Challenges Faced by Contractors in Adopting Industrial Revolution 4.0 in the Malaysian Construction Industry

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ABSTRACT

The Malaysian construction industry serves as a basis of national economic growth, yet it remains hindered by low labor productivity and a heavy reliance on manual, low-skilled labor. Despite the roadmap provided by the Construction 4.0 Strategic Plan (2021–2025) and the Industry4WRD policy, the transition toward cyber-physical systems remains stagnant among local contractors. The objective of this study is to investigate how the challenge impacts the contractor regarding the adoption of IR 4.0 technologies in the construction industry. This study employed a quantitative approach. A total of 115 out of 286 respondents in Selangor from G1 to G5 participated, for a response rate of 40%. The data were subsequently analysed using SPSS tools version 29. The result reveals that Increased expenses for tools and software are the most significant challenge faced by contractors when adopting IR 4.0 in their construction projects. Contractors agree that higher software and tool expenses are the biggest obstacle to IR 4.0 implementation in the construction industry. Thus, through gaining a deeper comprehension of these challenges, researchers and industry pioneers may develop strategies to overcome them and enhance the efficient implementation of digital technology in the construction sector.

Keywords: Challenges, Contractors, Industrial Revolution 4.0, Malaysian Construction Industry.

INTRODUCTION

The global construction industry is undergoing a paradigm shift driven by the Fourth Industrial Revolution (IR 4.0), often referred to as Construction 4.0. In the context of Malaysia, the construction sector remains a primary economic driver. To modernize this sector, the Malaysian government launched the Construction 4.0 Strategic Plan (2021–2025), aiming to enhance productivity, safety, and competitiveness through digitalization (CIDB, 2025). As mentioned by Hamidi, Aziz, Shuhidan, Aziz & Mokhsin, (2018), the IR 4.0 is all about digitizing processes from beginning to end and connecting them into a digital ecosystem along the value chain. In the context of the fourth industrial revolution, the concept of cyber-physical systems revolves around technology and enables both directions communication between humans and technology. The significance of IR 4.0 cannot be underestimated.

The Malaysian construction industry is currently at a critical junction in its digital transformation journey. A chronic shortage of technically competent personnel and a high level of organizational rigidity or resistance to change among middle management (Abdul-Samad et al., 2024). To enhance national productivity and reduce dependency on unskilled foreign labor, the Malaysian government through CIDB launched the Construction 4.0 Strategic Plan (2021–2025), aiming to integrate disruptive technologies like Building Information Modelling (BIM), Internet of Things (IoT), and Artificial Intelligence (AI) (CIDB, 2025). Although technology is readily available, IR 4.0 has yet to be fully implemented in Malaysia's building sector (Alaloul et al. 2020). By 2024, the sector demonstrated a robust recovery, expanding by 17.5% due to a surge in residential and specialized building activities; however, this growth has not yet fully translated into uniform digital maturity across the industry (Department of Statistics Malaysia, 2025). Consequently, despite the sector's economic rebound, the digital transformation required for long-term global competitiveness remains an ongoing challenge for Malaysian contractors (Jaafar et al., 2025).

LITERATURE REVIEW

The Fourth Industrial Revolution (IR4.0)

IR 4.0 in the construction industry aims to revolutionize the design, construction, and maintenance of buildings and infrastructure, fostering increased efficiency, sustainability, and enhanced quality in construction projects (Kozlovska et al., 2021). Moreover, this technological paradigm will drive the widespread integration of digital technologies across all phases of the construction lifecycle (Willar et al., 2021). Alaloul et al. (2018) found that IR 4.0’s success in the construction industry shows how digital access and big data can improve digitization efforts and how they can be seamlessly integrated into the value chain for electronic data processing. As mentioned by Abdul-Samad et al., (2024), to prepare for the future of the construction sector, companies must find ways to improve the skill of their current teams and recruit qualified technical expert. As noted by Weking et al. (2020), the value created by IR 4.0 necessitates a fundamental change in the construction industry’s overall company strategy, where the long-term viability of contractors depends on their ability to strategically reconfigure their resources to master digital business patterns.

"Construction 4.0" refers to the integration of the concepts and technologies of "Industry 4.0" into the construction process, seeking to enhance sustainability, optimize efficiency, and minimize waste. It utilizes digital technology and automation to significantly improve the design, construction, and maintenance of buildings and infrastructure. As a result, it represents a revolutionary approach to managing, organizing, and establishing infrastructure in the built environment, resulting in enhanced efficiency and effectiveness (Jaafar et al., 2024). This definition is closely aligned with the conceptual frameworks proposed by Forcael et al. (2020), who stated that Construction 4.0 encompasses all technological advancements related to the adoption of new work methods which impact construction processes, markets, and materials. Construction 4.0 has a similarity with Industrial Revolution 4.0, as both concepts focus on the combination of trends and advancements in both digital and physical technologies. This confluence of cyber-physical systems bridges the gap between field operations and virtual modeling platforms (Alaloul et al., 2023).

Challenges in Implementing the Fourth Industrial Revolution (IR4.0)

The primary challenge that contractors’ organizations face when attempting to fully benefit from Industrial Revolution 4.0 (IR 4.0) is the high expense related to its implementation. The costs associated with technical training and equipment maintenance are additional expenses that might complicate the implementation process, along with the uncertainty around the return on investment (Go et al., 2023). This financial strain is particularly acute within developing economies like Malaysia, where the adoption of cyber-physical tools demands substantial capital expenditure (Jaiswal et al., 2024). Husam (2023) said that new technologies are not widely used in the construction sector due to high implementation costs and investment requirements. This statement is also supported by Yahya et al. (2019), who noted that only a few firms can afford purchasing and integrating new technologies. High expenses associated with new technology also require high maintenance costs to sustain the technology. Consequently, smaller firms find it difficult to justify software licenses and continuous system upgrades on a project-by-project basis (Arshad, 2024). Furthermore, a lack of local technical expertise makes it highly risky for small firms to venture away from proven structural workflows (Ismail et al., 2024).

In the current era of digital transformation, the ability to effectively manage and adjust to change within an organization is becoming increasingly critical for the survival of many current companies. (Verhoef et al., 2021). Ghobakhloo and Ching (2019) emphasize that the absence of a dedicated strategic roadmap prevents firms from successfully executing these long-term transitions. The other challenges included under the nature of the organization are a lack of preparation, specifically regarding the critical need to retrain existing staff and train new labor (Bidhendi et al., 2024). This human-centric resource gap creates persistent operational roadblocks that continue to constrain organizational readiness for automation (Schnell et al., 2022). However, the Malaysian construction sector continues to grapple with a profound shortage of local digital experts, leaving most contracting firms with an aging workforce that exhibits steep resistance to cultural change (Nasir et al., 2024).

Among the primary challenges faced by contractors in adopting IR 4.0 is a fundamental lack of willingness to transition away from conventional workflows. Specifically, small-medium sized firms have a limited understanding and evaluation of the advantages that the Fourth Industrial Revolution (IR 4.0) can provide to their organization in the long run. This knowledge deficit often results in low awareness levels and misaligned strategic planning within developing construction markets (Jaiswal et al., 2024). According to Demirkesen & Tezel (2021), one of the primary obstacles that contractors may have in adopting IR 4.0 is a lack of willingness to adopt new technologies and innovations, resulting in a deep-seated reluctance to change. This deep-seated organizational inertia is reinforced by a widespread fear of technological complexity and an underlying resistance to disrupting long-established project-delivery routines (Ahmad Sekak et al., 2022; Mustafa, 2025).

Data privacy and security represent critical vulnerabilities that hinder the integration of digital twins and cloud networks on contemporary job sites. Previous study by Chia Kuang Lee et al. (2022) demonstrates that for most companies, data privacy and security are the two biggest concerns with the IR 4.0 platforms' web or cloud-based nature. An ideal situation for IR 4.0 would be companies with corporate value chains that could send and receive data via Cyber Physical Systems (CPS) or the Internet of Things (IoT). Furthermore, the fragmentation of typical construction supply chains exacerbates these security vulnerabilities, as a single cyber-attack on a minor sub-contractor can compromise the data integrity of an entire multi-tiered project network (Manzoor et al., 2021). Consequently, the absence of standardized data protection frameworks within the construction industry causes firm executives to remain deeply hesitant to migrate proprietary project metrics into shared cloud ecosystems (Alaloul et al., 2023; Zhou et al., 2024).

In a developed Industrial Revolution 4.0 (IR 4.0) environment, also referred to as Construction 4.0, contractors rely significantly on a strong digital infrastructure to facilitate cyber-physical activities. A primary technical bottleneck hindering this digital transition on modern jobsites is the critical requirement for fast, reliable, and efficient internet access. Technologies central to IR 4.0, such as the Internet of Things (IoT), real-time cloud-based Building Information Modeling (BIM) coordination, and autonomous site machinery, require seamless, high-bandwidth data transmission to function effectively (Goh et al., 2019). An ideal scenario for Construction 4.0 involves continuous data exchange between field-deployed sensors and off-site cloud platforms. However, remote or highly dynamic geographic locations often isolate construction sites, leaving them vulnerable to severe latency issues, localized network dropping, and inadequate cellular bandwidth (Siriwardhana et al., 2025).

RESEARCH METHODOLOGY

This study employed a quantitative research method, using simple random sampling as the sampling technique. Simple random sampling is applied for populations that are comparatively similar where the members of the research are randomly selected to participate in the research (Bhardwaj, 2019). This study was completed in Selangor on the Grade G1 to G5 contractors company registered with the Construction Industry Development Board (CIDB). A consulting firm in Selangor was chosen for the study due to the state's high concentration of companies compared to other regions. The total number of questionnaires that were distributed is 286 among G1 to G5 contractors based on sample size. A response rate of 40% was achieved with 115 out of 286 questionnaires. According to Sataloff & Vontela (2021), response rates for surveys are still up for discussion but previous research suggest that they should be between 40% and 75%, so this research rate falls within that range (Reinisch et al., 2016; Story & Tait, 2019). 115 respondents were successful in collecting the online questionnaire through Google Form or Email. The data were analyzed using the Statistical Package for Social Science (SPSS) software version 29.

FINDING AND ANALYSIS

A total of 115 respondents participated in this study. The majority were male (97%), while female respondents made up 3%. In terms of professional experience, the largest segment had over 10 years of experience (64%), followed by 3-6 years (19%), 7-10 years (14%) and below 2 years of experience (4%). The majority of the participants in this study were affiliated with contractor G4, comprising 38% of the total responses. Contractors G3 had a percentage of 36, while contractors G5 had a percentage of 15. The contractor with the lowest number of respondents was G2, with only 6%, followed by G1 with only 3%.

Table 1 shows the list of rank, mean index and perception level for the challenges faced by contractors in adopting Industrial Revolution 4.0. The highest mean is increased expenses for tools and software (m=4.61), followed by cybersecurity concerns, hacking and risk assessment (m=4.38), the shortage of skilled resources will lead to contractor's lack of confidence (m=4.21), need fast and efficient internet access (m=4.10) and lastly, the unpredictable nature of project's surroundings (m=4.08).

TABLE 1: Challenges faced by contractors in adopting Industrial Revolution 4.0

Description	Mean	Perception Level	Rank
Need fast and efficient internet access	4.10	Agree	4
The shortage of skilled resources will lead to contractor's lack of confidence to proceed.	4.21	Agree	3
Increased expenses for tools and software.	4.61	Strongly Agree	1
The unpredictable nature of a project's surroundings causes uncertainty which might result in project complications.	4.08	Agree	5
Cybersecurity concerns, hacking crimes, and risk assessment.	4.38	Agree	2

Notes: Strongly disagree = 0.00<AI<1.50, Disagree = 1.50<AI<2.50, Neutral = 2.50<AI<3.50 Agree = 3.50<AI<4.50, Strongly agree = 4.50<AI<5.00

The highest-ranked challenge identified by the respondents was the increased expenses for tools and software, with a mean score of 4.61, indicating a Strongly Agree perception level. This finding suggests that financial constraints remain the most significant obstacle preventing contractors from embracing Industry 4.0 technologies. This finding is consistent with Go et al. (2023) who identified the costs associated with technical training and equipment maintenance are additional expenses that might complicate the implementation process, along with the uncertainty around the return on investment. Furthermore, Jaiswal et al. (2024) reported that the financial strain is particularly acute within developing economies like Malaysia, where the adoption of cyber-physical tools demands substantial capital expenditure. These studies collectively support the present finding that financial investment remains the dominant concern among contractors considering digital transformation.

The second highest-ranked challenge was cybersecurity concerns, hacking crimes, and risk assessment, with a mean score of 4.38, indicating that respondents generally agreed that cybersecurity issues represent a major concern during the adoption of IR 4.0 technologies. Contractors therefore perceive cybersecurity as a critical risk that requires substantial investment in digital security infrastructure and risk management strategies. This finding aligns with previous studies highlighting cybersecurity as a growing concern in Industry 4.0 environments. Previous study by Chia Kuang Lee et al. (2022) demonstrates that for most companies, data privacy and security are the two biggest concerns with the IR 4.0 platforms' web or cloud-based nature. An ideal situation for IR 4.0 would be companies with corporate value chains that could send and receive data via Cyber Physical Systems (CPS) or the Internet of Things (IoT).

The shortage of skilled resources ranked third, with a mean score of 4.21, suggesting that respondents agreed that insufficient expertise reduces contractors' confidence in implementing Industry 4.0 technologies. The successful implementation of Construction 4.0 depends on employees who possess competencies in digital technologies, BIM, automation, IoT, artificial intelligence, robotics, cloud computing, and data analytics. According to Demirkesen & Tezel (2021), one of the primary obstacles that contractors may have in adopting IR 4.0 is a lack of willingness to adopt new technologies and innovations, resulting in a deep-seated reluctance to change. Similarly, Ahmad Sekak et al. (2022) and Mustafa (2025) emphasized that organizational inertia remains a significant barrier to Industry 4.0 adoption, with contractors showing reluctance to embrace digital technologies due to their perceived complexity and the challenges associated with changing long-established project delivery practices.

The need for fast and efficient internet access obtained a mean score of 4.10, indicating that respondents agreed reliable internet connectivity is necessary for successful Industry 4.0 implementation. Poor digital infrastructure can disrupt data exchange, delay decision-making, and hinder the effective adoption of digital technologies, particularly in remote construction sites. Goh et al. (2019) explained that technologies central to IR 4.0, such as the Internet of Things (IoT), real-time cloud-based Building Information Modeling (BIM) coordination, and autonomous site machinery, require seamless, high-bandwidth data transmission to function effectively.

The lowest-ranked factor, although still receiving agreement from respondents, was the unpredictable nature of project surroundings, with a mean score of 4.08. Construction projects operate in dynamic environments where changing site conditions, project complexity, and unforeseen constraints create uncertainties that complicate the implementation of advanced digital technologies. This finding is supported by Ghobakhloo and Ching (2019) who noted that the absence of a dedicated strategic roadmap prevents firms from successfully executing these long-term transitions. The other challenges included under the nature of the organization are a lack of preparation, specifically regarding the critical need to retrain existing staff and train new labor (Bidhendi et al., 2024).

To mitigate these challenges, a comprehensive strategy is essential. First, the construction industry should leverage public-private partnerships (PPP) to help offset the high initial capital needed for IR 4.0 adoption. Second, structured workforce reskilling initiatives must be established to bridge the current talent gap. Finally, as firms transition into a digital ecosystem, they need to implement robust cybersecurity frameworks alongside effective change management to minimize employee resistance and safeguard digital assets.

CONCLUSION

The findings of this study demonstrate that the adoption of Industry Revolution 4.0 in the Malaysian construction industry continues to face several significant challenges. The findings indicate that all identified challenges were perceived as significant, with mean scores exceeding 4.00, demonstrating a strong consensus among respondents regarding the barriers to digital transformation. Among these, the increased expenses for tools and software emerged as the most critical challenge, followed by cybersecurity concerns, the shortage of skilled resources, the need for reliable internet connectivity, and the unpredictable nature of construction project environments. At the organisational level, contractors should adopt strategic digital transformation plans that incorporate investment planning, workforce development, cybersecurity management, and collaboration with technology providers. These integrated efforts are expected to improve the readiness and sustainability of IR 4.0 implementation within the Malaysian construction industry. Consequently, achieving successful Industry Revolution 4.0 implementation requires a coordinated effort among government agencies, construction firms, technology providers, and academic institutions to create an ecosystem that supports digital transformation. Ultimately, overcoming these barriers will enable the Malaysian construction industry to fully harness the potential of Industrial Revolution 4.0, promoting sustainable growth, innovation, and long-term resilience in an increasingly digital and competitive global environment.

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