

Research Trends in Digital Infrastructure and Sustainable Construction: A Bibliometric Analysis

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Abstract

This scholarship explored research trends and emerging themes in digital infrastructure and sustainable construction using a bibliometric approach. The study employs a quantitative bibliometric research design, analysing peer-reviewed publications indexed in the Scopus database over a 10-year period from 2015 to 2025. Bibliometric indicators include publication trends, publication sources, keyword co-occurrence, and thematic clusters, mapping out the research output. The search string TITLE-ABS-KEY ("digital infrastructure" OR "smart infrastructure" OR "digital construction" OR "construction digitalisation") AND sustainab*. A total of 716 documents were extracted in CSV file and analysed using VOSviewer software. The study is confined to Scopus-indexed documents and English-language publications. The findings show a consistent increase in research output, with dominant themes centred on intelligent urban systems and smart technologies, digital economy and sustainable development policy and energy systems, investment, and environmental performance. Emerging topics outline the growing relevance of digital twin, smart systems, green economy, internet of things. In conclusion, the findings demonstrate that digital infrastructure is increasingly conceptualised as a systemic enabler of sustainable construction rather than a stand-alone technological intervention, signaling a shift toward integrated, data-driven sustainability transitions in the built environment. The analysis provides important implications for future research by identifying underexplored themes and opportunities for interdisciplinary collaboration. From a practical perspective, the results present valuable insights for policymakers, scholars, and construction professionals seeking to align digital infrastructure investments with sustainability goals. This study mapped the intellectual structure and evolution of digital infrastructure and sustainable construction research, identifying dominant themes, emerging trends, and collaboration networks. It clarifies knowledge gaps, informs interdisciplinary integration, and provides a robust evidence base to guide policy formulation, innovation strategies, and future high-impact scholarly inquiry in sustainable built environments.

Keywords: Built environment; Digital Infrastructure; Research Trends; Smart Infrastructure; Sustainable Construction

1. Introduction

The intersection between digital infrastructure and sustainable construction has attracted growing scholarly attention as governments and industries accelerate digital transformation to meet environmental targets. Recent contributions emphasise how digital infrastructure underpins green development pathways, enhances urban sustainability performance and supports structural upgrading within the digital economy (Liu *et al.*, 2025; Chen *et al.*, 2025). Other studies situate digitalisation within broader sustainability transitions, highlighting its influence on regional coordination, innovation capacity and environmental governance (Chisika & Yeom, 2025; Han *et al.*, 2025). Within construction research specifically, digital infrastructure is increasingly framed as an enabler of smart systems, efficiency

optimisation and low-carbon project delivery (He *et al.*, 2025; Zhang *et al.*, 2025). This expanding scholarship signals a decisive shift from viewing digital tools as operational enhancements to recognising digital infrastructure as a structural driver of sustainable construction transformation.

Notwithstanding this momentum, the literature remains conceptually dispersed. A substantial stream of research examines macro-level relationships between digital infrastructure and green development quality (Liu *et al.*, 2025; Zhang & Zhao, 2025), while parallel studies focus on digital governance mechanisms and institutional arrangements for sustainability transitions (Chen *et al.*, 2025; Zhang *et al.*, 2025). In construction-oriented research, emerging work explores smart construction technologies, sustainability-oriented risk governance and collaborative digital ecosystems

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(Dagou *et al.*, 2025; Shirwa *et al.*, 2025). However, these contributions are largely segmented across economic, environmental and engineering domains. There is limited systematic mapping of how intellectual structures, thematic clusters and collaboration patterns collectively shape the research landscape linking digital infrastructure to sustainable construction outcomes.

This bibliometric review addresses that deficiency by synthesising the corpus to identify publication trajectories, influential authors, thematic concentrations and emerging research fronts. Although existing studies provide empirical evidence on digital infrastructure's impact on green growth and sustainability performance (Chen *et al.*, 2025; Chisika & Yeom, 2025), they do not interrogate the knowledge architecture of the field itself. By offering a structured, data-driven analysis of research trends, this study clarifies conceptual linkages and exposes underexplored intersections within the literature. Its originality lies in repositioning digital infrastructure and sustainable construction as an integrated research domain rather than parallel discourses, thereby establishing an evidence-based agenda for future theoretical refinement and empirical investigation grounded strictly in the analysed dataset.

2. Literature Review

In construction, a recent empirical study explores smart construction systems and sustainability-oriented governance mechanisms (He *et al.*, 2025; Dagou *et al.*, 2025; Shirwa *et al.*, 2025). However, while these studies provide robust statistical evidence, they largely examine isolated relationships rather than systematically mapping how knowledge production in this field is structured and evolving.

Literature centres around three dominant themes: (1) digital infrastructure as a driver of green economic transformation, (2) digital governance and institutional capacity for sustainability, and (3) smart construction technologies and project-level optimisation (Chen *et al.*, 2025; Liu *et al.*, 2025; Zhang *et al.*, 2025). Despite this convergence, fragmentation persists across disciplinary boundaries. Studies show macro-level sustainability assessments rarely integrate construction-sector performance indicators (Zhang & Zhao, 2025; Han *et al.*, 2025; Chisika & Yeom, 2025), while construction-focused studies often treat digital infrastructure as a technical enabler without embedding it within broader digital economy frameworks (He *et al.*, 2025; Dagou *et al.*, 2025; Shirwa *et al.*, 2025).

Research on digital infrastructure and sustainable construction is increasingly interpreted through socio-technical systems (STS) theory and innovation systems perspectives, which together provide a robust lens for understanding technological transitions in the built environment. STS theory conceptualises infrastructure

development as the outcome of dynamic interactions between technological artefacts, institutional arrangements, and social actors (Han *et al.*, 2025). Within the construction domain, this implies that digital tools such as BIM, IoT, and blockchain do not operate in isolation but are embedded within organisational routines, regulatory frameworks, and stakeholder relationships. Consequently, sustainability outcomes depend not only on technological efficiency but also on alignment with social practices, governance mechanisms, and industry norms.

In the context of digital infrastructure, these perspectives underscore how collaboration among firms, governments, and research institutions drives sustainable innovation. They also stress the importance of policy incentives, capacity building, and ecosystem maturity in enabling the transition towards low-carbon and resource-efficient construction practices.

Despite their relevance, existing bibliometric studies often privilege descriptive mapping over theoretical integration. As a result, the co-evolutionary dynamics between digitalisation and sustainability transitions remain under-theorized. Positioning STS and innovation systems at the outset addresses this limitation by framing research trends as part of a broader systemic transformation rather than isolated technological advancements.

Again, literature confirms the positive sustainability implications of digital infrastructure but lacks integrative mapping and cross-cluster synthesis. By combining bibliometric analysis with socio-technical theoretical framing, this study fills the identified gap and advances a coherent understanding of research trajectories, intellectual structures and future directions within digital infrastructure and sustainable construction.

Addressing these gaps, this study is guided by two objectives:

- 1.To map intellectual structure and thematic evolution of research on digital infrastructure and sustainability.
- 2.To identify collaboration networks, influential contributors and emerging research fronts shaping the domain.

2.1. Theoretical Framework

Literature implicitly aligns with socio-technical systems theory and innovation systems perspectives, which conceptualise digital infrastructure as an enabling backbone for coordinated sustainability transitions (Chen *et al.*, 2025; Han *et al.*, 2025; Zhang *et al.*, 2025). These perspectives are suitable because they integrate technological capability, institutional arrangements and performance outcomes within a systemic framework. Complementing this, green

development and digital economy theories provide explanatory grounding for the productivity and spillover effects identified empirically (Liu *et al.*, 2025; Zhang & Zhao, 2025; Chisika & Yeom, 2025). Nevertheless, these frameworks have not been synthesised through a bibliometric lens to reveal structural connections within the knowledge base.

3. Research Methodology

A post-positivist bibliometric approach is therefore suitable for this review, as it explores the systematic mapping of publication patterns, co-authorship networks and thematic clusters using objective and quantitative bibliographic data (Han *et al.*, 2025; Zhang *et al.*, 2025; Dagou *et al.*, 2025). This paradigm supports evidence-based synthesis while acknowledging structural complexity in knowledge production. The study focuses on publication trends from 2015 to 2025. A total of 2142 documents were obtained at the initial search from the Scopus library having used the search string TITLE-ABS-KEY ("digital infrastructure" OR "smart infrastructure" OR "digital construction" OR "construction digitalisation") AND sustainab*. The choice of the Scopus database is influenced by a wide coverage of disciplines that are relevant to construction management and technology, and provides easy access to bibliographic data used by bibliometric software (Ghani *et al.*, 2022). The documents were filtered based on engineering and environmental science subject areas, articles and conference papers, journals and conference proceedings, publications at final stage and English language written documents. 716 documents were

finally exported in CSV file for analysis on VOSviewer software.

4. Findings and Discussion

4.1. Publication per year

Out of the total 716 documents that were analysed, 527 were journal articles while 189 were conference proceedings. Figure 1 illustrates a progressive upward trajectory in annual publications on digital infrastructure and sustainable construction between 2015 and 2025. Publication output shows three phases: emergence (2015–2018), consolidation (2019–2021), and rapid expansion (2022–2025). Early growth was modest, rising from 1 to 10 publications. Between 2019 and 2021, output accelerated despite a slight decline in 2021. This temporary decline may be attributed to delays in the publication cycle rather than reduced scholarly interest. From 2022 onward, publications increased sharply from 39 to 360 by 2025, indicating exponential growth. This surge reflects intensified scholarly attention to digital infrastructure as a driver of green productivity, governance reform and sustainable construction transformation (Chen *et al.*, 2025; Liu *et al.*, 2025; Zhang *et al.*, 2025). Recent empirical and governance-focused studies further explain this acceleration (Han *et al.*, 2025; Zhang & Zhao, 2025; He *et al.*, 2025).

4.2. Publication per Country

The bibliometric distribution highlights a clear geographical concentration of research in digital infrastructure and sustainable construction (Table 1 in Appendix 1, and Figure 2). China leads publication output (236 documents, 2601 citations), reflecting its

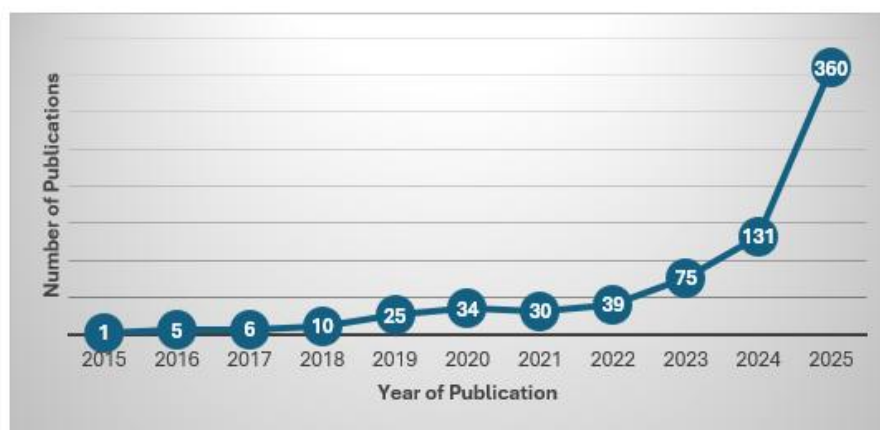


Figure 1: Publication per year

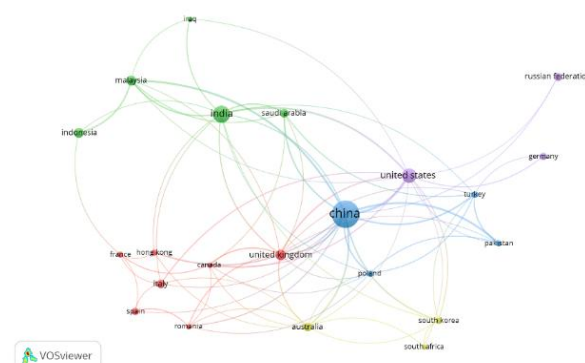


Figure 2: Network visualization for publication per country

large-scale investment in smart cities, digital construction technologies, and green infrastructure transitions. India (93 documents, 751 citations) shows accelerating scholarly engagement aligned with rapid urbanisation and digital transformation. The United States (64 documents, 1543 citations) maintains a strong influence through advanced research ecosystems and sustainability-driven innovation. The United States remains structurally significant due to its strong institutional ecosystem, R&D investment, and high-value output. European nations contribute steady, policy-driven study, while emerging economies demonstrate growing but comparatively limited output. Emerging economies like Saudi Arabia, Russia, Turkey, Poland, Pakistan, South Africa, Canada, and Iraq record comparatively lower totals. This pattern is consistent with global disparities in innovation systems, institutional capacity, and research funding (World Bank, 2023; UNESCO, 2021).

4.3. Analysis of Documents per source

Table 2 in Appendix 1 presents leading publication sources in digital infrastructure and sustainable construction, measured by document count and total citations. The criteria for document selection are minimum of 5 documents in a source and minimum of 5 citations in a source. Of the 234 sources 21 meet the thresholds. Sustainability dominates with (130 documents, 918 citations). This indicates it functions as a high-volume outlet with high acceptability. However, its citation per paper impact (=7 citations per article)

suggests moderate average influence relative to more specialised journals. Journal of Cleaner Production (13 documents, 651 citations) and Journal of Environmental Management (20 documents, 296 citations) show strong citation performance despite lower output. Notably, Journal of Cleaner Production averages approximately 50 citations per article, indicating high scholarly impact in sustainability research. Similarly, Sustainable Cities and Society (10 documents, 201 citations), Applied Energy (6 documents, 147 citations), and IEEE Access (6 documents, 139 citations) demonstrate strong citation efficiency, suggesting that research published in these outlets is more frequently referenced and potentially more theoretically or methodologically rigorous. Sources such as IOP Conference Series: Earth and Environmental Science (18 documents, 128 citations) and E3S Web of Conferences (16 documents, 55 citations) show moderate publication volume but lower citation density. This pattern aligns with the typical bibliometric profile of conference proceedings, which prioritise rapid dissemination over long-term citation impact. Resources Policy, Energy, Smart Cities, and Business Strategy and the Environment reflect the interdisciplinary spread of the field, integrating environmental policy, energy systems, digital technologies, and sustainability governance.

4.4. Co-authorship Analysis of Country

At least 5 documents and 3 citations of a country. Figures 3 and 4 show a globally interconnected

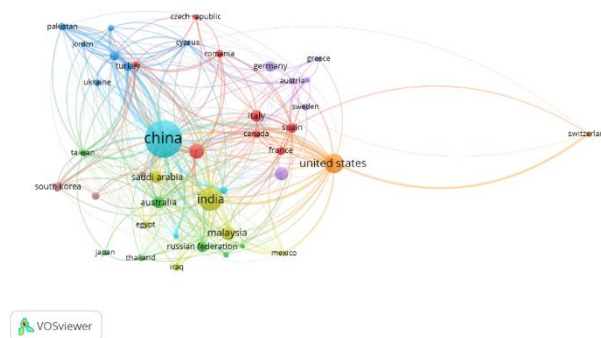


Figure 3: Network visualization of Co-authorship Analysis of Country

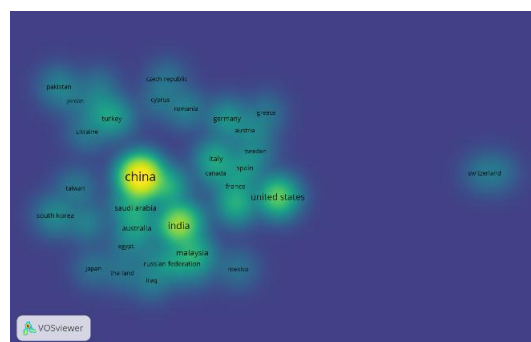


Figure 4: Network visualization Density of Co-authorship Analysis of Country

research network dominated by China, India, and the United States. China forms the largest and most collaborative node, linking extensively with Asian and European countries. India is closely connected to China and other Asian partners, reflecting strong regional integration. The United States also serves as a major hub, though with more selective ties concentrated in Western Europe and Switzerland. Asian and European countries form dense internal clusters, indicating cohesive regional research communities. Switzerland appears peripheral but maintains strong bilateral links, reflecting specialised, high-impact collaboration rather than broad multilateral engagement.

4.5. Cluster Analysis

The VOSviewer co-occurrence map in figure 5 reveals three major thematic clusters structuring the knowledge base on digital infrastructure and sustainable construction. Node size reflects keyword frequency, while link density indicates conceptual coupling.

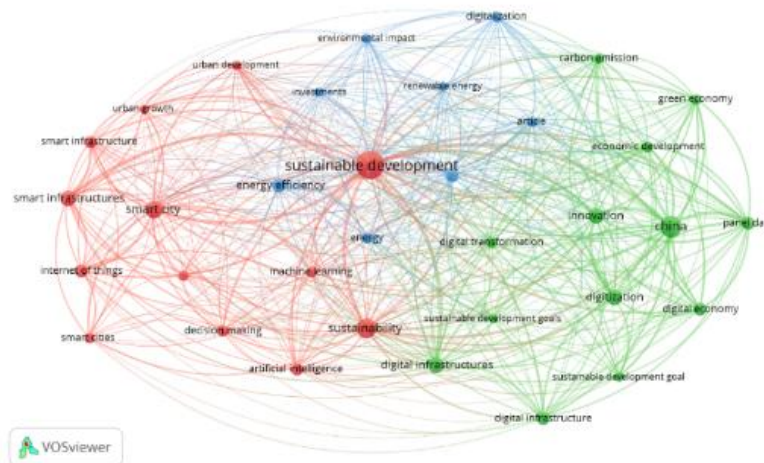


Figure 5: Network visualisation of keywords

Cluster 1: Smart Technologies and Intelligent Urban Systems

This cluster is anchored by smart city, smart infrastructure, artificial intelligence, machine learning, internet of thing, decision making, and urban development. The dense interlinkages suggest a techno-centric research stream focused on how digital technologies optimise infrastructure systems. The prominence of AI and IoT indicates emphasis on data-driven decision-support, predictive maintenance, and cyber-physical systems integration in construction and urban infrastructure (Bibri & Krogstie, 2017; Lee *et al.*, 2015). The strong association between smart cities and sustainability reflects the argument that digital infrastructure enhances resource efficiency, resilience, and lifecycle performance (Caragliu *et al.*, 2015). Within sustainable construction, this cluster aligns with BIM-enabled digital twins, intelligent transport

systems, and sensor-based infrastructure monitoring, which reduce operational inefficiencies and environmental burdens (Zhang *et al.*, 2022). The linkage with urban growth highlights digital infrastructure as a response to rapid urbanisation pressure.

Cluster 2: Digital Economy and Sustainable Development Policy

This cluster includes digital economy, digital infrastructure, digital transformation, green economy, carbon emission, economic development, innovation, panel data, and China. Network density indicates macroeconomic econometric research orientation. The coupling of digitalisation and carbon emission suggests empirical investigations into whether digital infrastructure reduces environmental externalities. Studies show that digital economy development can improve energy efficiency and reduce carbon intensity through innovation spillovers and structural

transformation (Zhang *et al.*, 2022; Truong, 2022). The presence of panel data reflects quantitative modelling approaches widely used in sustainability digitalisation nexus research (Li & Wang, 2022). The prominence of China indicates geographical concentration in empirical studies, given China's large-scale digital infrastructure expansion and carbon neutrality agenda (Yang *et al.*, 2024). In sustainable construction, this cluster situates digital infrastructure within broader economic restructuring toward green growth and Sustainable Development Goals (SDGs)

Cluster 3: Energy Systems Investment and Environmental Performance

This cluster centres on energy, renewable energy, energy efficiency, environmental impact, infrastructure, investments, and digitalization. It represents the energy–environment performance

dimension of sustainable construction. The close linkage between renewable energy and digitalisation reflects research on smart grids, distributed energy systems, and digital energy management platforms (Lund et al., 2017). Digital infrastructure enables real-time energy optimisation, supporting decarbonised construction and infrastructure systems (IEA, 2017). The presence of investments indicates increasing attention to green finance mechanisms that support digital-enabled sustainable infrastructure (Taghizadeh-Hesary & Yoshino, 2019). This aligns lifecycle sustainability assessment approaches that integrate environmental performance with capital allocation decisions.

5. Conclusion and Further Research

The findings show a strong upward trend in publications since 2022, indicating rapid growth and consolidation of the field. Journal articles dominate,

reflecting increased scholarly maturity. China leads in output and citations, followed by India and the United States, with co-authorship networks confirming their central role despite regional clustering. A dual publication system is evident: high-volume journals support dissemination, while specialised outlets achieve greater citation impact. Thematic analysis identifies three core clusters such as smart urban technologies, digital economy and policy, and energy and environmental performance with “sustainable development” as the integrative. However, from a socio-technical systems perspective, these themes reveal weak alignment between technology and social contexts. Innovation systems analysis further exposes uneven knowledge distribution and limited collaboration. Finally, the study highlights a critical gap: the lack of integrated, system-level frameworks linking digitalization with sustainability transitions.

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Appendix 1

Table 1: Publication per Country

Country	Document	Citation	Total Link Strength
China	236	2601	67
India	93	751	25
United States	64	1543	35
United Kingdom	35	770	22
Malaysia	33	249	21
Indonesia	31	116	6
Italy	25	424	7
Australia	23	388	15
Saudi Arabia	23	168	13
Russia	20	283	2
Germany	18	168	3
Spain	17	253	5
Turkey	15	63	16
Poland	14	101	13
South Korea	14	90	10
France	13	74	6
Pakistan	11	271	15
Hong Kong	11	251	7
Romania	10	141	9

Country	Document	Citation	Total Link Strength
South Africa	10	87	3
Canada	10	62	12
Iraq	10	53	4

Table 2: Documents per source

Source	Document	Citation	Impact Factor
Sustainability (Switzerland)	130	918	3.3
Journal of Environmental Management	20	296	8.4
IOP Conference Series: Earth and Environmental Science	18	128	0.402
e3s web of conferences	16	55	0.205
Journal of Cleaner Production	13	651	10
Frontiers in Environmental Science	12	30	3.7
Sustainable Cities and Society	10	201	12
Resources Policy	9	185	-
Energies	9	75	3.2
Land	8	82	3.9
Applied Sciences (Switzerland)	8	40	2.64
Frontiers in Sustainable Food Systems	8	38	3.1
Proceedings of spie - the international society for optical engineering	8	10	-
Applied Energy	6	147	11.446
IEEE Access	6	139	3.6
IOP Conference Series: Materials Science and Engineering	7	90	0.5
Systems	7	34	3.1
Energy	6	96	9.4
Smart Cities	5	167	5.5
Business Strategy and the Environment	5	69	13.3
Journal of Environmental Protection and Ecology	5	5	-