ARTIFICIAL INTELLIGENCE AND DIGITAL TRANSFORMATION IN CONSTRUCTION PROCUREMENT: ENHANCING SUSTAINABILITY, EFFICIENCY, AND STRATEGIC DECISION-MAKING

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Abstract. The construction industry is undergoing a major transformation driven by digitalization, artificial intelligence (AI), environmental restrictions, and new procurement strategies. "Procurement costs are about 50-60% of construction projects. Procurement has evolved from an administrative function to a strategic management function that influences long-term organizational performance, competitiveness, operational resilience, and environmental sustainability. The study explores the digital transformation of procurement processes in construction organizations through the use of digital technology and artificial intelligence. The analysis is based on recently published research concerning the integration of blockchain, circular economy principles, sustainability-oriented procurement, digital procurement ecosystems, AI-based procurement, and dynamic capabilities theory. Particular attention is paid to new technologies, such as building information modeling (BIM), blockchain-enabled procurement systems, agentic AI, generative AI, predictive analytics, and the Internet of Things (IoT). The study reveals how AI-enabled procurement solutions can significantly improve vendor evaluation, contract administration, demand forecasting, lifecycle analysis, and risk reduction. Similarly, construction companies can leverage machine learning algorithms and predictive analytics to make more informed purchasing decisions, enhance supply network visibility, minimize waste, and enhance project coordination. Moreover, the paper also discusses the relationship between AI and Construction 5.0, with a focus on the transition to a sustainable human-centered digital transformation. Companies can improve resource efficiency and lifecycle management and reduce their environmental footprint by using circular procurement techniques and AI. The following international case studies are examples of real-life use of digital procurement approaches and AI-based decision-making systems. High implementation costs, lack of technological capability, reluctance to organizational change, cybersecurity issues, and regulatory uncertainty were the main barriers to AI adoption, the study found. Results show that the challenges are significant. The strategic benefits of using AI to enhance the ability of construction firms to plan for, sense, seize, and transform on a large-scale, long-term basis can outweigh these challenges. Digital procurement technologies and artificial intelligence are transforming the construction industry, and procurement is becoming a strategic tool for the creation of value. Organizations will have to embed AI in existing systems, build digital skills and put in place governance frameworks to enable ethical and sustainable innovation. The paper deals with the application of supply network management, blockchain, artificial intelligence, digital transformation, sustainability, Construction 5.0, agentic AI, procurement innovation and BIM within the construction industry.

Keywords: *Sustainable Procurement; Supply Chain Resilience; Blockchain BIM Integration; AI-powered Procurement; Construction 5.0; Digital Transformation.*

Introduction

The construction industry is one of the most important sectors in the global economy. It plays a key role in the development of infrastructure, the creation of jobs, and the economic growth of a country. The sourcing of materials and services is an integral part of any project in this industry and can make or break the project, its costs, performance, and sustainability. In the past, construction companies' procurement focused on contract negotiations, vendor management, and material purchasing. Globalization, digitalization, environmental concerns, and technological innovation have transformed procurement into a strategic management function that can affect an organization's competitiveness and long-term resilience. Modern construction projects have complex supply networks with multiple players, fragmented

processes, long project lifecycles, and strict regulatory requirements. Most phases of the construction lifecycle involve procurement activities, including planning, vendor selection, contract administration, logistics management, quality control, and sustainability performance. Research has often shown that procurement accounts for 50 to 60 % of the overall cost of a construction project (Parisi and Donyavi, 2026). Procurement optimization is the foundation of operational performance and financial sustainability. Digital transformation has recently been the main driver of innovation in building procurement. Today, technologies such as AI, machine learning, big data analytics, blockchain, cloud computing, BIM, and IoT systems enable enterprises to automate procurement processes, increase transparency, reduce waste, and improve strategic decision-making. Artificial intelligence, in particular, has been a game changer. It can assess vendor performance, forecast demand changes, collect large volumes of procurement data, identify hazards, and support procurement planning with a sustainability angle. The shift from Construction 4.0 to Construction 5.0 has accelerated the deployment of AI in procurement (Nicoletti, 2023). Construction 5.0 is about human-centric digital transformation through intelligent automation, environmental goals, organizational agility, and collaborative decision-making. AI is seen as a strategic capability for long-term innovation, resilience and sustainable development, rather than just an operational tool. The COVID-19 pandemic, supply network disruptions, geopolitical volatility, and climate-related concerns have underscored the need for resilient and flexible procurement methods (Le and Phi Tran, 2026). Construction companies are leveraging digital procurement platforms, predictive analytics, and AI-powered supply network management to help mitigate disruptions and keep projects on track. Such developments have made purchasing an administrative support function a strategic tool for managing uncertainty and ensuring the firm's survival.

This paper clarifies how digital technologies and AI are changing the procurement processes of construction companies (Nicoletti, 2026). It considers the benefits of AI for risk management, strategic planning, sustainability, transparency, and procurement efficiency. The paper also discusses the implementation challenges and potential way forward for AI-powered procurement systems in the building industry.

Literature Review

In the construction industry literature, the intersection between digital procurement and AI is increasingly grounded in the idea that technological advancements are enhancing the effectiveness, transparency, sustainability, and strategic integration of procurement operations. But academics say there are still organizational, financial, and technological challenges that mean AI is rolled out in a scattergun fashion across the corporation.

Early research in digital procurement focused primarily on electronic procurement systems and the digitalization of the supply network. The primary drivers for e-procurement adoption are: organizational readiness, regulatory support, technological infrastructure, and perceived operational benefits (Yevu et al., 2021). Their analysis revealed that digital transformation in procurement is not a matter of technology adoption but tremendous organizational adaptiveness.

Further research adds emergent technologies such as blockchain, AI, IoT, and sophisticated analytics to the scope. According to Yevu et al. (2021), Digital procurement systems support risk management, lifecycle assessment, and vendor evaluation, all of which contribute to sustainable procurement. Digital platforms can assist companies in being more transparent in their operations and in incorporating environmental concerns into their purchasing decisions.

One of the most comprehensive evaluations of AI applications to procurement processes was provided by Guida, Caniato, Moretto and Ronchi (2023). They identified a number of important AI use cases, including vendor selection, contract analytics, demand forecasting, risk

assessment and process automation. "There is a lot of operational potential for AI, but it's still in its infancy in procurement," the authors write. The main benefits are improved risk mitigation, automation of tedious tasks, and better data-driven decision-making. But adoption is still constrained by data quality, digital capabilities, ethical concerns, and organizational resistance.

Studies on Construction 5.0 also indicate the integration of AI with environmental goals. Mokhojane and Foyo (2025) explored the application of AI in sustainable procurement for the development of construction enterprises in Gauteng. They found that AI-based solutions improve the evaluation of environmental consequences, vendor evaluations, lifetime cost analyses, and demand estimates. 5.0 Paradigms Under Construction: AI is seen as a complement to managerial judgment and sustainable performance, showing complementarity between humans and intelligent technologies, rather than full automation (Welsh and Batalla Martinez (2023).

Literature also suggests a growing interest in procurement solutions based on blockchain. Singh et al. (2025) examined the use of Blockchain and AI for sustainable procurement management. Predictive analytics and anomaly detection are possible with AI. Blockchain offers immutable transaction records and increased transparency. These technologies work in concert to improve supply network traceability, detect fraud, and monitor compliance.

Waste minimization and circular procurement are two other major issues for study. Ababio et al. (2025) (Pellegrini et al., 2020) suggest that AI can facilitate circular procurement by predicting waste generation, enhancing material reuse, and improving the coordination of reverse logistics. AI-driven analytics and BIM technologies can help prevent over-ordering and streamline material management throughout the entire lifecycle. Studies show the problems in the implementation of this in real-life situations. The literature reports the existence of some barriers that hinder the adoption of circular procurement, such as low digital literacy, high implementation cost, complex regulation, and organizational resistance to change (Sajid et al., 2024). These barriers are particularly important for small and medium-sized enterprises that lack access to cash and technological know-how.

In the literature, some common motifs are noted. The first is the use of AI in procurement intelligence, with better analytics, predictive forecasting, and evidence-based decision-making. Secondly, digital technologies can enhance transparency and accountability in procurement systems. Third, the importance of sustainability considerations in procurement procedures is more relevant, especially within the Construction 5.0 frameworks. Finally, the successful implementation of AI depends on the right organizational culture, digital readiness, and governance frameworks.

Scholarship is evolving, but there are significant gaps in the findings. Most studies are based on conceptual models or limited case studies rather than substantial empirical work (Tsao et al., 2026). Still, no standards have been set for measuring the effectiveness of AI-enabled procurement. There are no longitudinal studies evaluating the outcome of the deployment of AI. There is further work to do on ethical challenges around algorithmic bias, cybersecurity, and data governance.

Methodology

The research methodology of this study is a qualitative-analytical approach, which combines comparative case study analysis and systematic synthesis of the literature. The purpose of this study is to assess the effects of digital technology and AI on the procurement management of construction firms, as well as the strategic implications of these developments. The research methodology is divided into three parts. A comprehensive literature review of construction procurement, digital transformation, AI applications, blockchain systems,

sustainability, and Construction 5.0 frameworks was conducted from academic journals, conference proceedings, industry reports, and institutional publications. The literature selection was limited to the most recent studies (2019–2025) due to the importance of the latest technical developments. The second aim of this research is to look at real-world examples and case studies from around the world of the use of digital procurement in construction projects. Some of the examples of large-scale infrastructure projects and organizations are Burj Khalifa, Tesla Gigafactory, Smart Cities Mission in India, Heathrow Terminal 5, Crossrail, Masdar City, and FIFA World Cup infrastructure projects in Qatar. The case studies offer real data on supply network resilience, sustainable integration, creative procurement, and AI-enabled operational optimization (Kashef, 2025). Thirdly, this study uses the existing dynamic capabilities framework to understand AI adoption in the building procurement system. From this perspective, AI is not an operational technology but a strategic technology that improves the company's processes of sensing, seizing, reconfiguring and planning. This paradigm offers a partial account of how AI enables organizations to adapt and remain competitive in a volatile commercial environment.

The methodology is descriptive and interpretative, and not quantitative. The study does not scientifically measure financial performance results or AI adoption rates. Instead, it aims to identify patterns, conceptual linkages, implementation trends, and strategic implications that emerge from the research and practical experiences presented. The research adopts the perspective of circular economy and sustainability. The other factors used to analyze procurement methods include environmental performance, supply network resilience, lifecycle management, ethical governance issues, and operational effectiveness. The approach integrates theory and empirical evidence from case studies to provide a holistic view of digital transformation in construction procurement and to pave future pathways for practice and research in the sector.

Results

The research revealed that digital procurement technologies and AI play a vital role in improving procurement performance in aspects of supply network resilience, risk management, operational efficiency, sustainability, and strategic planning. The main benefits are process automation and operational optimization. Automation and AI-assisted procurement solutions can help reduce manual burden by automating repetitive tasks such as vendor evaluation, contract analysis, invoice processing, bid comparison, and inventory management. Procurement automation companies achieved a reduction of over 30% in processing time (Basiru et al., 2022). AI-enabled procurement platforms also help in enhancing the accuracy and efficiency of procurement by automating procedures and reducing human error.

Other key outcomes are predictive analytics and decision intelligence. Machine learning algorithms can look at historical procurement data to predict material requests, flag vendor risks, estimate costs, and maintain inventory levels. Predictive systems can help improve planning accuracy and reduce uncertainty of variable commodity prices, workforce shortages, and supply network interruptions. As firms adopt dual-source procurement strategies, a number are using AI to build supply network resilience and reduce dependency risks resulting from COVID-19. The analysis points to the increasing role of sustainability-driven buying. AI-based technology enables circular purchasing, life cycle analysis, and environmental impact assessments. More and more companies are taking sustainability criteria into account when choosing vendors and evaluating their performance. For instance, sustainable procurement practices at Masdar City and Apple's headquarters help improve environmental performance and economic efficiency. AI and blockchain make procurement even more transparent and traceable. Blockchain-based procurement solutions create immutable records of transactions that improve compliance monitoring, reduce the risk of corruption, and increase accountability

among vendors. Blockchain and AI analytics can track environmental compliance and detect fraud in complex global supply networks.

The dynamic capability framework is a better way to capture the strategic importance of adopting AI (Teece, 2018). AI improves planning, resulting in better resource allocation, portfolio optimization, and forecasting accuracy. Real-time monitoring systems and computer vision technologies improve sensing capabilities. Predictive maintenance analytics, generative design, smart contract management, and automated scheduling apps improve the ability to capitalize on opportunities. Finally, digital collaboration platforms and the reorganization of the organization for data-driven operations enable the development of reconfiguration capabilities and AI-based knowledge management systems.

The findings also reveal serious implementation problems. Many construction companies may not have the financial resources, digital skills, and technology infrastructure needed to properly adopt AI. Resistance to change is a great challenge in traditional construction businesses with dispersed processes and archaic managerial cultures. Implementation efforts are also hampered by cybersecurity threats, regulatory uncertainty and ethical dilemmas.

Table 1. AI Technologies and Their Impact on Construction Procurement

AI Technology Acquisition Role	Key Benefits	Challenges
Machine learning	Improvements in data quality, planning accuracy, and demand forecasting	Limitations of data quality
Blockchain	Vendor traceability, fraud prevention, and transparency	Integration complexity
BIM	Waste reduction, coordination, and lifecycle management	High cost of installation
Predictive analytics	Risk management, early disruption detection, and forecasting support	Lack of skills
Generative AI	Design optimization, faster decision-making, and innovation	Ethical concerns
IoT devices	Inventory tracking and real-time visibility	Cybersecurity threats

The argument also shows the shift to the ideas of Construction 5.0. Construction 5.0 is about human-centered innovation, sustainability, and collaborative intelligence rather than efficiency, which are distinct from previous models of digitalization. "AI technologies increasingly assist in managerial decision-making, rather than replace human competence. The approach emphasizes the importance of digital literacy, interdisciplinary collaboration, and organizational learning in AI-enabled procurement ecosystems. More examples of digital procurement innovation in action are shown in international case studies. India's Smart Cities Mission has identified e-procurement solutions that reduced procurement costs by some 10%. The Hong Kong-Zhuhai-Macau Bridge adopted digital communication technology to improve the efficiency of coordination and integration of foreign project teams. Vendor assessment processes using KPIs were implemented by London's Crossrail, leading to improved operational responsibility and on-time delivery performance (Hegde et al., 2026). Construction procurement is expected to be significantly affected by future technological developments. In the long run, the combination of agentic AI systems with IoT, ERP, blockchain, and digital twin systems can lead to the development of self-optimizing procurement ecosystems with autonomous decision-making and adaptive resource management. Japan has integrated platforms for urban development that are early examples of such cyber-physical procurement ecosystems (Herrador, 2026).

Conclusions

The building industry is undergoing a huge digital transformation, powered by AI, sustainability, and changing buying patterns. Procurement has evolved from a transactional administrative function to a strategic lever that drives operational resilience, innovation,

competitiveness, and environmental performance. Research shows that AI can improve procurement efficiency through automation, predictive analytics, vendor assessment, risk mitigation, and the ability to make more sustainable choices. AI-enabled solutions can help to increase supply network resilience, optimize resource allocation, minimize waste, and foster transparency. Technologies such as blockchain, BIM, IoT, generative AI, and predictive analytics enable the creation of intelligent procurement ecosystems that support complex building projects in unexpected locations. The results further highlight the importance of AI within Construction 5.0 frameworks. AI is an operational technology, but it is also a strategic capability that improves how firms plan, perceive, seize, and reorganize operations. Companies that are good at applying AI will be better able to respond to market disruptions, geopolitical uncertainty, environmental pressures, and changes in technology. There are huge challenges. Its broad implementation is hampered by high implementation costs, a lack of digital skills, cybersecurity concerns, unclear regulations, and resistance to organizational change. To harness AI-enabled procurement to its full potential, construction firms will need to invest in digital skills, organizational learning, governance frameworks, and technical infrastructure. Moving forward, we can expect an even closer integration of AI, blockchain, digital twins, IoT systems, and ERP platforms, leading to more self-contained and interconnected procurement ecosystems. Technology will continue to transform the way we do procurement, making it smarter, more predictive, and sustainability-led as a strategic activity. The successful adoption of AI in procurement processes by construction companies will result in significant gains in productivity, resilience, and sustainability performance. The AI-powered procurement innovation is not simply a technological breakthrough. It is a strategic shift that will shape the future of the global construction business.

The Authors have used Artificial Intelligence tools (Grammarly and ChatGPT) to verify and polish their English.

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References

1. Ababio, B. K., Lu, W., Antwi-Afari, P., & Ghansah, F. (2025). Exploring the interplay between digital technologies and circular procurement in the construction industry: Current trends and future research directions. *CIB Conferences*.
2. Basiru, J. O., Ejiofor, C. L., Onukwulu, E. C., & Attah, R. U. (2022). Streamlining procurement processes in engineering and construction companies: A comparative analysis of best practices. *Magna Scientia Advanced Research and Reviews*. [DOI Missing]
3. Guida, C., Caniato, F., Moretto, A., & Ronchi, S. (2023). The role of artificial intelligence in the procurement process: State of the art and research agenda. *Journal of Purchasing and Supply Management*.
4. Hegde, A., Shetty, R., Vinyas, Bolar, G., Shetty, S., JP, S., & Hegde, A. (2026). Comprehensive Review of the Architectural Metamorphosis and Techno-Economic Implications of Artificial Intelligence-Integrated Digital Twin Ecosystems. *Applied Sciences, 16*(14), 7233.
5. Herrador, M. (2026). Society 5.0 as an Enabler for Circular City Declarations: A Policy Integration Framework for Japan. *Available at SSRN 6981079*. [DOI Missing]
6. Le, M. H., & Phi Tran, P. (2026). Managing supply chain resilience in climate and disaster-prone environments: a bibliometric analysis. *Competitiveness Review: An International Business Journal, 36*(2), 299-320. [DOI Missing]
7. Kashef, M. (2025). Rethinking Masdar and The Line Megaprojects: The Interplay of Economic, Social, Political, and Spatial Dimensions. *Land, 14*(7), 1358.

8. Khomotho Mokhojane, & Foyo, M. (2025). Assessing the role of artificial intelligence in sustainable procurement for emerging construction companies towards Construction 5.0 in Gauteng. *Proceedings of the 19th Built Environment Conference*.
9. Nicoletti, B. (2023). Supply Network 5.0 Life Cycle. In *Supply Network 5.0: How to Improve Human Automation in the Supply Chain* (pp. 227-285). Cham: Springer International Publishing. [DOI Missing]
11. Nicoletti, B. (2026). *Agentic AI for Procurement: Concepts, Applications and Implications*. Palgrave.
12. Parisi, L., & Donyavi, S. (2026). Advancing materials procurement processes in construction: a framework for optimising technology integration in SMEs' construction supply chains. *International Journal of Construction Management, 26*(7), 1365-1389. [DOI Missing]
13. Pellegrini, L., Campi, S., Locatelli, M., Pattini, G., & Di Giuda, G. D. (2020). Digital transition and waste management in architecture, engineering, construction, and operations industry. *Frontiers in Energy Research, 8*, 576462.
14. Sajid, Z. W., Aftab, U., & Ullah, F. (2024). Barriers to adopting circular procurement in the construction industry: The way forward. *Sustainable Futures, 8*, 100234.
15. Singh, A., Mohandes, S. R., Shakor, P., Cheung, C., Arashpour, M., et al. (2025). Blockchain technology adoption for sustainable construction procurement management: A multi-pronged artificial intelligence-based approach. *Infrastructures*.
16. Teece, D. J. (2018). Business models and dynamic capabilities. *Long range planning, 51*(1), 40-49. [DOI Missing]
17. Tsao, J., Liang, C. X., Nogues, C., & Wong, A. (2026). Perceptions and integration of generative artificial intelligence in creative practices and industries: a scoping review and conceptual model. *Ai & Society, 41*(3), 2259-2278. [DOI Missing]
18. Welsh, D., & Batalla Martinez, S. (2023). Framework for usage potential for digital procurement in the construction industry. *International Conference on Computing: Theory and Applications*.
19. Yevu, S. K., Yu, A., & Darko, A. (2021). Digitalization of construction supply chain and procurement in the built environment: Emerging technologies and opportunities for sustainable processes. *Journal of Cleaner Production, 322*, 129093. Psychology of Popular Media Culture, 8(3), 207–217.