriers making it easier for teams to collaborate with one another, despite being scattered geographically or positioned at certain cloud-bases, workstations, or office locations.



Fig. 19. Framework for classifying knowledge management.

#### 5.4.4. Knowledge dissemination

Knowledge dissemination are enhanced as cloud-based platforms provide expertise to capture tools, such as digital whiteboards alongside interactive reporting systems, not only prompt individuals to contribute their expertise. KM uses ontology to disseminate knowledge on construction but also offer vital insights into the progress of the project and the lessons that have been gained [2,39–43].

#### 5.4.5. Knowledge integration

Knowledge integration in the context of risk management, is highly important as well as relevant in the age of innovation, digitalization and introduction of more advanced GenAI tools for the enhancement of project risk management processes. However, knowledge in this field is disseminated through publications on the use of technologies related to risks [9,121,122].

#### 5.4.6. Knowledge adoption

The construction management considers various key areas including cost reductions, adherence to schedules, improvements in quality, ensuring workplace safety, as well as a competitive advantage. The reputation of the construction firm is enhanced through successful project delivery and good project success. Hence, best practices must be adopted to support the daily operations on construction sites. Also, the knowledge adopted propels the construction firm towards unprecedented levels of success, enhancing more project collaboration and winning more construction contract bids.

#### 5.4.7. Knowledge Propagation

Another aspect that was found is the quantitative risk analysis (QRA), which involves a decision-making strategy. There are different QRA techniques that could be adopted, like the Latin hypercube Simulation (LHCS), Monte Carlo Simulation (MCS), Earned

Value Analysis (EVA) as well as sensitivity analysis [5,33,49,51,71]. With QRA, good RM can be achieved for construction projects. Thus, it can be stated that knowledge management and project management present some of the major benefits to the firm. However, further study can also consider SLR on QRA.

5.4.8. Knowledge transfer

The basic idea that knowledge has the power to alter the landscape of project management is still evident. Knowledge-based learning is acquired by adopting new technology, honing the new methods, and studying relevant works. Other areas that can impact on knowledge-driven risk management include exchanging experiences through experiential learning and knowledge transfer programs. Hence, managers and educators can work together to illuminate the route that upcoming generations of project managers will follow.

5.4.9. Knowledge dissemination

Knowledge management also enhances construction education through the combined power of collective learning, proactive mitigation, knowledge transfer as well as a dogged pursuit of knowledge-driven projects [79]. ‘Knowledge is power’, says the popular maxim. As such, when knowledge is harnessed effectively, it can transform the landscape of project management, leading to greater success and resilience in the face of uncertainty.

5.4.10. Knowledge Accessibility

It is ultimately necessary to undergo a cultural shift in order to successfully adopt a knowledge map. This shift should encourage participation in the process of knowledge production and utilisation, as well as develop a sense of shared ownership. By embracing knowledge maps as a tool for collaborative work, the construction sector has the potential to create a future in which information is freely exchanged, which will result in increased creativity, efficiency, and sustainable development.

5.4.11. Knowledge identification

Hence, the construction sector can be seen as a complicated ecology in which knowledge is frequently fragmented, siloed, and put to insufficient use [2,29,44,45]. This SLR found that there are different risks identified and classified [7,25,34,69]. The findings also highlight the importance of embedding KM principles into construction education and professional development. Training future project managers in knowledge-based risk management will be crucial for sustaining innovation and resilience in the sector.

5.4.12. Knowledge application

The deployment of digital platforms such as Building Information Modeling (BIM), Common Data Environments (CDEs), and enterprise content management systems can significantly aid KM for risk [115,124,126]. However, technological tools must be embedded within a broader knowledge-sharing culture. Without leadership support and training, digital solutions often fall short of fostering real-time, reflective learning among teams. Wang and Meng [44] presented a BIM-based framework for KM in the construction, which has been adapted for the proposed framework with 5 main phases considered, as shown in Fig. 20.

6. Conclusion

In recent decades, the academic community has conducted extensive research on knowledge mapping in project risk management, resulting in a significant body of literature. This paper presented a systematic literature review on knowledge management for project risk management in construction, using publication data from 2000 to 2025. This systematic literature review (SLR) was used to

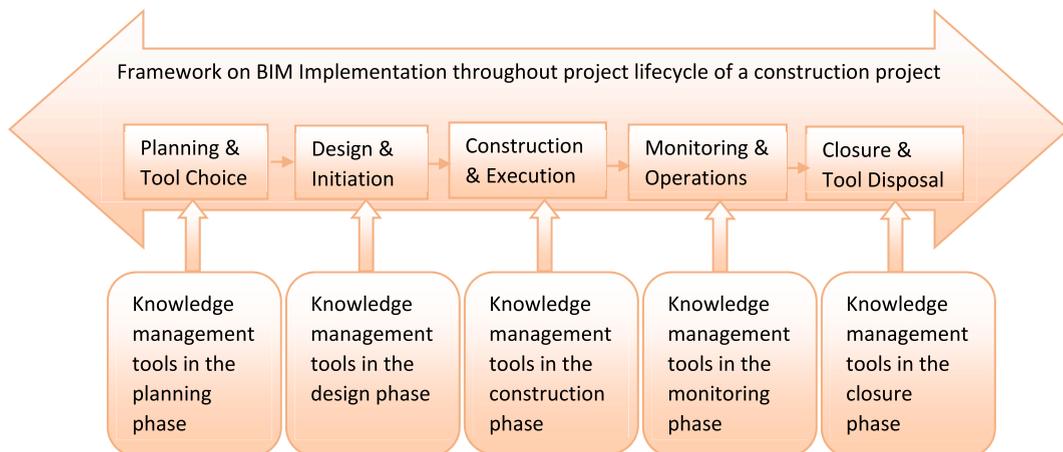


Fig. 20. BIM-based framework proposed on knowledge management in construction (adapted from Ref. [44]).

develop knowledge maps on publication trends achieved through the usage of knowledge acquired from researching academic databases. This study employed visual and content analysis methods to review research on political risk, using data sourced from two major academic databases: Scopus and Dimensions. The review offers a comprehensive overview of the existing literature, covering areas such as geographic distribution (countries), contributing institutions, influential authors, foundational references, frequently cited authors and journals, as well as research hotspots and emerging trends through keyword analysis. The research tools used include Mendeley reference manager, Notepad, Microsoft Excel, SCOPUS online database, Dimensions online database, VOSviewer, and an online word cloud tool. This paper makes several contributions to the literature. Firstly, it utilizes VOS Viewer to assess the current state of research in knowledge management and project risk, highlighting future directions. Unlike previous overviews, this study presents a series of knowledge maps that illustrate trends in project risk management research, thereby enriching visual analysis methods and expanding the scope of literature reviews. These methods are also adaptable to other fields, helping researchers understand the development of specific research areas. Secondly, through an analysis of 1660 publications from 2000 to 2025 in Scopus and Dimensions, the study identifies leading countries, institutions, authors, journals, and seminal works that have shaped the field. It also tracks major research issues and their development over time, offering scholars a clear and accessible understanding of the domain and assisting them in identifying valuable research opportunities. Thirdly, the paper highlights three key areas in knowledge mapping for construction project risk management that require further development, offering a foundation for future research aimed at addressing these gaps. Fourthly, the study shows that knowledge obtained from conducting this literature search has presented some classifications conducted on project risk. Also, this study supports KM readership by helping safety officers, students, salesmen, researchers, experts and professionals to understand the scope of the knowledge maps and construction work patterns.

Furthermore, based on the keyword and content analyses, the review identifies and explores some key aspects of knowledge mapping in project risk management. Hence, the first key finding of the study involves Knowledge Mapping. Knowledge-based learning, continuous learning, as well as risk management inquiry are all essential components of the continuous process that leads to efficient knowledge management. This study also found that KM in construction is fragmented and often tacit. Other areas are for future study include the use of machine learning in knowledge management on construction works. The second key finding involves classification, as this SLR classifies and identify various risks. In addition, ontology and semantic tools help classify and transfer knowledge. The third key finding is the Case study Collaboration. With case study collaborations, it was observed that knowledge management (KM) enhances collaboration, safety, and innovation in construction. The fourth key finding involves Top Authors and Countries' Collaboration. From the SLR, the leading authors in the search area include El-Adaway, Hwang, Chan, Chileshe, Zhao, Deng, etc. Also, the leading countries include USA, China, UK, Australia, Malaysia, etc. Knowledge sharing would enable the dissemination of knowledge as it enhances better collaboration, as seen with the co-authorships and top authors had high citations with their collaborators. The fifth key finding involves the Publication Trends. From the publication trends, there are steady growth in publications, with peaks and dips due to global events (like COVID-19 pandemic in 2020/2021). Regarding the subject areas, Engineering is the dominant subject area (39%), followed by Business and Computer Science. This knowledge management study reflects that future research in construction education can include these key areas. The sixth key finding involves the Top Journals. From the SLR, the top 6 journals found in the search area were Journal of Construction Engineering and Management, Engineering, Construction and Architectural Management, Buildings, Sustainability, and Safety Science. Lastly, the seventh key finding involves the Research Funding Sponsors. This study found various funding sponsors from the SLR, which include National Natural Science Foundation of China, UK Research and Innovation Council, EPSRC, NDDC, TETFUND, MOHE Malaysia, etc.

Additionally, whilst considerable progress has been made in this field, research specifically focused on construction projects as research regarding knowledge mapping on project risk management remains limited. Drawing from broader literature on project risk management across various areas, the study proposes four recommendations for advancing research in construction project risk management: a) Deepen the investigation into the impacts of project risk management; b) Enhance the quantitative methods used to evaluate project risks; c) Explore more areas of project risk management, and d) Widen the scope of risk management strategies. Thus, the recommendations on this SLR approach found that knowledge management (KM) enables the industry to move beyond the darkness of uncertainty through robust risk management strategies and embrace the light of knowing by ensuring safe practices. Also, another recommendation suggest that future research can increase focus on knowledge-driven risk management since a thorough understanding necessitates further exploration of particular tools, methods, and scenarios. Besides that, more studies can include the comparative use of bibliometric tools for knowledge management of quantitative risk analysis, project risk management, as well as cost estimation in construction. Lastly, future works using the search query should explore using other academic databases like ScienceDirect, Emerald, Google Scholar, Almetric Explorer and Web of Science (WoS) to investigate the publication trends.

### CRedit authorship contribution statement

**Chiemela Victor Amaechi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ahmed Reda:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Salmia Binti Beddu:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Daud Bin Mohamed:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Agusril Syamsir:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Idris Ahmed Ja'e:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition.

**Safi Ullah:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Deng Xiaopeng:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Bo Huang:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Chunguang Wang:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Xuanze Ju:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition.

### Data availability statement

All the data used in this study are original contributions as presented in the study. All the outputs of the systematic literature review are also included inside the article. Any additional inquiry may be directed to the corresponding author.

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### The Supplementary Data

The Dimensions database is available online as the data was retrieved using the search query on this link [https://app.dimensions.ai/discover/publication?search\\_mode=content&search\\_text=%E80%98knowledge%20management%E80%920AND%20%E80%98risk%E80%99%20AND%20%E80%98construction%20project%27&search\\_type=kws&search\\_field=text\\_search](https://app.dimensions.ai/discover/publication?search_mode=content&search_text=%E80%98knowledge%20management%E80%920AND%20%E80%98risk%E80%99%20AND%20%E80%98construction%20project%27&search_type=kws&search_field=text_search) (accessed on 20th July 2025).

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Data availability

I have shared the link to the additional data within the text

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