Exploring the Benefits and Challenges of Artificial Intelligence (AI) Implementation in Construction Projects

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ABSTRACT

In advancing the construction industry toward the green path, it is crucial to embrace the use of advanced technologies, such as Artificial Intelligence (AI). This shift is strongly supported as a nation strives to achieve its sustainable development goals. However, several challenges accompany this ambition, including the demand for a proficient workforce, high initial expenses, and resistance to change. Thus, this study endeavours to investigate the benefits of AI implementation, including the challenges that impede its adoption in construction projects within the Malaysian construction industry. The data for this study were obtained from G7 contractor firms in Selangor registered with the Construction Industry Development Board (CIDB). A simple random sampling was used to determine the sample size. A total of 156 respondents participated in this study. The data obtained was analysed using SPSS software. The findings highlighted the main benefits of implementing AI in the construction industry, revealing a growing use of AI technologies, including AI-based risk analysis and mitigation strategies to improve project outcomes, minimise potential disruptions and enhance project quality control through real-time monitoring. Insufficient data quality and availability hinder the effective utilisation of AI. Thus, this study recommends that the government offer more initiatives, incentives, and training programmes to construction practitioners to enhance the integration of AI in construction projects towards achieving environmental sustainability.

Keywords: Artificial Intelligence, contractor, construction project, Malaysian construction industry, sustainability.

INTRODUCTION

The construction industry encompasses the entire value chain of the industry, including the construction of buildings, civil engineering, specialised construction activities, manufacturing of construction products, facilities management, building maintenance and services (Ozorhon et al., 2010; Rani et al., 2021). The construction industry plays a crucial role in Malaysia's economic development and has steadily contributed around 3% to 5% of the country's GDP annually over the last decade (DoS Malaysia, 2021). Even though the construction industry contributes a small percentage to the Malaysian economy compared to services, manufacturing, tourism, and agriculture, it remains the country's most vital sector due to its spillover effect, including its backward and forward connections to other industries. Despite its significance, the sector has long been challenged by inefficiencies such as project delays, budget overruns, labour shortages, safety hazards and severe impacts to the environment (Bamgbade et al., 2017). Thus, the Malaysian government has implemented serious measures to enhance the construction sector's quality, safety, environmental sustainability, and productivity for successful project completion.

As global trends push industries toward digital transformation, Artificial Intelligence (AI) emerges as a powerful enabler for addressing these chronic issues. Technologies such as machine learning, computer vision, real-time monitoring, and robotics are increasingly being integrated into various phases of construction, from planning and design to site execution and maintenance, bringing potential for improved productivity, enhanced quality, and reduced risks. In Malaysia, efforts to digitise the construction sector have gained momentum

through initiatives like the Construction Industry Transformation Programme (CITP) and the Construction 4.0 Strategic Plan led by the Construction Industry Development Board (CIDB). However, the implementation of IR 4.0 within the Construction Industry is still lacking tremendously despite having access to these technologies (Alaloul et al., 2020). The AI adoption remains in its infancy, with uptake concentrated in large firms and urban centers. Key barriers include high implementation costs, a lack of skilled professionals, limited data infrastructure, and ethical concerns surrounding surveillance and job displacement. This study aims to explore the impacts of AI implementation in Malaysian construction projects, identifying the benefits and challenges that shape its future integration. By doing so, it seeks to provide actionable insights for policymakers, industry leaders, and researchers to navigate the digital transformation of the construction industry in Malaysia.

LITERATURE REVIEWS

AI in the Construction Industry

The construction industry is traditionally labour-intensive and slow in adopting digital technologies as compared to manufacturing and automotive industries, resulting in persistent productivity and safety challenges (Abioye et al., 2021). Thus, due to digital transformation pressures, sustainability demands, and productivity challenges, there has been an accelerating interest in AI. The Malaysian construction industry has made significant strides in positioning AI as a core element in the digital transformation of the construction industry in redefining construction processes and enabling data-driven decision-making to enhance efficiency and drive innovation.

Benefits of AI in construction projects

In the construction project, project management and planning are crucial areas where the integration of AI has made a significant impact. Predictive analytics are now more accessible through software and tools powered by AI (Bird et al., 2021). This advancement allows construction stakeholders to anticipate potential problems, create better schedules, and make strategic decision-making supported by data-driven insights (Akinosho et al., 2020). Consequently, this approach is increasingly seen as essential for enhancing productivity, reducing delays, and lowering overall project costs in the dynamic landscape of Construction 4.0.

In addition, AI-integrated Building Information Modelling (BIM) have become more prevalent in the Malaysian construction industry. Studies by Chen et al. (2022) and Xue et al. (2018) emphasise that AI-integrated BIM can streamline workflow performance and facilitate better decision-making throughout project lifecycles. AI-BIM integration supports early risk identification, can analyse vast amounts of design data, detect conflicts more accurately, and recommend corrective actions in real time. This not only minimises design errors and rework but also strengthens collaboration across multidisciplinary project teams. This promotes sustainability and cost-effectiveness.

AI plays a crucial role in enhancing safety on construction sites and managing construction projects. By integrating Internet of Things (IoT) devices with AI-powered sensors, it is now possible to monitor the condition of a site in real time. These systems can identify potential hazards, track equipment usage, and alert construction workers if safety protocols are violated (Zhang et al., 2021). This significantly improves workplace safety and reduces accidents that can cause delays in projects. In the Malaysian construction industry, the use of AI helps operations run more smoothly and fosters innovative approaches to project development. Additionally, technologies such as drones, robotics, and predictive analytics are being gradually adopted by major construction firms to enhance site productivity and improve safety outcomes.

Challenges of AI in construction projects

AI is increasingly recognised as a transformative capability for the construction industry, providing opportunities to enhance productivity, safety, and improve project delivery. However, the adoption of AI remains limited, and the construction industry is lagging other industries in digital maturity. The implementation of AI technologies brings various challenges, including data accessibility, the need for

technical expertise, financial difficulties, ethical considerations, and organisational culture. Understanding these challenges is essential to ensuring the successful integration and long-term effectiveness of AI in construction projects.

One of the primary challenges in implementing AI is the quality and availability of data. AI systems depend heavily on structured and clean datasets to train predictive models and support real-time decision-making. However, construction projects often produce fragmented, inconsistent, and unstructured data due to decentralised project environments and manual documentation practices (Darko et al., 2020; Hilmy et al., 2024). Inadequate data collection frameworks and limited standardisation hinder model accuracy and prevent effective AI deployments (Zhong et al., 2022). Mohamed and Mohamad (2021) conducted a survey among construction firms, identifying poor data quality, lack of interoperability, and high implementation costs as primary barriers. Without reliable data ecosystems and supportive organisational structures, successfully implementing AI is difficult. Consequently, AI systems struggle to deliver reliable insights, which limits organisational trust and can lead to poor implementation outcomes.

Another major barrier is the high initial investment and financial risk associated with AI technologies. Construction firms, particularly small and medium-sized enterprises (SMEs), often operate on tight project margins and may view AI adoption as a costly and uncertain investment (Amuda-Yeboah et al., 2023). The expenses related to hardware, software, licensing, cloud computing, and skilled labour can discourage the implementation of AI. Furthermore, the return on investment (ROI) may not be immediately visible, creating reluctance among decision-makers to commit resources to AI transformation (Abioye et al., 2021).

Skills gaps and workforce resistance also present serious obstacles. Successful AI adoption requires data scientists, software engineers, digital specialists, and project managers who understand AI capabilities and limitations. However, many construction organisations lack personnel with these competencies (Zhang et al., 2022). Additionally, workers may resist digital transformation due to concerns about job security, fear of technology, or lack of digital literacy (Farmer et al., 2021). This resistance can inhibit implementation and hinder organisational learning.

METHODOLOGY

The unit of analysis of this study is the construction professionals employed by contractor firms registered with the Construction Industry Development Board (CIDB) under grade G7 in Selangor. This study employed a quantitative method by administering an online survey using Google Forms to this target population to obtain their perceptions and responses to the questionnaire. According to CIDB, a total of 25,631 registered contractor firms are classified from G1 to G7 in Selangor. However, this study specifically focuses on those G7 contractor firms. Within this category, there are only 3,421 G7 contractors in Selangor. The sample size was determined following the methodology proposed by Krejcie and Morgan (1970). Hence, to adequately reflect a specific population, a sample size of 346 was deemed necessary for this investigation. Thus, a total of 600 questionnaires were distributed among the respondents, and 156 usable responses were received from all sources. This amount indicates a response rate of 26%, which is considered acceptable. According to Nulty (2008), a 20% response rate is deemed satisfactory.

This study used a 5-point Likert scale to measure each construct in the survey. The scale ranges from 1 to 5, where 1 indicates ‘strongly disagree’, 2 indicates ‘disagree’, 3 indicates ‘neutral’, 4 indicates ‘agree’, and 5 indicates ‘strongly agree’ regarding the benefits and challenges of AI implementation in construction projects. The questionnaire consisted of three (3) sections. Section A: Demographic background, Section B: The benefits of AI implementation in construction projects, and Section C: The challenges of AI implementation in construction projects. The collected data were analysed using descriptive analysis using SPSS software. The Mean Score (MS) analysis was employed to calculate the mean score for each variable and to rank the variables based on the level of agreement among the respondents. The mean score ranking technique has been widely used in the field of built environment studies to assess the relative significance or importance of specific factors (Shi et al., 2013). The Cronbach’s Alpha coefficient for the collected data is 0.942. These figures were above the limit of .70, as suggested by Nunnally (1978, cited by Cheng et al., 2014, p.85). This finding provides evidence of the consistency and reliability of the gathered data.

FINDINGS AND DISCUSSIONS

Demographic background

Table 1 displays the distribution of respondents based on their position within their respective firms. According to the findings, all respondents are from the middle management level and hold a variety of positions in the firms, including project manager, project engineer, construction manager, site manager, and site supervisor, as well as quantity surveyor. This data shows that the information acquired is reliable, as the respondents are knowledgeable and actively involved in the operation and management of construction projects.

Table I Respondents Working Positions

Working Position	Frequency	Percentage (%)
Project Manager	32	20.5
Project Engineer	23	14.7
Construction Manager	26	16.7
Site Manager / Site Supervisor	38	24.4
Quantity Surveyors	37	23.7
Total	156	100

Meanwhile, Table II shows the distribution of respondents based on their working experience in the construction industry. Among the 156 respondents, the majority (33.3%) had 6–10 years of experience, indicating a substantial representation of middle-level professionals actively engaged in construction operations. This is followed by 11–20 years (32%) and more than 21 years (27.6%), indicating well-experienced contractors with significant industry exposure. Meanwhile, only 7.1% of respondents had less than 5 years' experience, reflecting the participation of younger contractor professionals.

Table II Respondents Working Experience

Working Experience	Frequency	Percentage (%)
1 – 5 years	11	7.1
6 – 10 years	52	33.3
11 – 20 years	50	32.0
More than 21 years	43	27.6
Total	156	100

Benefits of AI implementation in construction projects

Based on the findings indicate that respondents highly value AI-based risk analysis and mitigation strategies, with a mean score of 4.40. This suggests a strong consensus on their effectiveness in improving project outcomes and minimising potential disruptions. Baryannis et al. (2018) support this view, noting that AI techniques, such as machine learning and big data analytics, are successfully used to identify, assess, and respond to supply chain risks, which ultimately enhances decision-making and adaptability. Additionally, real-

time monitoring and AI-driven data insights, which improve the quality of project control and assurance, received a mean score of 4.36. The use of AI technologies to reduce human error and enhance project safety is highly regarded, with a mean score of 4.35. This finding is aligned with Bigham et al. (2018), who mention that the risk of accidents on the construction site can be significantly decreased by an AI platform's ability, which can identify hazards before and during the construction operation and recommend appropriate safety standards. Furthermore, the construction industry's productivity and project timelines are dramatically improved by AI applications, with a mean score of 4.32. In general, respondents perceive the implementation of AI in construction projects as highly beneficial, as they acknowledge its ability to enhance various aspects of project management and execution.

Table I Benefits of AI Implementation

Benefits of Artificial Intelligence (AI) Implementation	Mean	Standard Deviation	Rank
AI provide risk analysis and mitigation strategies to improve project outcomes and minimise potential disruptions.	4.40	0.721	1
AI-driven data insights and real-time monitoring enhance project quality control and assurance.	4.36	0.733	2
AI technologies reduce human errors and enhance overall project safety in construction.	4.35	0.748	3
AI applications significantly enhance productivity and accelerate project timelines	4.32	0.480	4
AI-enabled automation streamlines repetitive tasks, allowing for better focus on complex project requirements.	4.28	0.748	5
AI integration fosters innovation and competitiveness within the Malaysian construction industry.	4.12	0.703	6
AI-driven tools and systems enable the reduction of costs and the optimisation of budgets in construction projects.	4.04	0.813	7
AI-powered analytics and predictive modelling enhance decision-making processes in construction project management.	3.99	0.810	8
The integration of AI improves project efficiency by optimising the allocation of resources and scheduling.	3.72	0.494	9

Challenges of AI implementation in construction projects

Most respondents agree that the effective use of AI technologies is hindered by insufficient data quality and availability, as reflected in the highest mean score of 4.50. This finding aligns with Whang et al. (2023), who stated that unreliable AI models and poor decision-making outcomes stem from poor data quality, which includes issues such as incompleteness, errors, and biases. As supported by Abioye et al. (2021) and Omar et al. (2022), most of the construction information is stored in various formats like PDFs, CAD files, and spreadsheets across different systems, often lacking consistency and control. Data collection is often viewed as an administrative burden rather than a core project activity, and without clear incentives or training for field staff, the accuracy and consistency of site-level data remain poor (Omar et al., 2022). Moreover, the lack of collaboration and partnerships between construction firms and AI solution providers closely follows this concern, with a mean score of 4.48. Data security and privacy are major concerns when adopting AI applications, with a mean score of 4.46. This finding is consistent with Murdoch (2021), who revealed that AI technologies pose significant threats to data security, heightening the risk of reidentification and serious

privacy violations. Another significant challenge in Malaysia is the current infrastructure, which requires more support for the effective implementation of AI in construction projects, reflected by a mean score of 4.33. Additionally, the seamless integration of AI applications was hindered by financial constraints and regulatory complexities, which received an average score of 4.22. Several studies have emphasised that financial constraint is not merely limited to the purchase of AI tools but stems from a combination of structural, technical, and organisational factors (Abioye et al., 2021; Alaloul et al., 2020; Chen et al., 2022). Furthermore, the lack of skilled professionals compounds challenges. The shortage of data engineers and AI specialists means that many firms depend on external consultants for implementation, inflating project budgets (Omar et al., 2022). Accordingly, this perception can impede the growth of technology adoption in construction projects within the Malaysian construction industry, leading many practitioners to prefer the traditional practices they are accustomed to.

Table I Challenges of AI Implementation

Challenges of Artificial Intelligence (AI) Implementation	Mean	Standard Deviation	Rank
Insufficient data quality and availability hinder the effective utilisation of AI technologies.	4.50	0.527	1
Lack of collaborations and partnerships between construction firms and AI solution providers	4.48	0.501	2
Concerns regarding the security and privacy of data in adopting AI applications.	4.46	0.551	3
The current infrastructure in Malaysia lacks support to implement AI successfully in construction projects.	4.33	0.761	4
Financial constraints in AI implementation.	4.22	0.699	5
Regulatory complexities and unclear guidelines hinder the seamless integration of AI applications.	4.22	0.863	6
There is a lack of skilled personnel knowledgeable about AI technologies.	4.05	0.796	7
Resistance to change and a lack of willingness to embrace new technologies.	3.98	0.793	8
There is a fear of job displacement among the existing workforce due to AI adoption.	3.66	0.577	9

CONCLUSIONS

AI offers remarkable potential to tackle inefficiencies in the construction industry, improve safety, and facilitate meeting environmental sustainability targets. Additionally, AI can significantly transform construction operations by increasing efficiency, reducing risks, and supporting sustainable project delivery. While the adoption of AI technologies requires investment in skills, infrastructure, and digital maturity, the competitive advantages and operational improvements they offer are substantial. Thus, despite the challenges that come with the implementation, the Malaysian construction industry is expected to invest more in AI-driven digital transformation. Although challenges in adoption persist, strategic investments in digital talent, robust data systems, and regulatory support can accelerate AI integration and foster Construction 4.0 transformation. The government, including other relevant agencies, must implement a vigorous range of initiatives, incentives, and comprehensive training programs for construction practitioners to enhance the integration of AI in the industry to effectively promote environmental sustainability and drive significant

progress toward a more sustainable future. Thus, future research should focus on developing AI implementation frameworks, assessing the construction industry's readiness, and evaluating a comprehensive strategy to overcome these challenges, allowing the full potential of AI to be used in construction projects.

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