Transforming Construction with Off-site Methods and Technologies - TCOT 2026 Conference

August 18-20, 2026, Newcastle upon Tyne, UK

MAPPING THE KNOWLEDGE STRUCTURE AND RESEARCH TRENDS IN CONSTRUCTION AUTOMATION: A GLOBAL BIBLIOMETRIC REVIEW

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Abstract: The rapid advancement of digital technologies has positioned construction automation as a critical enabler of efficiency, safety, and productivity within the built environment. However, despite the growing body of literature, existing studies remain fragmented and largely technology-specific, lacking a unified understanding of the field's intellectual structure and evolution. Addressing this gap, this study provides one of the first comprehensive and data-driven mappings of construction automation research through a global bibliometric review of Scopus-indexed publications. A total of 1,420 documents published between 2015 and 2026 were analysed using productivity analysis and advanced network-based techniques, including keyword co-occurrence and bibliographic coupling. The findings reveal a significant acceleration in research output after 2020, indicating a transition from exploratory studies to a more mature and application-oriented research domain. The field exhibits a moderately concentrated authorship structure and strong geographical dominance by technologically advanced countries, particularly the United States and China. Keyword network analysis identifies three dominant and interconnected thematic clusters: robotics and automated construction technologies, AI-enabled safety monitoring and performance optimisation. The strong interlinkages among these clusters highlight an emerging convergence toward integrated and intelligent construction ecosystems. This study advances theoretical understanding by explicitly mapping the knowledge structure and revealing the convergence of engineering and management perspectives in construction automation research. Unlike prior technology-specific reviews focusing primarily on artificial intelligence, digital intelligence, or Construction 4.0 applications, this study provides a holistic and systematic bibliometric synthesis of construction automation as an integrated research domain, revealing its intellectual structure, thematic convergence, and emerging research trajectories. The findings offer valuable guidance for researchers, practitioners, and policymakers seeking to advance digital and automated construction practices.

Keywords: Construction automation; Bibliometric analysis; Knowledge structure; Research trends; Digital construction.

1 INTRODUCTION

Construction automation has emerged as a critical component of the ongoing digital transformation within the built environment, fundamentally altering how construction processes are executed, monitored, and controlled. Advances in intelligent systems, particularly those driven by artificial intelligence and data-centric technologies, have enabled the automation of repetitive and high-risk construction activities, thereby enhancing operational efficiency and decision-making capabilities (Pan and Zhang 2021, Zhang, 2023). Traditionally characterised by fragmented workflows and low productivity growth, the construction industry is increasingly integrating automation technologies to improve performance and reduce inefficiencies. These developments reflect a broader transition toward data-driven and intelligent construction systems capable of supporting real-time analysis and adaptive project management (Olatunde et al.2023, Li and Yang 2023). The growing relevance of construction automation has led to a rapid expansion of scholarly research, with studies exploring a wide range of applications and technological innovations. Existing literature demonstrates that automation technologies are increasingly applied in areas such as construction monitoring, process optimisation, and intelligent control systems (Dawood et al. 2022, Zhang et al. 2018,). In particular, the integration of automation with digital platforms has enabled improved coordination across project stages, facilitating more efficient information flow and decision-making processes (Zhang 2023, Liu et al. 2024). However, despite the increasing volume of research, the diversity of applications and methodologies has contributed to fragmentation within the field, with recent studies highlighting ongoing methodological convergence challenges (Abioye et al. 2021).

Over the past decade, construction automation research has diversified across several thematic areas, including safety automation, predictive modelling, and intelligent decision-support systems. Automation-driven monitoring systems using computer vision techniques have demonstrated significant improvements in identifying safety hazards and enhancing site supervision (Huang et al. 2020, Liu et al. 2023). Similarly, machine learning–based approaches have been applied to predict construction performance and optimise project outcomes. In addition, studies have explored lifecycle-oriented automation systems that support coordination across project phases (Oesterreich and Teuteberg 2020, Liu et al. 2024). While these contributions highlight the expanding scope of research, they also underscore increasing complexity and the need for integrative frameworks. The maturity of construction automation research is further reflected in its application to critical industry challenges. Automated monitoring systems improve situational awareness and reduce human error (Huang et al. 2020, Kim et al. 2023). Predictive models have also enhanced forecasting accuracy and decision-making reliability (Akanmu et al. 2020, Liu et al. 2023). These developments suggest a transition toward scalable and application-oriented solutions, although recent evidence indicates that integration across project lifecycles remains uneven. A significant limitation in the current body of knowledge is the absence of comprehensive synthesis capturing the evolution and structure of the field. Existing studies often focus on isolated applications without providing integrated insights into publication trends and thematic clusters (Li and Yang 2023). This lack of consolidation makes it difficult to identify emerging trends and underexplored areas, particularly in rapidly evolving domains such as robotics and intelligent construction systems (Sacks et al. 2020).

Although several review and bibliometric studies have examined digital technologies within the construction industry, most existing reviews have focused on specific technological domains such as artificial intelligence, digital intelligence, robotics, BIM integration, or Construction 4.0 technologies (Abioye et al. 2021; Pan and Zhang 2021; Li and Yang 2023; Olatunde et al. 2026). For example, Pan and Zhang (2021) critically reviewed the roles of artificial intelligence in construction engineering and management, while Li and Yang (2023) provided a bibliographic review of digital intelligence in construction management. Similarly, Olatunde et al. (2026) examined trends in artificial intelligence research within the construction industry. Despite these valuable contributions, existing studies remain largely technology-specific and do not comprehensively map the broader intellectual structure and interdisciplinary evolution of construction automation as an integrated research domain.

Prior reviews have tended to focus on isolated technological applications or conceptual discussions, with limited attention to the interconnections among automation technologies, safety systems, predictive modelling, robotics, and lifecycle-oriented digital integration. Furthermore, few studies have employed large-scale bibliometric network analysis to examine the global knowledge structure, thematic convergence, and collaborative patterns underpinning construction automation research. Addressing this gap, the present study provides a comprehensive bibliometric mapping of construction automation research between 2015 and 2026, combining productivity analysis, citation analysis, and keyword co-occurrence network visualisation to reveal the field's intellectual structure, dominant research fronts, and emerging trajectories.

Addressing this gap is essential given the increasing importance of automation in improving productivity and efficiency. As projects become more data-intensive, the need for intelligent systems continues to grow. Bibliometric analysis provides a robust approach for examining publication trends and knowledge structures (Li and Yang 2023). By applying network-based techniques, it becomes possible to uncover the intellectual architecture of construction automation research and identify emerging research frontiers (Bilal et al. 2020).

2. LITERATURE REVIEW

Conceptual Evolution and Foundations of Construction Automation

Construction automation has undergone significant conceptual evolution, transitioning from mechanised and rule-based systems to intelligent, data-driven frameworks embedded within digital construction ecosystems. Early research focused on structured computational approaches, such as neural networks and expert-driven models, to support planning and estimation processes (Zhang et al. 2018). However, recent studies emphasise adaptive and learning-based systems capable of processing real-time data and responding dynamically to complex construction environments (Huang et al. 2020, Abioye et al. 2021). This transition reflects a broader shift from static automation toward integrated intelligence, where automation is no longer treated as a standalone tool but as a core component of digital construction transformation (Oesterreich and Teuteberg 2020, Li and Yang 2023). Furthermore, contemporary research highlights the increasing integration of automation across the construction lifecycle, enabling seamless coordination between design, execution, and operational phases (Liu et al. 2024, Zhang 2023). These developments position construction automation as a foundational enabler of modern construction management systems.

Technological Domains and Application Areas

The literature indicates that construction automation research is strongly application-driven, with dominant focus areas including safety management, predictive modelling, and performance optimisation. Computer vision and sensing technologies have been widely adopted for automated safety monitoring, demonstrating improved hazard detection and enhanced situational awareness on construction sites (Akanmu et al. 2020, Kim et al. 2023). In parallel, predictive modelling approaches, particularly those based on machine learning, have been applied to forecast project performance, optimise resource allocation, and improve decision-making accuracy (Yaseen et al. 2020, Bilal et al. 2020). Studies further show that automation technologies are increasingly integrated with digital platforms, enabling real-time data exchange and lifecycle coordination across construction processes (Zhang 2023, Liu et al. 2024, Awodele et al. 2024). Additionally, emerging research highlights the role of hybrid computational models in addressing complex construction challenges, combining multiple algorithms to improve robustness and predictive capability (Zhang et al. 2018, Liu et al. 2023). Collectively, these findings indicate that construction automation is evolving toward a multidisciplinary and technologically convergent field, where practical applications drive methodological advancement.

Knowledge Structure, Growth Patterns, and Scholarly Development

The growth trajectory of construction automation research reflects a rapidly expanding and increasingly structured field. Bibliometric evidence suggests that early research was characterised by exploratory studies and limited publication output, with a focus on foundational computational methods (Zhang et al. 2018). However, recent years have witnessed a substantial increase in research activity, driven by advances in digital technologies and growing industry demand for automation solutions (Dawood et al. 2022, Zhang 2023). This growth is accompanied by increasing conceptual consolidation, as studies converge around key thematic areas such as safety automation, predictive analytics, and lifecycle integration (Li and Yang 2023, Liu et al. 2024). Furthermore, citation and co-occurrence analyses indicate that knowledge production is concentrated among a relatively small group of influential contributors and research clusters (Li and Yang 2023). The emergence of these structured knowledge domains suggests that construction automation research is transitioning from fragmented experimentation toward a more mature and coherent scholarly field (Zhang 2023, Liu et al. 2024).

Geographical Distribution, Adoption Challenges, and Research Gaps

Despite the rapid growth and technological advancements in construction automation research, significant disparities remain in its global distribution and practical adoption. Existing studies indicate that research output and influence are concentrated within specific regions and institutions, reflecting variations in technological infrastructure and research capacity (Pan and Zhang 2021). While some regions demonstrate increasing participation, differences in citation impact suggest persistent inequalities in global knowledge production (Zhang 2023, Liu et al. 2024). In addition to geographical disparities, several barriers limit the adoption of automation technologies in practice. Key challenges include data fragmentation, lack of standardisation, and insufficient organisational readiness to support advanced digital systems (Liu et al. 2024). Furthermore, the complexity of construction projects, involving multiple stakeholders and dynamic environments, complicates the integration of automation technologies into existing workflows (Huang et al. 2020, Kim et al. 2023).

Existing review studies have significantly contributed to understanding digital transformation within construction; however, important limitations remain. Previous reviews have predominantly concentrated on specific technologies such as artificial intelligence, BIM-enabled systems, digital intelligence, or Construction 4.0 applications (Abioye et al. 2021; Li and Yang 2023; Olatunde et al. 2026). While these studies provide valuable thematic insights, they do not comprehensively examine construction automation as a unified and evolving scholarly domain. In addition, limited attention has been given to the interconnected knowledge structure linking robotics, predictive analytics, safety automation, and intelligent lifecycle systems.

Moreover, existing bibliometric studies have generally focused on narrower technological scopes or regional analyses, with limited exploration of the broader conceptual convergence occurring across automation-related research streams. Consequently, there remains insufficient understanding of how construction automation research has evolved globally, which thematic clusters dominate the field, and how interdisciplinary relationships are shaping future research directions. This study extends the existing literature by providing a holistic and network-based bibliometric synthesis of construction automation research, thereby offering deeper insights into its intellectual architecture, growth patterns, and emerging areas of convergence.

3. METHODOLOGY

This study employs a bibliometric review approach to systematically examine the knowledge structure, thematic evolution, and research trends in construction automation. The methodological design follows a structured and transparent approach consistent with established bibliographic review practices in construction and digital technology research. Bibliometric analysis is particularly suitable for this study because construction automation represents a rapidly expanding and interdisciplinary field, where traditional narrative reviews may be insufficient to capture the scale, complexity, and interconnectedness of scholarly developments. By integrating quantitative bibliometric techniques with systematic data filtering and validation procedures, the study provides a comprehensive and reproducible synthesis of the field.

The bibliographic data were retrieved from the Scopus database, which is widely recognised for its extensive coverage of peer-reviewed literature in engineering, construction management, and environmental sciences. The choice of Scopus as the sole data source ensures consistency in indexing, citation tracking, and metadata structure, which are essential for reliable bibliometric analysis. Previous studies have demonstrated that Scopus provides robust coverage for built environment research and is suitable for longitudinal and network-based bibliometric investigations (Mongeon and Paul-Hus 2016, Olatunde et al, 2026). A structured search strategy was developed using a combination of keywords and Boolean operators to ensure comprehensive retrieval of relevant studies. The search string included: “construction automation” OR “automated construction” OR “construction robotics” OR “robotic construction” OR “automation in construction” OR “construction process automation.” These terms were selected to capture variations in terminology and to ensure broad coverage of automation-related research within the construction domain. The search was conducted on March 17th, 2026, yielding an initial dataset of 3,100 publications.

To ensure relevance and analytical consistency, a multi-stage filtering process was applied. First, the dataset was restricted to publications between 2015 and 2026, reflecting the contemporary phase of construction automation research characterised by rapid technological advancement and increased adoption of intelligent systems. This temporal boundary aligns with recent studies that emphasise the growing significance of data-driven and automated systems in construction research (Liu et al. 2023, Zhang 2023). Second, subject area filtering was applied to retain only publications indexed under Engineering and Environmental Science, ensuring disciplinary relevance to construction processes and systems. Third, the dataset was limited to peer-reviewed journal articles, conference papers, and book chapters, as these represent the primary channels for validated scholarly contributions in the field. Following these criteria, the dataset was reduced to 1,450 documents; excluding 1650 documents that did not fit in the criteria.

A language-based refinement was subsequently applied to ensure consistency in interpretation and analysis. The distribution of publications indicated that English-language documents constituted the overwhelming majority (1,420 out of 1,450), with a small number of publications in other languages, including Chinese, Korean, German, Japanese, Russian, Spanish, Portuguese, Italian, and Hungarian. Given this distribution and the need for analytical consistency, only English-language publications were retained, resulting in a final dataset of 1,420 documents (Fig.1). The decision to restrict the dataset to English-language publications is consistent with common practice in bibliometric studies and helps to minimise ambiguity in data interpretation while maintaining a sufficiently large and representative sample (Mongeon and Paul-Hus 2016).

To further enhance the validity of the dataset, an additional screening process was conducted at the title and abstract level. This step ensured that all retained publications explicitly addressed construction automation or closely related concepts. Studies that referenced automation only peripherally or lacked a clear construction context were excluded. This relevance-driven screening approach is essential in bibliometric research to prevent conceptual dilution and to ensure that the dataset accurately represents the domain under investigation. Similar screening procedures have been emphasised in recent construction-focused bibliographic reviews to improve methodological rigor and analytical precision (Li and Yang 2023). Following data selection, a combination of bibliometric techniques was applied to analyse the dataset. Productivity analysis was used to examine the temporal distribution of publications and identify growth patterns within the field. Citation analysis was conducted to evaluate the influence of authors, journals, and publications, enabling identification of high-impact contributions and leading research actors. To explore the intellectual structure of the field, keyword co-occurrence analysis was performed to identify relationships between frequently used terms and to detect dominant thematic clusters. Network visualisation was carried out using VOSviewer, a widely used tool for bibliometric mapping that enables the representation of relationships between keywords, authors, and publications (Van Eck and Waltman 2014). A minimum occurrence threshold was applied to exclude infrequent terms and to enhance the clarity and interpretability of the network structure. These techniques have been widely used in previous studies to map intellectual structures and to identify core research domains within construction and digital technology research (Li and Yang 2023). The findings from the bibliometric analysis were interpreted using a combined quantitative and qualitative approach. Quantitative indicators, including publication counts, citation metrics, and network relationships, were used to identify key trends and influential contributors. These results were complemented by qualitative thematic synthesis, where studies were grouped into major research domains such as safety automation, predictive modelling, lifecycle integration, and decision support systems. This integrative approach ensures that the analysis captures both the structural and conceptual dimensions of construction automation research.

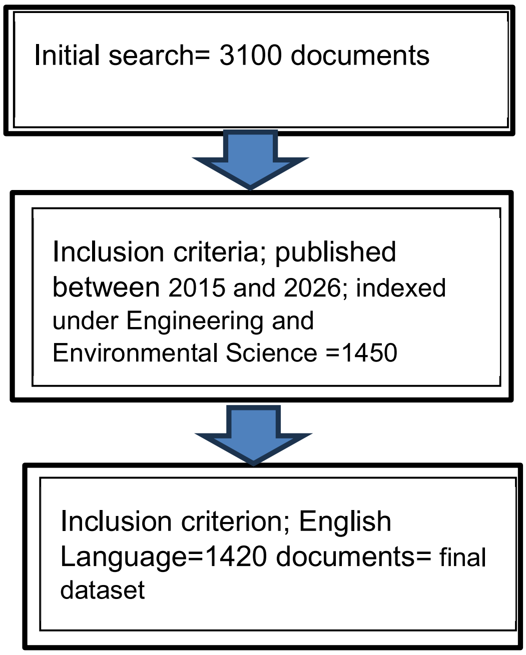

Figure 1: Documents selection and screening processes

4. RESULTS

Figure 2 illustrates the annual distribution of publications in construction automation between 2015 and 2026, revealing a clear and sustained upward trajectory in research output. The early phase (2015–2017) is characterised by relatively low publication volumes, with outputs increasing modestly from 38 to 47 documents, reflecting an exploratory stage in the development of construction automation research. This period corresponds to initial experimentation with robotics and early automation technologies within construction processes.

From 2018 onwards, publication output begins to increase more significantly, rising from 77 documents in 2018 to 145 in 2022. This phase indicates growing academic interest and coincides with the broader adoption of digital technologies such as machine learning, sensing systems, and data-driven construction methods. The most pronounced growth occurs after 2022, with publications reaching 269 in 2024 and peaking at 290 in 2025. This sharp increase reflects a maturation phase in which construction automation transitions from exploratory research to application-oriented and integrated digital solutions. The slight decline observed in 2026 (51 documents) should be interpreted cautiously, as it reflects partial-year data at the time of database extraction rather than an actual reduction in research activity. Overall, the temporal trend demonstrates that construction automation has evolved into a rapidly expanding research domain, with particularly strong growth after 2020, indicating increased institutionalisation and alignment with global digital transformation agendas in the construction industry.

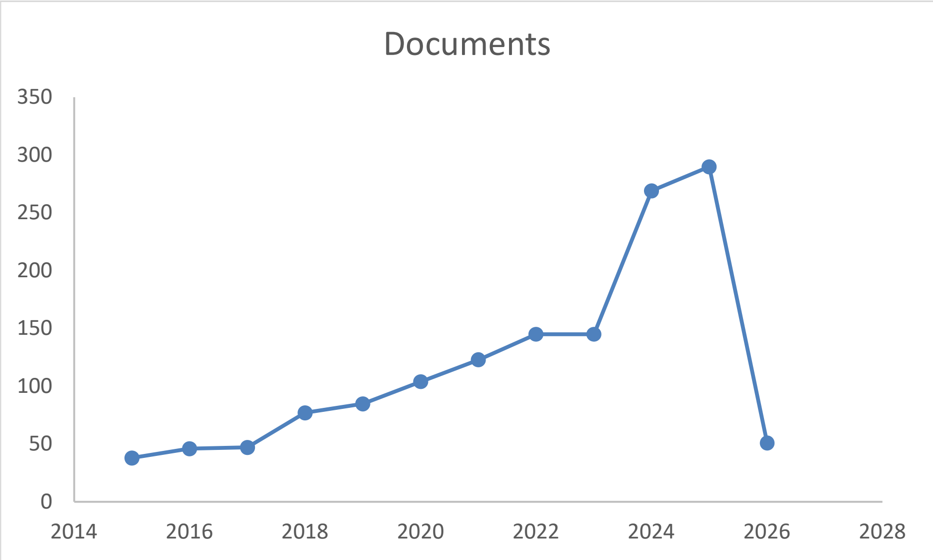

Figure 2: Number of Publication per Year

Table 1 presents authors with a minimum of 10 publications in construction automation research, highlighting a relatively concentrated group of influential contributors. A total of seven authors meet this threshold, indicating that knowledge production in this field is driven by a core group of recurring researchers. Zhang, Jiansong emerges as the most prolific and influential author, with 21 publications and a significantly higher citation count (1,083 citations) compared to other contributors. This suggests not only high productivity but also strong scholarly impact and recognition within the field. Bock, Thomas follows with 17 publications and 773 citations, alongside a notable total link strength of 9, indicating strong collaborative engagement within the research network. Similarly, Linner, Thomas also records a total link strength of 9, suggesting active participation in collaborative research clusters. Other notable contributors include Menges, Achim (15 publications), Jebelli, Houtan (14 publications), and Kazemian, Ali (13 publications), although their citation counts vary significantly. For instance, Kazemian demonstrates relatively high citation impact (468 citations) despite fewer publications compared to Zhang and Bock, indicating strong influence per publication. In contrast, Jebelli records lower citation counts, suggesting variability in research visibility and impact across authors. Overall, Table 1 indicates that construction automation research is characterised by a moderately concentrated authorship structure, where productivity and citation influence are not uniformly distributed. While some authors demonstrate both high productivity and impact, others contribute significantly in terms of output but with comparatively lower citation visibility. This pattern reflects a developing research field where intellectual leadership is distributed across multiple contributors rather than dominated by a single group.

Table 1: Authors with minimum of 10 documents

Author	Documents	Citations	Total link strength
Zhang, Jiansong	21	1083	0
Bock, Thomas	17	773	9
Menges, Achim	15	160	0
Jebelli, Houtan	14	70	0
Kazemian, Ali	13	468	0
Linner, Thomas	11	231	9

Hutter, Marco	10	262	0

Table 2 presents countries with a minimum of 40 publications, revealing a geographically concentrated yet globally distributed pattern of construction automation research. The United States leads both in publication volume (371 documents) and citation impact (8,376 citations), indicating its dominant role in shaping the field. China follows as the second most productive country with 240 publications and 2,823 citations, reflecting strong research activity and growing global influence. European countries also demonstrate significant contributions. Germany records 124 publications and 1,807 citations, while the United Kingdom and Australia each contribute 78 publications, with citation counts of 1,623 and 1,819 respectively. Notably, Switzerland exhibits a relatively high citation count (1,818 citations) despite a lower publication volume (48 documents), indicating strong research impact relative to output.

Asian countries such as South Korea (74 publications; 1,017 citations), Japan (59 publications; 239 citations), and India (44 publications; 264 citations) also contribute meaningfully to the field. However, disparities in citation impact suggest differences in research visibility and influence across regions. For example, Japan's relatively low citation count compared to its publication volume indicates lower global impact, while Hong Kong demonstrates strong influence with 61 publications and 1,614 citations. The presence of countries such as the Russian Federation (42 publications; 126 citations) indicates broader participation; however, citation-based indicators highlight a concentration of intellectual influence within established research systems. Overall, the findings reveal that construction automation research is globally distributed but remains dominated by technologically advanced countries with strong research infrastructure and collaborative networks.

Table 2: Countries with Minimum of 40 Documents

Country	Documents	Citations	Total link Strength
United States	371	8376	68
China	240	2823	68
Germany	124	1807	26
Australia	78	1819	31
United Kingdom	78	1623	39
South Korea	74	1017	21
Canada	68	1128	17
Hong Kong	61	1614	36
Japan	59	239	15
Switzerland	48	1818	22
India	44	264	13
Russian federation	42	126	2

Table 3 highlights organisations with a minimum of five publications, demonstrating that research output is concentrated within specific academic and research institutions. The Myers-Lawson School of Construction at Virginia Tech emerges as the most productive institution, with six publications and 108 citations. Although its citation count is moderate, its inclusion reflects consistent research activity within construction automation. The Department of Industrial and Systems Engineering at the University of Southern California records five publications but a notably high citation count (446 citations), indicating strong research influence despite lower output volume. This suggests that institutional impact is not solely dependent on productivity but also on the quality and visibility of research contributions. Similarly, the Department of

Building and Real Estate at The Hong Kong Polytechnic University contributes five publications with 70 citations, reflecting steady participation in the field. The relatively small number of institutions meeting the publication threshold suggests that construction automation research is institutionally concentrated, with key contributions originating from specialised departments in engineering, construction management, and built environment disciplines. These findings indicate that institutional research in construction automation is characterised by both productivity and impact disparities. While some institutions demonstrate consistent output, others achieve higher citation influence with fewer publications. This pattern reinforces the notion that research visibility and impact are influenced by factors such as collaboration networks, journal placement, and thematic relevance rather than publication volume alone.

Table3: Organisations with Minimum of 5 documents

Organization	Documents	Citations	Total link Strength
Myers Lawson School of Construction, Virginia Tech, Blacksburg, VA, united states	6	108	0
Department of Building and Real Estate, the Hong Kong Polytechnic University, Hong Kong	5	70	0
Department of Industrial and Systems Engineering, University of Southern California, Los Angeles, CA, united states	5	446	0

Figure 3 presents the keyword co-occurrence network, revealing the conceptual structure of construction automation research. The analysis identifies several interconnected clusters, indicating a structured yet multidisciplinary research landscape. The first cluster centres on robotics and automated construction technologies, highlighting the core role of robotic systems and automation tools in transforming construction processes. The second cluster focuses on safety monitoring and site management, incorporating terms related to computer vision, hazard detection, and risk management. This reflects strong research attention to improving construction safety through automation. The third cluster is associated with performance optimisation and predictive modelling, including keywords related to machine learning, forecasting, and resource management. The co-occurrence network further indicates strong interconnections between clusters, suggesting that construction automation research is not fragmented into isolated domains but is increasingly converging around integrated digital construction frameworks. The prominence of keywords related to artificial intelligence, robotics, and digital systems underscores the technological convergence shaping the field.

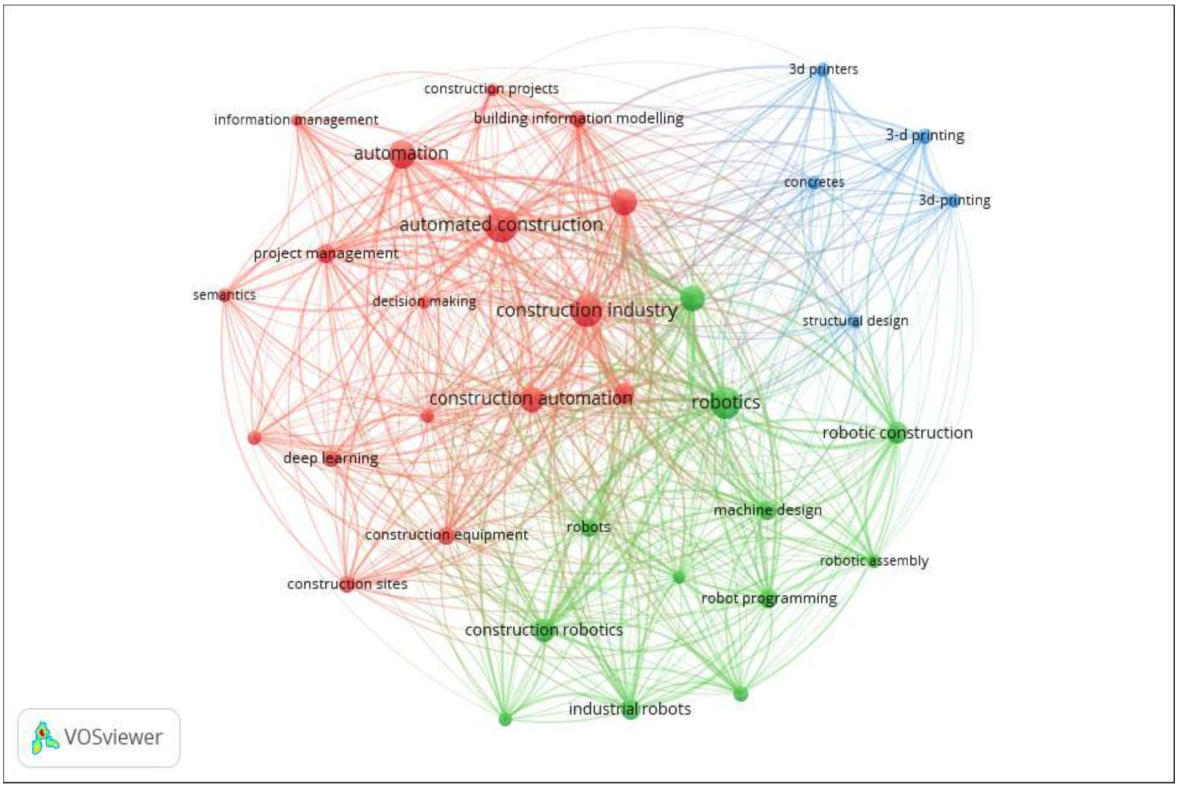

Figure 3: Keyword Network visualisation

5. DISCUSSION OF FINDINGS

Theoretical Contributions: Structuring the Intellectual Domain of Construction Automation: From a theoretical perspective, the findings provide empirical evidence that construction automation research has evolved into a structured and increasingly coherent intellectual domain. The keyword co-occurrence analysis (Figure 3) reveals three dominant thematic clusters—robotics and automated construction, AI-enabled safety monitoring, performance optimisation, and digital lifecycle integration—indicating that the field has moved beyond fragmented experimentation toward conceptual consolidation. This supports existing arguments that automation is no longer a peripheral technological advancement but a foundational component of digital construction transformation (Zhang 2023, Liu et al. 2024, Bock and Linner 2022). The strong interconnections observed among clusters further suggest theoretical convergence between engineering-oriented automation technologies and management-oriented decision-support systems. The integration of safety, optimisation, and lifecycle management concepts within the same network structure reinforces the view that construction automation research is problem-driven rather than technology-driven (Kim et al. 2023, Liu et al. 2023). Moreover, the prominence of predictive modelling and safety-related themes aligns with the industry's structural exposure to uncertainty, risk, and operational inefficiencies. These findings contribute to theory by positioning construction automation as a cognition-enhancing and risk-mitigating mechanism embedded within complex project systems. The co-evolution of robotics, artificial intelligence, and digital integration also highlights the emergence of a multi-paradigmatic research domain. Rather than operating in isolation, these technologies interact within a unified framework, suggesting that future theoretical models should emphasise integration and interoperability across construction processes. This represents a shift from siloed technological approaches toward holistic digital construction ecosystems.

Methodological Contributions: Advancing Bibliometric Understanding of Automation Research: Methodologically, the findings demonstrate the value of bibliometric techniques in uncovering the structure and evolution of construction automation research. The temporal growth pattern (Figure 1) confirms a transition from exploratory research to rapid expansion and conceptual maturity, particularly after 2020. This aligns with broader observations that digital construction technologies have gained significant traction in recent years due to increased computational capabilities and industry demand (Bilal et al. 2020). The authorship and institutional analyses (Tables 1 and 3) further reveal that research productivity and citation impact are not uniformly distributed. While certain authors, such as Zhang and Bock, exhibit both high productivity and influence, others achieve strong citation impact with relatively fewer publications. This supports methodological arguments that publication volume alone is insufficient to measure scholarly influence, and that citation-based indicators provide a more nuanced understanding of research impact (Li and Yang 2023). The country-level analysis (Table 2) highlights the importance of incorporating geographical dimensions into bibliometric studies. The concentration of research output and citation impact within countries such as the United States, China, and the United Kingdom demonstrates that knowledge production is closely linked to national research ecosystems and technological capacity. At the same time, the presence of emerging contributors indicates gradual diversification of the field, although disparities in citation impact persist.

Industry and Policy Implications: Linking Research Trends to Practice: The findings have important implications for construction practice and policy. The dominance of safety, automation, and predictive modelling themes indicates that research is closely aligned with key industry challenges, including accident prevention, productivity improvement, and decision uncertainty. This suggests that construction automation is not merely a technological innovation but a strategic tool for addressing fundamental inefficiencies within the industry (Sacks et al. 2020, Liu et al. 2023). The strong linkage between automation technologies and digital platforms such as BIM and digital twins highlights the importance of integrated data environments for successful implementation. Construction organisations are likely to derive the greatest value from automation when it is embedded within lifecycle-oriented digital systems that enable real-time data sharing and decision-making (Zhang 2023, Liu et al. 2024). This underscores the need for organisations to invest not only in automation technologies but also in data infrastructure and governance frameworks. The geographical concentration of research output further suggests that policy interventions are necessary to support more inclusive participation in construction automation research and development. Developing regions may require targeted investments in digital infrastructure, research capacity, and industry–academia collaboration to enhance their contribution to the field. Without such interventions, disparities in research influence and technological adoption are likely to persist. At a strategic level, the findings indicate that construction automation should be viewed as part of a broader digital transformation agenda. Policymakers and industry leaders must therefore adopt integrated approaches that combine technological innovation with organisational change, skills development, and regulatory support.

6. CONCLUSION

This study provides a comprehensive bibliometric analysis of construction automation research between 2015 and 2026, offering a structured understanding of its intellectual development, thematic evolution, and global distribution. By analysing 1,420 Scopus-indexed publications, the study reveals a rapidly expanding research domain characterised by strong growth, increasing conceptual consolidation, and technological convergence. The findings demonstrate that construction automation research is organised around three major thematic clusters: robotics and automated construction technologies, AI-enabled safety monitoring and performance optimisation. From a theoretical perspective, the study contributes by clarifying the intellectual structure of construction automation and demonstrating the convergence of engineering and management research domains. The integration of automation technologies with digital construction systems highlights the transition from isolated technological applications to holistic and data-driven construction ecosystems. Methodologically, the study advances bibliometric research in construction management by combining productivity, citation, and network-based analyses to provide a multidimensional understanding of the field. The findings also offer important implications for practice and policy. The alignment of research themes with industry challenges underscores the relevance of construction automation in improving safety, productivity, and decision-making. However, the concentration of research output within specific countries and institutions highlights the need for more inclusive and globally distributed research efforts. Despite these contributions, the study is limited to Scopus-indexed and English-language publications, which may exclude relevant research from other sources. Future studies should expand the scope of analysis and incorporate empirical investigations to assess real-world implementation of automation technologies. Overall, this study provides a robust and evidence-based foundation for understanding construction automation research and supports future advancements in digital construction and intelligent project delivery systems.

ACKNOWLEDGEMENTS

This research is funded by the Directorate for Research and Postgraduate Support at Durban University of Technology, P.O. Box 1334, Durban 4000, South Africa, under the Harnessing Talent (HANT) Postdoctoral Fellowship (PDF) Grant.

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