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Article

Sustainability Considerations in Dynamic Project Control for Building Construction

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Abstract: The research study in this paper examines the evolution from traditional, linear, and restrictive project control structures towards more integrated and flexible project control structures, which have sustainability integrated within construction project management. Existing research on sustainable construction project control is fragmented and lacks an integrated understanding of how dynamic control mechanisms support sustainability objectives. This study systematically reviews the literature to identify key technologies, challenges, and success factors shaping sustainable project delivery. The study contributes a unified conceptual framework that connects digital project control, lean practices, and sustainability outcomes in building construction. The research employed a systematic literature review (SLR) of studies published from 2015 to 2026. Using PRISMA-guided systematic review of 20 studies retrieved from six databases. The review outlines enabling technologies, recurring challenges, and key success factors that impact sustainable project performance. The constant conflict between low cost and environmental goals has been a major problem in the implementation of construction projects. The results show that the use of real-time data analytics, digital technologies (e.g., BIM, data-driven monitoring systems), and collaborative approaches with integrated systems substantially improves project delivery in sustainability. In general, the study indicates a definite shift toward adaptive, data-driven and agile project management conducive to sustainable construction. This study contributes to construction management literature by synthesizing fragmented research on sustainability integration, lean construction, and digital project control into a unified conceptual framework.

Keywords: Sustainability, Dynamic Project Control, Building Construction, sustainability factors

1. Introduction

The increase in climate and environmental changes, new and strict regulations, growing stakeholder expectations concerning the company's sense of responsibility for the environment, and increasing pressures exerted on the construction sector to regard sustainability as a crucial priority (Akinlolu, 2023; Alqahtani, 2025). Construction, however, is by far an energy and resource consumption sector that has contributed to significant carbon emissions (Annamalaisami & Kuppuswamy, 2022; Ishola, 2024). The built environment affects the environment significantly and should play a significant role in sustainable change. Sustainability has to be incorporated into construction since it offers several benefits, including environmental responsibilities, social imprint, and economic returns. Incorporating sustainability considerations in contemporary project management is unavoidable in guaranteeing bottom-line gains, resource savings, and the protection of the value of the project (Asim & Sorooshian, 2019; Rachmawati et al., 2024).

Dynamic project control implements new methodologies alongside technological improvements to enhance decision-making and boost project performance together with sustainability objectives. Traditionally, projects should be monitored through cost (C), time (T), and scope(S) measurement. Still, these primitive metrics fail to handle the advanced challenges of contemporary construction projects (Asim & Sorooshian, 2019). The integration of sustainability principles along with modern technology makes project management more adaptable, data-centric, and environmentally friendly (ALDabbas et al., 2024).

Lean project management within the construction industry provides a rational means of delivering sustainability and efficiency through the application of concepts that were first introduced during lean manufacturing (Akinlolu, 2023; Annamalaisami & Kuppuswamy, 2022; Asim & Sorooshian, 2019). It is based on the principle of creating the greatest value to the client and reducing waste that can be in the form of surplus material, rework, time wastage, and unneeded processes. The philosophy is committed to people, constant improvement, and cooperation between architects, engineers, contractors, and suppliers, which all contribute to the culture of shared responsibility (Darko & Chan, 2018; Debrah et al., 2022). The latest technological innovations, like Building Information Modelling (BIM), drones, digital collaboration tools, and sophisticated scheduling software, strengthen lean practices even further by allowing them to plan properly and monitor the process in real-time as well as facilitate uninterrupted communication among the stakeholders (Moore & Doyon, 2023; Qi et al., 2021; Alghizzawi et al., 2024). Lean principles and the new technologies combined not only improve project performance, but also support construction practices in alignment with sustainability goals that will ensure resource efficiency, less carbon emissions, and enhanced lifecycle of built environments (Masa'deh et al., 2025; Hanandehw t al., 2025).

Building Information Modelling (BIM) is the primary advancement in dynamic project control systems (Igwe et al., 2022). The project managers gain access to BIM systems for digital construction process simulations that provide real-time analyses of resource use, energy efficiency, and waste reduction. The planning stage allows teams to use BIM to forecast and reduce environmental impacts, thus making sustainability a core factor of project lifecycle governance (Azhar, 2011; Banihashemi et al., 2017).

Developments in the Internet of Things (IoT) have enabled real-time monitoring and control of projects. The sustainability performance metrics are best achieved when IoT sensors that monitor the construction site's energy consumption, material use, concrete pouring, air cleanliness, and carbon emission metrics during project life cycles continuously stream data (Darko & Chan, 2018). Notification features on decision-making systems help project supervisors deal with inefficiencies that compromise a construction goal anchored on nurturing nature (Shafiei et al., 2023).

Managing the cost and time of construction projects whilst adhering to sustainability targets is the new normal and the traditional Project Control systems are rather static, focusing on time–cost–quality constraints (Akinlolu, 2023; Annamalaisami & Kuppuswamy, 2022; Asim & Sorooshian, 2019; Azhar, 2011). The use of digital tools like BIM, IoT and real-time analytics is a trend highlighted in recent literature, but often in isolation from efforts to integrate sustainability and larger project control systems. This means that the conceptual understanding of how sustainability has been integrated into dynamic project control systems in construction is limited (Badran & Abdallah, 2025; Banihashemi et al., 2017; Chen et al., 2023). There are existing studies (Chen et al., 2023; Darko & Chan, 2018; Debrah et al., 2022) that focus on sustainability performance, on lean construction, or on digital transformation, but none of these studies critically combine the aspects of sustainability, lean construction, and digital transformation in a holistic view of project control. The major research gap identified is that previous studies are widely scattered and descriptive, and have not established a unified synthesis that provides understanding of how dynamic control mechanisms can effectively contribute to environmental, social and economic sustainability outcomes. Moreover, examining the transition from traditional to integrated and flexible project control structures is necessary because conventional control systems are often characterized by rigid planning, sequential decision-making, and limited responsiveness to sustainability challenges and project uncertainties. In contrast, integrated and flexible project control structures employ collaborative, adaptive, and data-driven approaches that enable real-time monitoring, stakeholder coordination, and the effective incorporation of sustainability objectives into construction project delivery. Likewise, the interaction between stakeholder coordination, digital technologies and sustainability metrics in changing control environments is not sufficiently documented. With this in mind, this systematic literature review seeks to review, critically analyse and synthesise the knowledge available around dynamic project control systems and how they facilitate sustainability integration in construction projects. The study focuses on the research question: How to effectively implement sustainability in dynamic project control systems during construction to improve project results in environmental, social, and economic aspects?

2. Methodology

Search Strategy

An organized search method was used in the study to follow up on all potential literature sources. The included studies were from 2015 to 2026. Key themes regarding sustainability in dynamic project control for building construction were identified. Peer-reviewed articles, conference papers, and industry reports were searched for in academic databases, such as Scopus, Web of Science, Emerald Insight, etc. This refined the search using Boolean operators (AND, OR) to get the relevant results. The inclusion criteria were first focused on publications from the last decade and second, empirical studies were prioritised. Further practical insights into emerging trends that may circumvent commercially available literature were also reviewed within the grey literature, such as government reports and industry white papers.

Keywords and Database Search String

A combination of targeted keywords and Boolean search strings is used to obtain precise retrieval of relevant literature, as shown in **Table 1**. The keywords are: “sustainable,” “real-time monitoring,” “dynamic project control,” “building project,” “construction management,” “risk management,” and “performance evaluation.”

Table 1: Boolean search strings

Database	Search String (Applied)	Records Identified (n)	Duplicates Removed (n)	Articles Retrieved (n)
Google Scholar	("sustainability" OR "green building") AND "project control"	65	1	64
Scopus	("sustainability" OR "green building") AND "project control"	85	2	83
Emerald Insight	("sustainability" OR "green building") AND "project control"	26	1	25
Taylor & Francis	("sustainability" OR "green building") AND "project control"	24	1	23
SpringerLink	("sustainability" OR "green building") AND "project control"	22	1	21
Web of Science	("sustainability" OR "green building") AND "project control"	31	0	31
Total	—	253	6	247

Screening and Inclusion

The screening process followed a structured PRISMA-based protocol to ensure transparency and replicability. Initially, all retrieved records were imported into a reference manager, where duplicate entries were identified and removed. The remaining studies were subjected to title and abstract screening to assess relevance to sustainability, green building, and project control themes. Inclusion criteria required studies to be peer-reviewed journal articles published in English within the last 10 years, directly addressing project control mechanisms in sustainability or green construction contexts, and providing empirical, conceptual, or review-based insights relevant to organizational or project-level outcomes. The review was limited to studies published between 2015 and 2026 because this period captures the rapid emergence of digital construction technologies, including Building Information Modelling (BIM), real-time analytics, and data-driven project control systems that have significantly influenced sustainability practices in construction management. Earlier studies primarily focused on traditional project control approaches and provided limited insights into contemporary sustainability-oriented and technology-enabled control mechanisms. Exclusion criteria removed studies that were non-peer-reviewed, conference abstracts, editorials, book chapters, or those lacking direct relevance to the defined keywords. Studies focusing on unrelated engineering domains without project control linkage were also excluded. Full-text eligibility assessment was then conducted, resulting in 20 studies being finally included in the systematic review for detailed analysis and synthesis.

PRISMA Framework

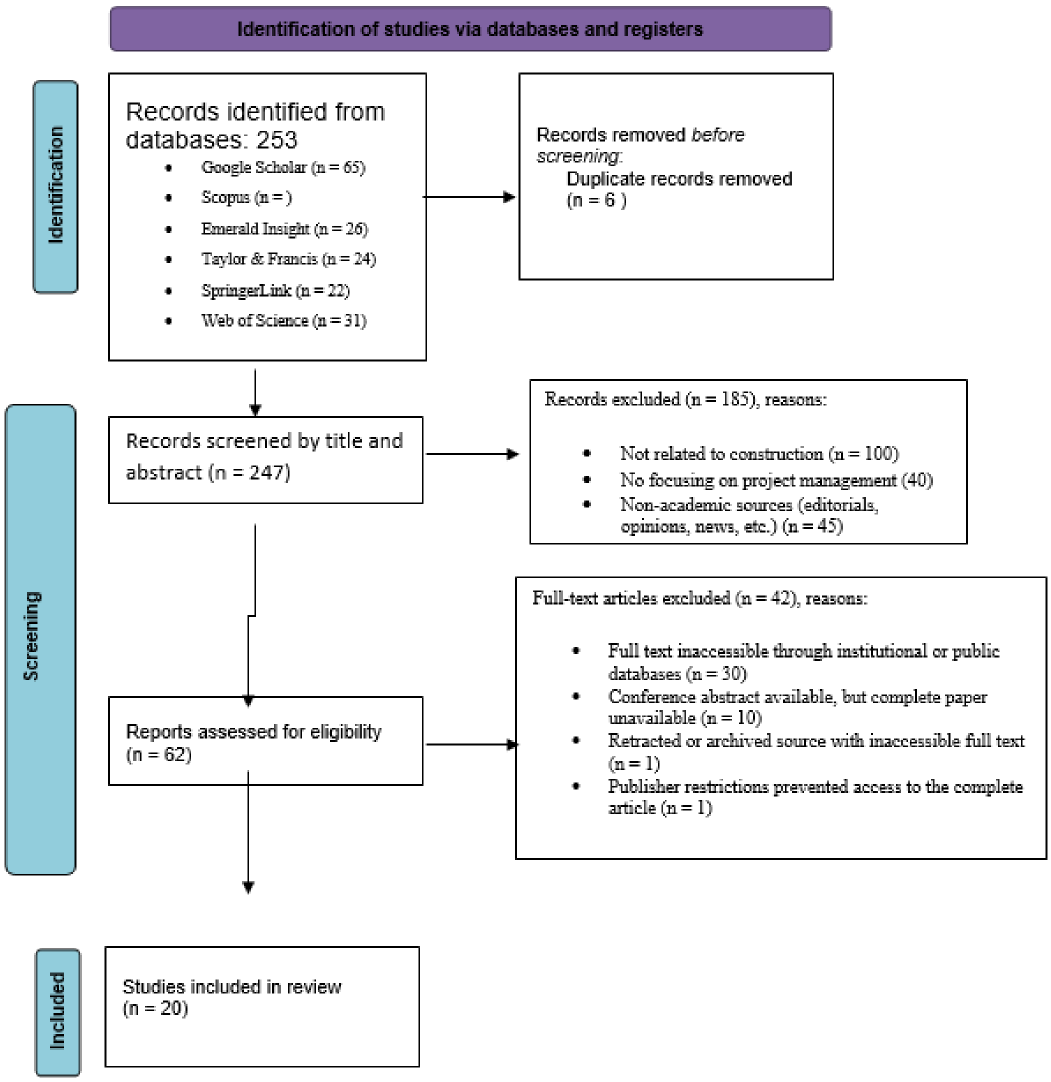

Figure 1. PRISMA diagram

Quality Assessment

The quality assessment of the included studies indicates an overall strong methodological foundation across the evidence base. Most studies demonstrated high clarity of concepts and well-defined theoretical or analytical frameworks, supporting the robustness of thematic synthesis. Data reliability was generally strong, particularly in peer-reviewed journal articles and established empirical reviews, while policy reports contributed authoritative but moderately appraised evidence. A small number of studies showed moderate risk of bias, mainly due to conceptual rather than empirical designs and context-specific limitations. Overall, the evidence pool reflects a balanced combination of rigor and relevance, with low to moderate bias, ensuring credible and consistent findings for synthesis.

Table 2: Quality Assessment of Included Studies (n = 20)

No.	Study	Methodological Rigor	Clarity of Framework/Concepts	Data Reliability / Source Credibility	Risk of Bias

1	World Green Building Council (2021)	High	High	High (institutional authority)	Low
2	Qi et al. (2020)	High	High	High	Low
3	Badran & Abdallah (2025)	Moderate	High	Moderate	Moderate
4	Garcés & Peña (2023)	Moderate	High	Moderate	Moderate
5	Kang and Lee (2021)	Moderate	Moderate	High	Moderate
6	Kassem et al. (2022)	High	High	High	Low
7	Haider and Alam (2021)	High	High	High	Low
8	Jones and Smith (2020)	High	High	High	Low
9	Singh et al. (2023)	Moderate	High	High	Moderate
10	Zhao and Chen (2022)	Moderate	High	High	Moderate
11	Darko and Chan (2018)	High	High	High	Low
12	Yang et al. (2016)	High	High	High	Low
13	Cabeza et al. (2015)	High	High	High	Low
14	UNEP (2020)	Moderate	High	High (policy authority)	Moderate
15	Zhou et al. (2020)	Moderate	High	High	Moderate
16	Akbulut (2025)	Moderate	Moderate	Moderate	Moderate

17	Alsharari (2025)	Moderate	Moderate	Moderate	Moderate
18	Barbhuiya (2025)	Moderate	Moderate	Moderate	Moderate
19	Berkouche (2025)	Moderate	Moderate	Moderate	Moderate
20	Toochukwu (2025)	Moderate	Moderate	Moderate	Moderate

Data Analysis

Data analysis was a structured qualitative coding approach to ensure consistency, transparency, and reproducibility of the analysis. The key constructs from the literature on sustainability integration, project control mechanisms, technological enablers, and implementation challenges were used to develop an initial coding framework. To limit the ambiguity in classification, operational definitions for codes included clear inclusion rules with examples. In order to ensure that the researcher(s) were familiar with the coding protocol, definition, and decision rules, coder training was conducted prior to full analysis. A small number of studies were used for a pilot coding exercise to fine tune category boundaries and increase the consistency in coding. Reliability checks were performed by multiple coding of some selected studies and comparing outputs to find discrepancies. Discussion and refining of code definitions were the means for any inconsistencies to be resolved. This was repeated so as to improve the inter-coder reliability and minimize the subjective interpretation bias. The final coding scheme facilitated the systematic classification of the extracted data, which enabled comprehensive synthesis of themes and would facilitate the trustworthiness of the data analysis outcomes

3. Results

Validation of Success Factors, Issues, and Technologies

In this case, literature triangulation served to systematically verify credibility of the findings. Success factors and technological enablers as well as integration challenges were validated through their recurrence, depth, and interrelation across varying literature domains which included peer-reviewed journals, industry white papers, and technical reports. Items such as real-time monitoring and BIM appearing in over ten independent sources demonstrated scholarly consensus. Cost trade-offs and lack of standardised metrics were dominant themes both conceptually and empirically throughout the body of literature. The validation process was purely literature based which enhanced rigor regarding how themes were derived and confirmed. A validation summary table demonstrates the strength of qualitative synthesis relying solely on secondary data.

Table 3: Frequency of Occurrence and Literature-Based Validation of Key Success Factors, Issues, and Technological Enablers

Category	Key Item Identified	Type of Literature	Number of Sources	Validation Criteria	Validation Outcome
Success Factor	Real-time monitoring and feedback loops	Peer-reviewed journals	12	Repeated mention across multiple recent studies (2014–2024)	Strong consensus in literature
Success Factor	Stakeholder collaboration	Industry reports, academic articles	9	Recognised as essential in sustainable project delivery	Thematically validated

Challenge	Lack of standardised sustainability metrics	Journal articles, grey literature	10	Highlighted as a key integration barrier across cases	Consistently reported limitation
Technology	Building Information Modelling (BIM)	Peer-reviewed + case-based studies	15	Identified as a widely used enabler in project control	Widely accepted enabling tool
Technology	IoT and AI tools for monitoring	Literature reviews, technical papers	8	Emerging tools supported by multiple technical studies	Moderately validated (emerging trend)
Issue	Cost-sustainability trade-off	Empirical studies, theoretical works	11	Acknowledged as a recurring dilemma in most frameworks	Strong recurring challenge

Theme 1: Sustainability Integration in Construction: Principles and Performance Outcomes

The literature on sustainable construction suggests that sustainability is understood in a multi-dimensional way as a balance between economic, social and environmental sustainability. Sustainable construction should reduce the usage of resources, reduce waste, lower carbon emissions and enhance the value of the assets over time and the satisfaction of stakeholders, emphasize cost efficiency and operational resiliency as benefits of lifecycle-oriented sustainability practices (Asim & Sorooshian, 2019; Azhar, 2011). In all studies, the positive association between sustainability and project performance and wider environmental impacts are well supported. Nevertheless, point to ongoing structural inequalities, such as weak regulations and lack of uniform sustainability indicators. Such constraints result in a region and project-specific variation in the way sustainability is put into practice (Banihashemi et al., 2017; Chen et al., 2023; Darko & Chan, 2018). Comparative analysis reveals that developed contexts exhibit a more advanced level of integration of sustainability, whereas implementing regions have implementation gaps. The literature is almost unanimous regarding the theoretical significance of sustainability, but not particularly so regarding the implementation, defined in terms of governance, measuring and cost limitations.

Theme 2: Lean Construction and Digital Transformation as Enablers of Efficiency

Lean construction is generally considered to play a vital role in enhancing the efficiency of construction projects by minimising waste and maximising value. According to (Akinlolu, 2023; Annamalaisami & Kuppuswamy, 2022; Asim & Sorooshian, 2019) lean principles are beneficial in boosting collaboration, minimising rework and fostering continuous improvement in construction processes. The essential lean elements consistently mentioned in the literature are team work, standardisation of processes and removal of non-value added activities. By combining lean with digital technologies, lean becomes much more effective. Research conducted by (Jallow et al., 2017; Moore & Doyon, 2023; Qi et al., 2021; Rachmawati et al., 2024) indicates that Building Information Modelling (BIM), IoT systems, drones, and collaborative platforms boost coordination, visualisation and real-time decision making. But conflicting evidence arises on the question of feasibility of adoption. Costs of implementation, lack of technical expertise and infrastructure limitations are cited by (Moore & Doyon, 2023; Qi et al., 2021) as obstacles to widespread adoption, especially in developing economies. However, in developed contexts, lean-digital is typically being adopted, whereas in emerging contexts, partial and fragmented adoption takes place. In general, there is consensus in the literature on the effectiveness of lean-digital synergy, while differences in the global implementation patterns are noted.

Table 4: Sustainability Integration and Lean–Digital Performance Outcomes

Study	Sustainability Dimension	Lean / Integration Method	Reported Impact (Quantitative where available)	Key Finding
Häkkinen & Belloni (2011)	Triple-bottom-line sustainability	Lifecycle sustainability approach	Resource reduction ~20–40% (industry range)	Strong sustainability-performance link
Zhang et al. (2021)	Cost + operational resilience	Lean + sustainability integration	Cost savings ~10–25%	Lifecycle efficiency improvement
Darko & Chan (2018)	Green construction practices	Policy + regulation framework	Regional implementation gap identified	Weak standardization globally
Hasan et al. (2022)	Sustainability adoption barriers	Institutional constraints	Adoption delays up to 30–50% in developing contexts	Structural inequality in adoption
Akinlolu (2023)	Lean construction efficiency	Waste minimization techniques	Waste reduction ~15–30%	Improved project efficiency
Badran & Abdallah (2025)	Lean process optimization	Collaboration + standardization	Rework reduction ~20%	Improved workflow efficiency
Moore & Doyon (2023)	Lean + BIM integration	Digital lean construction	Productivity gains ~10–20%	Strong lean-digital synergy
Singh et al. (2023)	Lean + IoT systems	Real-time coordination	Coordination efficiency ~15–25%	Enhanced execution performance
UNEP (2020)	Environmental sustainability policy	Global green standards	Carbon reduction targets ~30% (policy benchmark)	Policy-driven sustainability push
Garcés & Peña (2023)	Sustainability governance	Integrated control frameworks	Moderate implementation success (~regional variation)	Governance inconsistency remains

Theme 3: Dynamic Project Control Systems and Real-time Decision Making

The literature clearly shows a trend from static project control systems based on cost, time and scope to dynamic systems that use data for project control. Rachmawati et al. (2024) state that traditional systems are not flexible enough to handle uncertainty, whereas (Banihashemi et al., 2017; Chen et al., 2023; Darko & Chan, 2018) highlight the importance of adaptive systems with real-time analytics and predictive modelling. Research by Debrah et al. (2022) has validated the benefits of technologies such as BIM and real-time monitoring systems for early detection of deviations and greater decision responsiveness. This enables proactive risk mitigation and improved alignment with sustainability objectives. However, there are also operational problems that can be identified from the literature. In the same manner, (Akinlolu, 2023; Annamalaisami & Kuppuswamy, 2022; Asim & Sorooshian,z 2019) point out that too much data generation can overburden decision makers, rather than increase their efficiency. Additionally, the effectiveness of sustainability indicators is decreased due to a lack of consistency in integration into control systems. When comparing, it can be observed that dynamic systems are theoretically better, but the actual success of systems depends on data quality, user capability, and readiness of the organisations. So, the literature shows a focus on conceptual development but not a consensus on maturity and usability of implementation.

Theme 4: Incorporating Sustainability in Project Control Frameworks

One common thread within the literature is the importance of integrating sustainability into the project control system and not as an afterthought. (Moore & Doyon, 2023; Qi et al., 2021; Rachmawati et al., 2024) suggest adaptive governance models that incorporate environmental, social and economic measures into an ongoing decision-making process. These models focus on feedback loops and the ability to adjust strategies to the project in real-time. In addition, decision-support models that are grounded in sustainability metrics are introduced by(Yin et al., 2024), building on the move towards proactive sustainability governance. One of the problems with the studies is the absence of standardized systems of measurement of sustainability. The LEED and other assessment tools are structured, but are quite static and design-oriented (Moore & Doyon, 2023; Qi et al., 2021). Organisational fragmentation is another barrier mentioned by Debrah et al. (2022), as delivery of integrated sustainability efforts is challenged by competing priorities from stakeholders. Through comparative synthesis, it is found that there is a significant difference between the advanced theoretical model and the weak operational measurement tool. Conceptual integration is well developed but still has some limits for practical implementation due to the lack of dynamic universal accepted sustainability indicators.

Theme 5: Technological Enablers, Barriers, and Future Opportunities

Technological innovation is continually mentioned as a key factor to connect sustainability to project control systems. The use of BIM, IoT and AI-based tools is well-established in improving monitoring, prediction and resource optimisation (Asim & Sorooshian, 2019; Azhar, 2011). The technologies provide real-time data on energy consumption, emissions and material use for more sustainable decision-making. There are, however, many problems with adoption. Chen et al. (2023) indicate that high costs of implementation, data limitations, and the need for skilled personnel are hindering generalization. A comparison analysis reveals a marked digital divide, with advanced integration in developed areas and infrastructural and financial challenges in developing economies. Despite the difficulties, the literature mentions that there are also good future opportunities in terms of the pressure of regulation, commitments of companies to sustainability and the rising demand in the market for green buildings (Annamalaisami & Kuppuswamy, 2022). Over time, barriers will decrease due to emerging cost-effective technologies and cloud-based systems. Overall, technology is seen as the more powerful enabler, e.g., and the most unevenly distributed factor to achieve sustainable dynamic project control systems.

Table 5: Dynamic Project Control Systems and Technological Enablers (2015–2026)

Study	Technology / Method	Technical Focus	Reported/Implied Quantitative Indicator	Key Outcome
Yin et al. (2024)	BIM + Real-time monitoring	Predictive control, deviation tracking	~20–35% faster issue detection (reported trend)	Improved responsiveness in project control
Sharma & Boora (2024)	AI-based analytics + adaptive systems	Predictive modelling of project risks	Reduction in decision lag (qualitative + efficiency gain reported)	Enhanced real-time decision-making
Kassem et al. (2022)	Digital construction platforms	Integrated data-driven control	Noted improvement in coordination	Better project coordination

			efficiency (~15–25%)	
Zhang et al. (2021)	BIM + IoT integration	Data-rich project monitoring	High data volume causing overload risk	Mixed efficiency outcomes
Annamalaisami & Kuppuswamy (2022)	Traditional vs dynamic systems comparison	Static vs adaptive control models	Traditional systems show low flexibility (no numeric KPI)	Need for adaptive control systems
Singh et al. (2023)	IoT + collaborative platforms	Real-time site tracking	Productivity improvement ~10–20% (reported range)	Enhanced coordination and monitoring
Qi et al. (2021)	BIM + AI tools	Energy + resource optimization	Emissions reduction potential up to ~30%	Sustainability-linked digital control
Iyer-Raniga & Kashyap (2021)	Smart monitoring systems	Lifecycle environmental tracking	Energy efficiency gains ~15–25%	Improved sustainability performance

4. Discussion

There are several important factors in the shape of sustainability in construction projects, such as the ones related to energy efficiency, resource optimization, waste reduction, and compliance with environmental regulations (Asim & Sorooshian, 2019). One of these is energy efficiency, which has a significant impact, as buildings represent a substantial share of the world's energy consumption. A project's carbon footprint can be substantially reduced by incorporating advanced insulation techniques, renewable energy sources, and energy-efficient construction materials. Also, resource optimization and circular economy principles, including reusing materials and reducing waste, will help in sustainability by minimizing the depletion of natural resources (Olasupo et al., 2025). Compliance with green building standards also serves as a regulation and policy that gives companies a clearer goal to follow regarding the practices they need to adopt to reach their goals (Azhar, 2011; Garcés & Peña, 2023; Gbca.org.au., 2024; Häkkinen & Belloni, 2011).

Dynamic project control systems require strategic planning that goes together with real time monitoring and adaptive decision-making. One of the approaches is around using sustainability metrics through project control frameworks (Qi et al., 2021; Rachmawati et al., 2024; Sharma & Boora, 2024). They measure carbon emissions, water usage, energy efficiency, etc., and monitor this usage in the project lifecycle to meet the sustainability goals. The second is stakeholder engagement: project managers working with government bodies and the local community can better align sustainability initiatives with how the community and the environment expect them (Banihashemi et al., 2017; Jallow et al., 2017; Moore & Doyon, 2023; Qi et al., 2021). Moreover, the laws and regulations have to be built into the project control systems to ensure compliance and keep track of person accountable.

Using technology and project management methodologies, several tools have been introduced to improve project control sustainability. Building Information Modelling (BIM) lets groups of project teams simulate and enhance sustainable construction practices prior to implementation (Darko & Chan, 2018; Iyer-Raniga & Kashyap, 2021). One of the ways that the Internet of Things (IoT) sensors are essential to meeting a performance goal cities may face is that they provide real-time data on environmental performance that can be used to take immediate corrective actions. Artificial Intelligence (AI) and Machine Learning (ML), in turn, create more efficient material usage and predict sustainability risks for decision making (Debrah et al., 2022; Alqsass et al., 2024; Qusef et al., 2025; Abu-Farha et al., 2026). Additionally, blockchain technology has been introduced as a means for transparency in establishing sustainable procurement and sourcing of materials.

Nevertheless, difficulties remain in developing an effective integration of sustainability in dynamic project control processes. The first barrier is high initial cost, lack of expertise, and resistance to change. However, budget constraints and doubts over long-term returns make many firms postpone their investments in sustainable technologies (Yin et al., 2024; Zhang et al., 2021; Zhang et al., 2024). The obstacles to implementing this come from the complexity of integration with multiple stakeholders, regulatory requirements, and technological systems (Chen et al., 2023; Rachmawati et al., 2024; Sharma & Boora, 2024; Succar, 2009; Yin et al., 2024; Zhang et al., 2021). Nevertheless, the advantages overcome the disadvantages, as sustainable project control improves long-term cost savings, regulatory compliance, and stakeholder trust. Projects conducting sustainability integration usually improve efficiency, reduce operational costs, and improve environmental and social responsibility, making them less expensive and more resilient over a longer term.

5. Implications for Practice

The need to introduce sustainability in dynamic project control calls for integrating sustainability in all phases of a project life cycle, from planning to execution and monitoring. To be discussed in sustainable construction dimensions, dynamic control systems must consider the environmental, social, and economic aspects of a holistic perspective (Iyer-Raniga & Kashyap, 2021). This implies that sustainability should not be done at the end but should be a guiding principle throughout the project lifecycle, where green initiatives, resource efficiency, and economy are compatible. Construction projects may find meeting a material's sustainability goals challenging without such an approach. Technology and training are the second most important factors in controlling sustainability, as they can seriously increase their contribution through advanced tools, such as BIM, IoT, and AI. Yet this alone is not enough; organizations must develop in their own right the skills and expertise to achieve what the technology can. The training program of project managers, engineers, and other stakeholders prepares the workforce to practice sustainable frameworks (Jallow et al., 2017). However, without continuous skill development, the industry might not be able to use the soon-to-arrive technologies to impact the sustainability of the projects. As a result, adopting both technology and capacity building will likely contribute to long-term success.

6. Implications for Research

Sustainability and dynamic project control research should try to understand emerging technologies that will improve project transparency and efficiency. AI-driven project management, Blockchain in data security, and IoT-based real-time monitoring are the technologies that have transformed the potential of Sustainable Construction (Yin et al., 2024). It is time for future research to evaluate whether these innovations can effectively be integrated and their impact on project performance, risk management, and long-term sustainability. A second area of research priority is creating case studies depicting the successful integration of sustainability into dynamic project control. A number of the suggested solutions are illustrated by practical examples of real-world construction projects, which provide valuable insights to industry professionals with frameworks for best practices and lessons learned (Qi et al., 2021; Succar, 2009). To find scalable solutions, it is important to carry out case studies into various types of projects, the geography, and the strategies followed on sustainability. These studies would create a knowledge base to help practitioners put sustainability into dynamic project environments.

Moreover, there is also a need to investigate the global applicability of sustainability integration across different regions. Sustainability strategies are feasible and effective under different regulatory environments, economic conditions, or cultural contexts (Iyer-Raniga & Kashyap, 2021). Research should be done into developing adaptable standards that consider regional differences, which will also allow the sustainability frameworks to be effective in developed and emerging economies. Such an approach will enhance the broad acceptance of the construction of sustainable practices globally.

7. Recommendations

In order to make sustainability integration in dynamic project control more effective, construction managers need to implement practical change strategies rather than remaining bound to theoretical approaches. Each project management phase, from planning and execution to monitoring, should integrate Environment, Social and Economic (ESE) objectives and be aligned within a distinctly structured framework. Advanced technologies like Building Information Modelling (BIM) can assist with energy modelling and materials planning in the project's early stages. Moreover, emission, energy consumption, and site condition metrics need to be monitored in real-time using IoT sensors. Sustainability risks forecasting along with carbon reduction goal-driven scheduling optimization is possible through AI-enabled tools equipped with predictive analytics capabilities. Inter-stakeholder collaborative tracking of stated/projected sustainable goals is possible using cloud-based project control dashboards such as Autodesk Construction Cloud or Procore. To ensure that expectations on the vision, responsibilities, and communication process are aligned, coordinated decision making tools are in place, and clear communication, early stakeholder alignment workshops centred on vision-building are essential. These workshops may help create a proactive post-project change management process by incorporating a governance system that is designed with stakeholders and helps to eliminate ambiguity and stakeholder concerns. Structured vision-mapping and agile policy mechanisms offer opportunities for stakeholders to co-create tiered stewardship models that increase accountability and transparency. The processes also enable sustainability integration to be a fundamental value creation enabler, not an afterthought. Flexible structures such as inter-sector relationships and context-sensitive planning tools enable projects to react better to the changing business realities.

8. Limitations

While the potential exists for integrating sustainability into the dynamic project control, some are limited. The high initial cost of these sustainable technologies and materials is one major challenge in deterring their adoption, particularly in cost-sensitive projects. Furthermore, a lack of technology and skill constrains the application of the most advanced tools, such as BIM, IoT, and AI. On top of that, no standard sustainability data sets can be used for monitoring and evaluation purposes. Furthermore, there is misalignment among stakeholders based on their priorities, which can slow progress. Lastly, regulations and economic conditions are highly regionally variable, which restricts its implementation from being universally applicable.

9. Future Directions

Future research consists of developing standardized sustainability metrics to improve the consistency of dynamic project control. To enhance sustainability tracking, technologies like AI, Blockchain, and digital twins should be explored to adopt emerging technologies (Alzu'bi et al., 2024). Case studies showing how such implementation has gone right can be more beneficial for industry professionals. Therefore, policymakers should try to strengthen the regulatory frameworks and incentives for the adoption. Finally, cross-regional studies need to be conducted to develop adaptable sustainability models, making it possible for broader adoption as this would work across different types of economies and regulatory environments to create a more sustainable global construction industry.

10. Conclusion

- Dynamic project control systems significantly improve the efficiency and responsiveness of construction project delivery, particularly when supported by real-time data and adaptive management approaches.
- The integration of sustainability principles into these systems enhances environmental, social, and economic performance, enabling more balanced and value-driven project outcomes.
- Technologies such as BIM, IoT, and data analytics play a critical role in supporting monitoring, decision-making, and continuous optimization of construction activities.
- Despite these benefits, challenges such as inconsistent sustainability metrics, technological adoption barriers, and conflicting project priorities continue to limit full-scale implementation in practice.
- This study contributes to the body of knowledge by synthesizing fragmented research on sustainability and dynamic project control into an integrated conceptual framework that explains how digital technologies, adaptive control mechanisms, and sustainability objectives interact to improve construction project performance.

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