
BUILDING INFORMATION MODELLING AND RISK IN INDUSTRIALISED BUILDING SYSTEM PROJECTS: A SCIENTOMETRIC REVIEW

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ABSTRACT

The scholarly exploration of Building Information Modelling (BIM), risk management, and Industrialised Building System (IBS) research has expanded rapidly, reflecting the construction industry's increasing reliance on digital and prefabricated technologies. Despite this growth, there remains a fragmented understanding of how research in these areas has developed over time, including dominant themes, influential contributors, and methodological trends. This study addresses this gap through a scientometric review of 1,153 publications retrieved from the Scopus database between 2010 and 2025. Using VOSviewer and Scopus analytical tools, publication trends, document types, co-authorship networks, and keyword co-occurrence were systematically examined to provide a structured overview of the field. The analysis reveals a steady increase in scholarly output, particularly after 2015, indicating rising global interest in technology-driven risk management and prefabricated construction methods. Journal articles constitute the majority of the literature, followed by conference papers and reviews, reflecting the evolution of research dissemination. Geographical and citation analyses show that countries such as China, Malaysia, and the United Kingdom dominate the field, while highly cited authors provide conceptual and methodological foundations for emerging studies. Keyword analysis highlights recurring themes of safety, process optimization, digital innovation, and project management. Despite the rapid expansion of literature, persistent gaps remain, including limited empirical validation, uneven adoption across industry contexts, and the lack of standardized methodologies. By mapping these patterns and gaps, this scientometric review offers a critical lens on the evolution of BIM, Risk, and IBS research, providing scholars and practitioners with actionable insights on knowledge trends, collaborative networks, and potential directions for future investigation. Overall, this work supports informed decision-making and fosters the development of rigorous, context-sensitive research agendas in construction studies.

Keywords: Industrialised Building System (IBS), Building Information Modelling (BIM), Risk Management, Scientometric Analysis, Construction Research

1. INTRODUCTION

The construction industry is undergoing a significant transformation through the adoption of digital technologies, with Building Information Modelling (BIM) recognized as one of the key drivers of this change (Eck & Waltman, 2010; Eck & Waltman, 2017). BIM enables the management of multidimensional project information, improving collaboration, visualization, and decision-making efficiency across the lifecycle of construction projects. In parallel, the Industrialised Building System (IBS), which emphasizes offsite prefabrication, has emerged as a strategic approach to enhance productivity, quality, and sustainability in construction (Zhen et al., 2022; Gu, 2022). Despite these advancements, construction projects particularly those involving IBS continue to encounter risks related to design errors, coordination challenges, and supply chain disruptions (Liu et al., 2022; Tabatabaee et al., 2021a).

Although numerous studies have examined BIM functionalities and IBS risk profiles individually, a fragmented understanding persists regarding broader research trends, thematic developments, and collaborative patterns across the field. Scientometric analysis offers a systematic, evidence-based method to map the intellectual structure of a research domain. Techniques such as co-authorship, co-citation, and keyword co-occurrence mapping enable researchers to identify influential contributors, thematic clusters, and emerging trends (Appio et al., 2014). Applying these methods to BIM, risk management, and IBS research provides a comprehensive overview of the field's evolution, revealing both well-explored areas and persistent gaps.

This study addresses this gap by conducting a scientometric review of 1,153 publications retrieved from the Scopus database between 2010 and 2025. Using tools such as the Scopus Analyzer and VOSviewer, the study examines publication trends, document types, co-authorship networks, and keyword co-occurrence patterns. The aim is to provide a structured understanding of dominant research themes, influential authors and institutions, and underexplored areas within BIM, risk, and IBS research. By synthesizing these insights, the study contributes a critical, data-driven perspective that informs future research directions, highlights opportunities for cross-disciplinary collaboration, and supports the development of rigorous, context-sensitive strategies for construction studies.

2. LITERATURE REVIEW

The growing interest in prefabricated and industrialised construction systems has coincided with a parallel evolution of BIM technologies. These technologies have emerged as key enablers in mitigating inherent risks within the IBS framework. Multiple studies underscore the role of BIM in early detection of risks, process optimisation, and collaboration enhancement. For example, Cho et al. (2021) identify a strong relationship between the nonuser of BIM and schedule delays in precast projects, highlighting BIM's importance in early-stage project management. Similarly, the developed risk assessment prototype (PRAT) specific to BIM-integrated IBS projects using fuzzy logic and network processes, further demonstrating BIM's potential in structured risk prioritization (Tabatabaee et al., 2021). Meanwhile, Mahmoud et al. (2022) focus on barriers to BIM implementation in SMEs, particularly in prefabricated wood construction, reinforcing the need for tailored integration strategies across varying organizational scales.

Another notable trend relates to the integration of BIM with emerging digital technologies to manage specific risks. The explore Digital Twin-based framework for safety risk analysis during hoisting operations in prefabricated projects, where BIM enables real-time visualization and coupling analysis (Liu et al., 2021). Shen et al. (2022) introduce ontology-based monitoring for prefabricated building safety using Revit, demonstrating effective integration of BIM with semantic technology. These studies reflect the movement towards intelligent automation in risk monitoring and suggest that

the intersection of BIM with technologies such as IoT and ontology holds transformative potential in real-time decision-making and proactive risk avoidance.

The digitization of prefabricated construction in broader contexts also reveals national and industrial variations. Gu, (2022) critically reviews the digitization journey of China's prefabricated construction industry and highlights the fragmented integration of BIM with other digital technologies. Zhen et al. (2022) further contribute by proposing a BIM system for comprehensive safety assessment across a building's life cycle, exposing the challenges of interoperability and information continuity. These investigations underscore the gap between conceptual digital frameworks and their holistic execution across project phases, especially in developing regions where technological and infrastructural limitations persist.

Risk identification and mitigation strategies in IBS remain a critical concern, especially with increasing project complexity. Bataglin et al. (2024) argue for the use of 'slack' as a risk management tool in engineer-to-order IBS projects, suggesting the combination of lean philosophy with BIM-based production planning. Similarly, Zhang et al. (2024) employ game theory and system dynamics to investigate stakeholder willingness to implement BIM in prefabricated building processes. These perspectives highlight a deeper shift from tool-centric to system-level thinking in BIM adoption. However, they also reveal a lack of consensus on universal implementation pathways, which hinders scalability and broader institutional uptake.

Quality and rework risks also remain a central concern in IBS projects. Liu et al. (2022) pointed to urgent needs for BIM-based quality traceability systems to support offsite construction, while Meng and Cao (2024) demonstrated that ontology-enabled BIM systems could reduce error propagation and rework cycles. Studies in Malaysia have also recognised persistent issues in manual BIM data entry and information encoding for IBS components (Zhang & Tang, 2024; Ismail, 2019), reinforcing the need for automation, standardisation, and domain-specific BIM libraries capable of supporting the complexity of IBS projects.

Despite these advancements, significant gaps remain in achieving seamless digital integration across the IBS project lifecycle. Jamalluddin et al. (2022) identify critical risk areas in Malaysian IBS projects and recommend standardisation and Just-in-Time delivery supported by BIM. Yet, there is minimal empirical evidence of such integrations in live projects, especially those involving SMEs or public infrastructure (Ismail & Motawa, 2019). Similarly, Ahmadi and Arashpour (2020) acknowledge the promise of 4D-BIM in improving construction planning, but stress the lack of automation and coding optimisation for broader application. This suggests an urgent need for cross-sector collaboration to develop user-friendly, scalable BIM applications that are responsive to the unique demands of IBS.

Recent advancements in digital construction show a growing integration of BIM with advanced technologies to address risks in prefabricated and IBS. Wang and Li (2025) highlight that BIM maturity strongly influences coordination and lifecycle performance in prefabricated projects. Complementary studies by Doan et al. (2025) and Wen (2025) show that Digital Twins, IoT, AI, and robotics, when coupled with BIM, enhance early risk prediction, safety monitoring, and decision-making. Research on BIM-related risk factors such as Tang et al. (2025) and Bayzidi et al. (2025) identifies key challenges including interoperability issues, inconsistent BIM standards, and fragmented collaboration across supply chains. These findings indicate a shift from basic BIM coordination toward integrated, multi-technology systems that offer real-time visibility and predictive analytics for more effective IBS risk management.

Recent studies also reinforce BIM's growing role in risk mitigation, especially in safety, quality assurance, and lifecycle governance. Wang et al. (2025) demonstrate that BIM-based automated hazard detection significantly improves early-stage safety planning, while Zhu et al. (2025) and Li et

al. (2025) show that BIM-enabled compliance and automated checking systems reduce modelling errors and rework risks. BIM has additionally been linked to enhanced dispute prevention (Tantawy et al., 2025), lean process optimisation (Yang et al., 2025), and sustainability risk assessments (McNeil-Ayuk & Jrade, 2025). Collectively, these works confirm that BIM now functions as a comprehensive risk management enabler within IBS ecosystems, supporting safer designs, more integrated prefabrication processes, and improved project performance.

In conclusion, the literature confirms that the study of BIM and risk management in IBS projects is both promising and underdeveloped. Studies such as those by Cho et al. (2021), Tabatabaee et al. (2021), and Shen et al. (2022) provide conceptual and empirical support for BIM's role in addressing risks, but a fragmented implementation landscape and lack of standardized frameworks continue to limit progress. Future research should focus on developing interoperable systems, industry-wide BIM standards, and longitudinal case studies to validate the effectiveness of BIM-driven risk mitigation in real-world IBS settings.

Research Questions

- Q1: What are the publication trends in BIM, Risk, and IBS research over the years?
- Q2: Who are the most cited authors and where are they affiliated?
- Q3: What is the type of document by subject of research?
- Q4: What is the map of Co-Authorship of BIM, risk, and IBS research?
- Q5: What are the popular keywords related to the study?

3. METHODOLOGY

Bibliometric analysis involves the systematic organization, evaluation, and interpretation of bibliographic data sourced from scholarly publications (Verbeek et al., 2002; Alves et al., 2021). In addition to basic descriptive metrics such as the year of publication, journal source, and authorship patterns, this method also incorporates advanced procedures like document co-citation analysis. Conducting an effective literature review requires a cyclical approach, starting from keyword formulation and database searching, followed by detailed assessment of selected sources, which together support the development of a reliable body of literature (Fahimnia, 2015). Based on this methodology, the present study concentrated on high-impact scholarly outputs, as these are instrumental in shaping the theoretical foundations of the field. To enhance data validity, the SCOPUS database was selected for literature extraction, given its reputation for comprehensive indexing of peer-reviewed research (Stefano et al., 2010; Khiste & Paithankar, 2017; Khoury et al., 2022). Furthermore, only peer-reviewed journal articles were included in the dataset, excluding materials such as books and lecture notes to maintain academic rigor.

3.1 Data Search Strategy

In order to collect literature aligned with the thematic focus of BIM, risk assessment, and IBS, within the construction sector, a structured query was executed in the Scopus database. Table 1 show the search query employed:

Table 1: The search string

Scopus	ALL ("building information modeling" OR bim OR "industrialized building system" OR ibs AND "construction risk") AND PUBYEAR > 2009 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE, "English"))
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This search was carefully constructed to include various expressions and abbreviations frequently used in the academic literature. By using both full terminologies and acronyms such as "building information modeling" and "BIM", or "industrialized building system" and "IBS", the search scope

was broadened to capture diverse phrasings found in relevant publications. The inclusion of the term "construction risk" helped concentrate the results on studies specifically dealing with risk within building and infrastructure development contexts.

To ensure consistency in language and improve clarity in analysis, a filter was applied to include only documents written in English. Table 2 show, the publication date range was set from 2010 to 2025, allowing for the examination of over a decade of scholarly output, encompassing both pioneering works and current research trends in this domain.

This search strategy targeted in Scopus, which retrieves results from multiple metadata layers, including titles, abstracts, and keywords. As a result, this method facilitated the identification of a comprehensive and relevant dataset, forming the basis for the subsequent scientometric mapping and literature analysis.

Table 2: The selection criterion in searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2010 – 2025	< 2026
Literature type	Journal (Article)	Book, Review

3.2 Data Analysis

To conduct a visual and quantitative analysis of the bibliographic dataset retrieved from Scopus, the study employed VOSviewer software (version 1.6.19), a widely adopted tool for bibliometric mapping. This software was developed by Nees Jan van Eck and Ludo Waltman at Leiden University and is recognized for its ability to translate large-scale bibliographic data into interactive visual maps that depict intellectual, social, and conceptual structures within a research domain (Eck & Waltman, 2017; Eck & Waltman, 2010).

The data set comprising publication titles, authors, source journals, keywords, citations, and publication years was extracted from Scopus in PlainText format, covering studies published between 2020 and December 2023. VOSviewer facilitated the analysis of keyword co-occurrence patterns, co-authorship networks, and citation relationships among the publications. Its interface allowed for the clustering of related terms and authors, as well as the visualization of network density, offering deeper insights into the structure and evolution of research concerning BIM, IBS, and construction risk.

Unlike traditional methods such as Multidimensional Scaling (MDS), which are often dependent on similarity metrics such as the cosine or Jaccard index (Appio et al., 2014), VOSviewer employs the association strength index (AS_{ij}) to normalize co-occurrence frequencies. This method more effectively captures the proximity and relational intensity between items in a low-dimensional space, ensuring the spatial arrangement of nodes corresponds to their actual relatedness (van Eck & Waltman, 2007, 2010).

The software's ability to handle various types of bibliometric networks such as co-citation, co-authorship, and keyword co-occurrence provides researchers with a flexible and intuitive platform or identifying dominant themes, knowledge gaps, and evolving trends within their field. Its ease of use makes it accessible to both novice and experienced researchers, and its continuous updates help maintain its position as a leading tool in scientometric analysis.

4. RESULTS AND DISCUSSION

4.1 Publication Trends in BIM, Risk, and IBS Research (2010–2025)

Figure 1 shows the annual publication trend from 2010 to 2025 and illustrates a clear upward trajectory in scholarly interest at the intersection of BIM, risk management, and IBS projects. Between 2010 and 2014, the growth was modest, reflecting an emerging interest in digital construction tools and prefabrication technologies. Starting around 2015, a steady increase is observable, likely driven by global efforts to digitize construction practices and mitigate risks through data-driven planning. The acceleration becomes more pronounced post-2018, which coincides with the mainstreaming of BIM in construction education and policy mandates in various countries. Notably, the sharp rise in publications between 2020 and 2023 suggests a heightened academic response to the challenges of the COVID-19 pandemic, where digital tools and prefabrication methods gained prominence for their efficiency, safety, and minimal on-site labor needs.

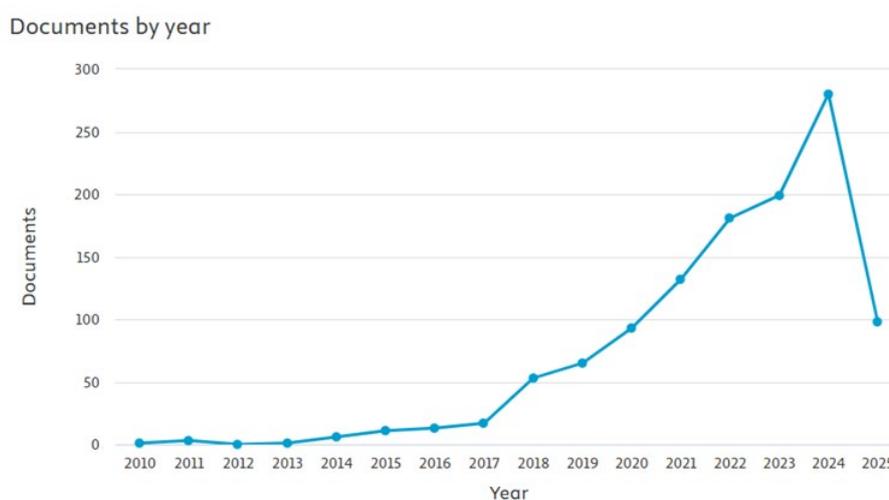


Figure 1: Plotting Document Publication by Years.

Despite the upward trend, fluctuations in annual output may point to shifting research priorities or funding allocations. The projected data for 2024 and 2025, while slightly tapered, still indicate sustained engagement in this research domain. This reflects the growing integration of BIM into risk-centric construction workflows and the increased awareness of IBS as a viable industrial strategy for rapid urban development. The trend also suggests that the topic has evolved from niche to mainstream within the construction research landscape. However, the relatively low output in the early years and the observed gaps in empirical validation signal the need for deeper longitudinal studies and cross-disciplinary approaches to unify digital tools with risk frameworks in IBS. These patterns collectively validate the relevance of a scientometric investigation and highlight the necessity for ongoing research to bridge existing theoretical and practical divides.

4.2 Most Cited Authors and Their Institutional Affiliations

The analysis of author productivity shows in Figure 2 and Table 3 highlights a diverse range of contributors in the field of BIM, risk management, and IBS research. Among the top contributors, Adeleke, A.Q. emerges as the most prolific author, with 12 publications, accounting for approximately 1.04% of the total output. This level of contribution indicates a strong research focus and sustained engagement with digital construction and risk-related topics. Authors such as Arashpour, M., Li, H., and Luo, H., each with 8 publications (0.69%), also demonstrate consistent scholarly output, suggesting active involvement in the development of frameworks and methodologies that connect BIM to risk mitigation in prefabricated construction contexts.

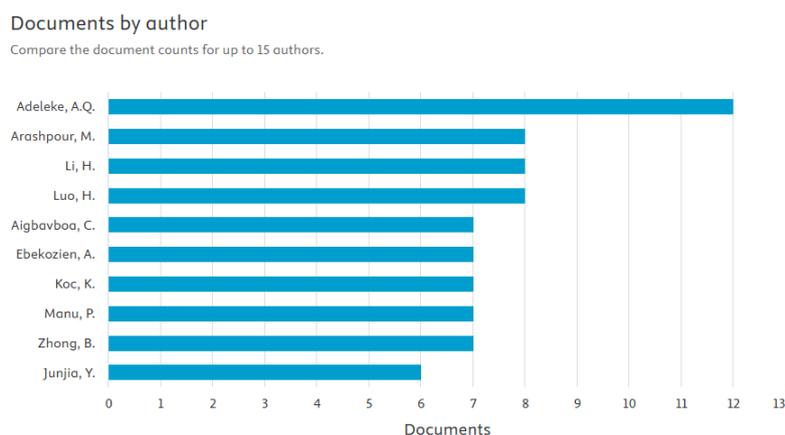


Figure 2: Top 10 Authors by Document Count on Intersection of BIM and Risk in IBS Projects (2010–2025)

A closer look at the list reveals a balance of authors from varying institutional and geographic backgrounds, reflecting the global relevance of this research area. For instance, Aigbavboa, C. and Ebekozi, A., each with 7 publications (0.61%), have contributed to the discourse with a particular emphasis on the African construction environment and the adaptation of BIM within developing economies. Similarly, authors like Koc, K., Manu, P., and Zhong, B. each with 7 papers have produced works that span topics such as safety management, stakeholder dynamics, and the integration of digital modeling with construction risk frameworks. This diversity in authorship underscores the multidimensional nature of the topic, incorporating perspectives from engineering, project management, and digital innovation.

Table 3: The selection criterion in searching

AUTHOR NAME	Number of Document	Percentages (%)
Adeleke, A.Q.	12	1.04
Arashpour, M.	8	0.69
Li, H.	8	0.69
Luo, H.	8	0.69
Aigbavboa, C.	7	0.61
Ebekozi, A.	7	0.61
Koc, K.	7	0.61
Manu, P.	7	0.61
Zhong, B.	7	0.61
Junjia, Y.	6	0.52

The presence of authors such as Junjia, Y., with 6 publications (0.52%), indicates the emergence of new scholars who are gradually becoming influential in this niche domain. The distribution of productivity, although not sharply skewed, suggests that while there are a few dominant voices, the field is still open to broader academic participation. This distribution is advantageous for the evolution of the discipline, as it allows space for methodological innovation and comparative research across regions and contexts. The pattern also highlights the importance of interdisciplinary and cross-institutional collaboration, which can enhance the richness and applicability of future research in digital construction and IBS-related risk management.

4.3 Distribution of Document Types Across the Research Domain

The distribution of document types in Figure 3 indicates that article follow by conference papers constitute the largest share, making up 69.4% and 15.9%. This suggests that much of the discourse surrounding BIM, risk, and IBS integration is being write, presented and debated at academic and

industry conferences. Article and, conference papers typically reflect ongoing or preliminary research, providing a snapshot of emerging ideas, methodologies, and case studies. The high presence of this document type reflects the fast-paced nature of digital construction research, where timely dissemination and professional networking are critical for refining research questions and frameworks.

Review articles, accounting for 10.9%, represent another significant portion of the dataset. These documents often provide comprehensive syntheses of existing knowledge, identify research gaps, and outline future directions. Their presence at this level suggests that the field has matured to a point where consolidation and critical reflection on accumulated findings are both needed and possible. Moreover, reviews often serve as entry points for new researchers, indicating a healthy ecosystem of foundational and interpretive scholarship. In contrast, book chapters (2.0%) and books (1.3%) are less prominent, which is consistent with the field's preference for concise, peer-reviewed dissemination rather than extended monographs.

Documents by type

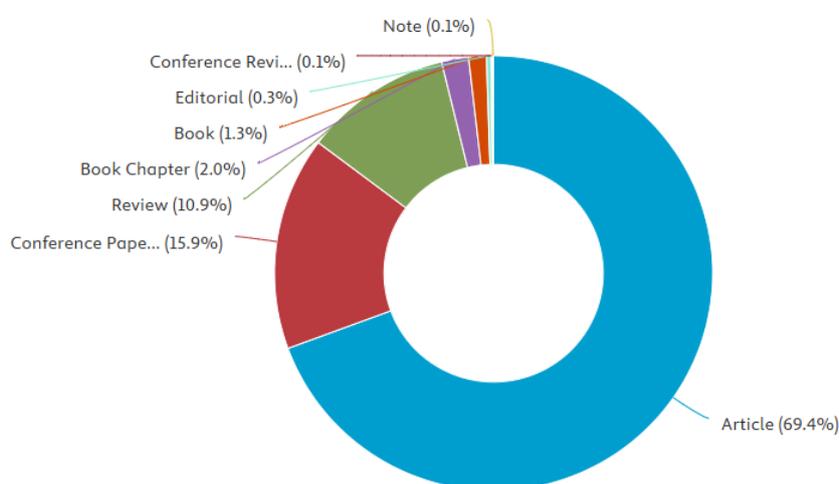


Figure 3: Type of Document by Subject of Research

Other document types, such as editorials (0.3%), conference reviews (0.1%), and notes (0.1%), collectively form a very small segment of the publication landscape. These types typically offer opinion pieces, short commentaries, or brief methodological insights, and their low frequency is not unusual in technical domains. The limited presence of such formats may indicate a field that prioritizes empirical studies and applied research over speculative or policy-driven commentary. Overall, the dominance of peer-reviewed papers and the growing share of review studies reflect a field that is both dynamic and steadily consolidating its theoretical and practical foundations.

4.4 Co-Authorship Network Structure in BIM, Risk, and IBS Studies

The co-authorship network visualization in Figure 4 highlights the significant role of international collaboration in the development of research at the intersection of BIM, risk, and IBS projects. China emerges as the dominant contributor, evident from the largest node size, reflecting its leading role in publication volume and international research engagement. China's strong connections with countries like Hong Kong, South Korea, and Singapore illustrate regional collaboration trends within Asia. Additionally, links extending towards Europe and North America indicate that Chinese researchers actively contribute to global dialogues on digital construction technologies and risk management frameworks, reinforcing China's position as a central knowledge hub in this domain.

Malaysia and the United Kingdom also stand out as influential nodes, signifying their active contributions and strategic partnerships. Malaysia, in particular, displays extensive connections with countries such as Nigeria, Egypt, and New Zealand, suggesting a focus on applying BIM and IBS practices within developing economies and diverse climatic contexts. Similarly, the United Kingdom's collaboration network extends broadly across Europe, Asia, and the Middle East, highlighting its role in integrating multidisciplinary approaches into risk analysis and digital construction research. The clustering patterns suggest that these countries not only contribute individually but also act as bridges connecting different regional research communities, enhancing cross-pollination of ideas and methodologies.

Smaller yet visible nodes such as India, Turkey, Saudi Arabia, and Canada reflect emerging contributors that are increasingly engaging in international collaboration. Although their node sizes are relatively smaller compared to China and Malaysia, their connections with major hubs demonstrate a growing research interest and capacity-building effort within these regions. The relatively sparse connections of some countries like Thailand and Greece suggest opportunities for stronger integration into the broader international research network. Overall, the co-authorship structure reflects a healthy trend of collaborative research in BIM and risk management for IBS projects, though there remains potential to deepen partnerships across less-represented regions to foster a more inclusive and globally distributed research landscape.

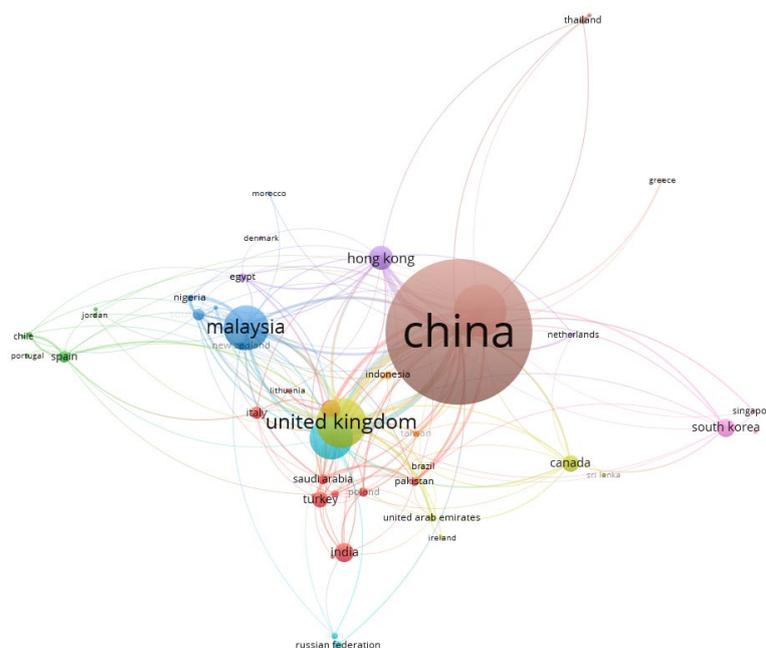


Figure 4: Network Visualization Map of Co-Authorship

4.5 Popular Keywords and Dominant Research Themes

The keyword co-occurrence analysis map in Figure 5 provides a deeper understanding of how scholarly work positions the relationship between BIM, risk, and IBS within the broader construction research landscape. The mapping reveals three dominant research themes, each characterised by strong conceptual linkages across keywords, confirming the increasing convergence of digitalisation, prefabrication, and risk management within current literature.

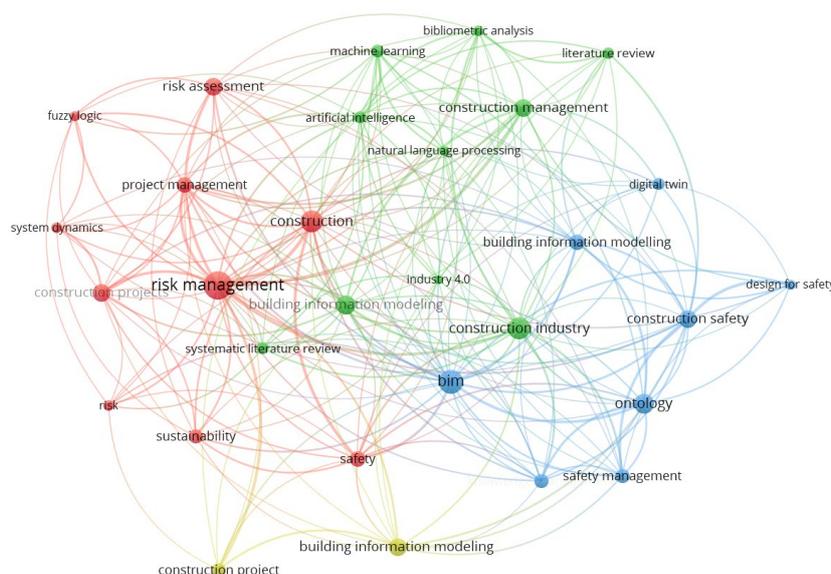


Figure 5: Network Visualization Map of Keywords Co-Occurrence.

4.5.1 Theme 1: BIM-Enabled Risk Identification and Safety Management

The strongest cluster is centred around the keywords “BIM,” “risk,” “safety,” “hazard,” “management,” and “simulation.” This indicates that BIM is widely studied as a core digital tool for managing construction risks across planning, design, and execution phases. The frequent co-occurrence of “hazard” and “simulation” reflects the rise of BIM-driven safety analytics such as 4D simulation, digital hazard prediction, automated checking, and safety compliance modelling. This aligns with contemporary work emphasising BIM’s expanding capabilities for early risk detection, improved communication of risk scenarios, and data-driven decision-making.

4.5.2 Theme 2: Digitalisation of Prefabrication and IBS Processes.

A second prominent cluster groups keywords such as “prefabrication,” “modular construction,” “offsite construction,” “industrialised building system (IBS),” and “coordination.” The strength of this cluster demonstrates the growing research focus on digital transformation within IBS workflows. The co-occurrence pattern shows that BIM is increasingly integrated with prefabrication planning, production scheduling, logistics optimisation, and factory-based quality management. This theme confirms that BIM-supported IBS research is primarily concerned with solving coordination issues, reducing uncertainties, and improving productivity in industrialised construction environments.

4.5.3 Theme 3: Integration of BIM with Emerging Digital Technologies.

The third cluster includes keywords such as “digital twin,” “Internet of Things (IoT),” “automation,” “AI,” and “monitoring,” which frequently appear alongside “BIM.” This indicates an expanding ecosystem of digitally integrated tools that enhance BIM’s capability to manage construction risks in real time. The presence of these terms reveals a shift from traditional BIM applications to hybrid, multi-technology frameworks enabling predictive analytics, sensor-driven safety monitoring, automated model updating, and lifecycle optimisation. These emerging intersections reflect the direction of global Construction 4.0 research.

Collectively, the three clusters confirm that the dominant research themes in existing literature align strongly with the BIM, Risk, IBS intersection. The thematic structure also highlights the fragmented nature of current approaches, where risk is often analysed separately within safety,

prefabrication, or digital innovation categories. This reinforces the need for more comprehensive frameworks that integrate BIM features with critical risk dimensions specifically for IBS projects precisely the research gaps this study aims to address.

4.6 Opportunities for Future Research

The findings from the scientometric analysis reveal several critical research gaps that remain insufficiently addressed within the existing BIM, risk, and IBS literature. First, although BIM-related risk studies are expanding, very few explicitly focus on risk management within IBS or prefabricated construction environments, despite the unique multi-stage risks inherent in design, manufacturing, transportation, and onsite assembly. This indicates a fragmented understanding of how BIM features can be systematically aligned with IBS-specific risk categories.

Second, the keyword clusters show the emergence of multiple digital technologies such as digital twins, IoT, AI, automation, and simulation but these appear in isolated and unintegrated clusters, reflecting the absence of a unified digital ecosystem for risk mitigation. Current studies tend to examine single technologies in isolation rather than exploring how BIM can function as an integrative platform that coordinates advanced tools for real-time risk visibility and decision support.

Third, while prefabrication and modular construction frequently co-occur with BIM, most studies address coordination challenges or production efficiencies, with limited attention to comprehensive lifecycle-oriented risk analyses. This gap is significant, as IBS projects face risks across interconnected phases that cannot be captured by single-stage studies.

Fourth, the co-authorship and publication trends indicate that global scholarship is growing, yet the literature remains dominated by conceptual or simulation-based research, with limited empirical validation in live IBS projects, particularly in developing countries such as Malaysia. This limits the generalisability of existing findings and highlights the need for context-specific frameworks.

Finally, despite repeated emphasis on keywords such as safety, coordination, simulation, and prefabrication, there is no established framework that integrates critical risk factors with BIM functional features tailored to IBS workflows. This absence of a structured integration model represents a fundamental gap that this study seeks to address by mapping the BIM, Risk, IBS intersection and identifying opportunities for a more coherent risk-informed BIM framework.

5. CONCLUSION

This scientometric study maps global research connecting BIM, risk management, and the Industrialised Building System (IBS) from 2010 to 2025. The review reveals a clear growth in publications, stronger international collaboration, and increasing integration of digital tools such as simulation, digital twins, IoT, and AI within BIM workflows. However, the analysis also shows that most studies remain fragmented focusing separately on safety, prefabrication efficiency, or technology adoption without a coherent framework that systematically links BIM functionalities to IBS-specific risk factors across design, manufacturing, transportation, and onsite assembly.

Practical implications highlight that industry practitioners can leverage BIM for early hazard detection, coordination of prefabrication processes, and enhanced decision-making, especially when combined with emerging technologies. The findings also point to the need for standardised data structures and shared digital protocols to support risk-informed IBS delivery, particularly in regions where BIM–IBS maturity is still developing.

Future research should focus on:

- i. developing an integrated BIM–IBS risk framework that connects BIM features with critical risk pathways;
- ii. validating BIM-supported risk strategies through real project case studies;
- iii. exploring multi-technology ecosystems (digital twins, sensors, AI) for predictive risk analytics;
- iv. Strengthening interoperability and semantic standards for IBS information flow; and examining organisational readiness, human factors, and governance mechanisms influencing digital risk adoption.

Overall, this study establishes a clearer understanding of current knowledge structures and highlights the significant potential and urgent need for holistic, risk-informed BIM frameworks tailored to the unique demands of IBS projects.

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