Journal of Engineering Science and Technology
Special Issue on STAAUH, November (2024) 96 - 110

MANAGERIAL PERSPECTIVES ON DIGITAL TOOLS APPLICATIONS IN PROJECT MANAGEMENT PRACTICES WITHIN MALAYSIAN CONSTRUCTION INDUSTRY: AN EXPLORATORY STUDY

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Abstract

The construction industry in Malaysia has long relied on conventional project management methods, making it challenging to incorporate digital tools due to resistance to modern technology adoption. These traditional practices often need help to keep up with the fast-paced nature of construction projects, leading to inefficiencies and delays. Integrating digital tools into project management can address these challenges and improve productivity, transparency, and collaboration. This research aims to promote the implementation of digital tools in project management practices in the Malaysian construction industry. The objectives are as follows: (i) to identify the current application of digital tools in project management phases, (ii) to investigate the challenges in implementing digital tools, and (iii) to propose strategies for enhancing the utilisation of digital tools in project management practices. The study uses a qualitative approach via semi-structured interviews with seven industrial experts. These interviews offered valuable insights into the awareness of industry professionals regarding the application of digital tools in construction projects. Findings also indicate that while many professionals recognise the advantages of digital tools, practitioners face significant challenges in adopting them widely. Thus, several strategies have been proposed to enhance the implementation of digital tools in project management practices in the Malaysian construction industry. Further recommendations were highlighted for future research studies.

Keywords: Challenges, Construction, Digital tools, Managerial perspectives, Project management.

1. Introduction

The demand for construction projects is rising globally to meet the needs of an expanding population and economy, causing a spike in activity [1]. As for Malaysia, the construction industry has always played an important role in the country's economic development with significant contributions to the nation's gross domestic product (GDP) and employment as it has been contributing 14,641 MYR million by steadily growing 3.3% from 1.5% during the second quarter of 2023 [2]. However, Malaysia has been reluctant to adopt modern technology in the construction industry, where there has been a persistent lack of new technology, even though international project management firms have always had the chance to provide local contractors and developers with options [3].

This is due to traditional project management practices in construction being deeply rooted in the principles of initiation, planning, execution, control, and closure phases. It is increasingly problematic in an era where digital transformation reshapes various sectors, including construction. The linear model of traditional project management works best in stable and certain contexts; however, it frequently requires assistance to account for the inherent uncertainties and dynamic changes that construction projects frequently encounter [4, 5].

As a result, it is less useful in today's complicated environment. Traditional project management practices in the Malaysian construction industry are largely derived from established methodologies such as the Project Management Body of Knowledge (PMBOK) by the Project Management Institute (PMI) [6]. These practices are typically characterised by a sequential and linear approach, emphasising rigorous planning, control, and execution of project activities.

First and foremost, the waterfall project management approach is a sequential and linear method in which each project phase must be completed before moving on to the next [7]. It involves distinct phases such as project initiation, planning, execution, monitoring, and closure. This sequential and linear approach provides a structured framework for managing projects and ensuring that each stage is thoroughly completed before proceeding to the next.

Another traditional project management practice used in the Malaysian construction industry is the Critical Path Method (CPM). The Critical Path Method (CPM) is a well-established project management practice crucial in identifying the critical path within a project schedule [8]. It determines the most extended sequence of activities that must be completed on time to prevent potential delays in the project timeline [9]. This method is particularly valuable in complex projects where various interdependent tasks need to be carefully coordinated. Additionally, Gantt charts, commonly used with CPM, offer visual representations of project schedules, providing a detailed overview of tasks, durations, and interrelationships throughout the project.

Malaysia's construction projects rely heavily on manual documentation and paperwork, including physical drawings, blueprints, contracts, change orders, and progress reports, typically maintained in hard copy formats or basic digital files [10]. Furthermore, traditional project management practices in the Malaysian construction industry emphasise face-to-face meetings and regular site visits for communication, coordination, and progress monitoring. These meetings involve stakeholders such as project managers, contractors, consultants, and clients.

Not only that, but many construction projects in Malaysia also depend heavily on the expertise and experience of individual project managers, engineers, and contractors. Decision-making and problem-solving often hinge on the knowledge and judgment of these experienced professionals. Historically, traditional, manual, and paper-based project management practices have struggled to adapt to the dynamic and evolving nature of construction projects. Thomsett [11] argues that the linear approach of traditional project management is too rigid and "poorly suited to the chaotic and client-driven business environment of the 21st century."

Additionally, Mathews and Howell [12] stated that traditional project management tends to lack coordination when subcontractors are involved, working individually rather than as part of a team. Haron et al. [13] emphasise the need for effective project management techniques from the beginning to the conclusion of projects to achieve their functional goals within the allotted service period. Traditional project management not only follows sequential procedures but also faces issues of flexibility, teamwork, and comprehensive project management, all of which are increasingly important in today's fast-paced, client-focused business environment [14].

Despite their long-standing use, traditional practices in the construction industry are often characterised by time-consuming processes, susceptibility to errors, and a lack of adaptability and real-time visibility crucial for modern construction projects. Therefore, there is a growing need for the Malaysian construction sector to embrace digital tools and cutting-edge technologies. This strategic shift will be pivotal in optimising project management strategies, fostering seamless collaboration among stakeholders, and ultimately elevating the overall efficiency and success rates of construction projects in the region.

Digital tools have been transforming project management practices across industries by providing solutions to issues with traditional project management techniques. These tools include project management software, collaborative platforms, building information modelling (BIM), and advanced data analytics, known for improving efficiency, communication, and collaboration, as well as reducing project delays and cost overruns, ultimately leading to increased project success rates [15]. The construction industry globally has been increasingly integrating digital tools into project management practices, with leading firms recognising the benefits of real-time monitoring, data-driven decision-making, and streamlined workflows.

However, the adoption of digital tools in the construction industry is still relatively low, hindering the industry's ability to maintain global competitiveness and fully leverage digital transformation [16]. Unlike small-scale construction firms in Malaysia, only a few leading construction firms have embraced digital tools in their projects [17]. This situation has arisen due to various challenges the Malaysian construction industry faces, such as high costs, lack of awareness, reluctance to move away from traditional methods, and a shortage of skilled professionals who can effectively utilise these technologies. The industry's hesitance to adopt digital tools in project management practices is worrisome as it may cause Malaysia to lag behind its global counterparts. Failing to adapt to these technological advancements could result in reduced competitiveness, inefficiencies, and an inability to meet the changing needs of clients and stakeholders.

1.1. Exemplars of case studies involving the application of digital tools in project management organisations

Brief project background for Case Study 1 and Case Study 2

Both case studies involve a power plant company. The main goal is to create a stable and safe foundation for the future power plant. One company was tasked to prepare the site and handle the construction work, while another company would monitor the project's quality, safety, and structural planning. The project's total cost is more than RM40 million, including several key tasks such as building strong and stable platforms for the power plant and securing slopes with grass coverings and protective gabion walls. Case Study 1 uses Primavera P6 and Microsoft Project to create project schedules and a Work Breakdown Structure (WBS). These tools help organise tasks and timelines after setting an initial budget, track progress, and allocate resources. The case also highlights the importance of estimating costs early and assessing risks during planning. However, the software is outdated compared to the more advanced technologies now available in the construction industry. Modern tools, such as those based on Industry 4.0 and Industry 5.0, use artificial intelligence, automation, and advanced data analysis, offering more innovative and efficient solutions. Meanwhile, Case Study 2 highlights the use of Excel to estimate costs and manage resources in project planning. The case study shows that some companies rely on simple tools like Excel for budgeting, especially if they don't have access to advanced software. They also emphasise the need for proper training, and clear instructions to help team members overcome challenges with new technology. They have suggested assigning a specific staff to guide and support others in learning and adapting to these tools.

1.2. Challenges in implementing digital tools

The construction industry has been slow to adopt digital tools despite their potential to improve the efficiency and productivity of construction projects. Several challenges are hindering the smooth integration of digital tools in the industry. One of the primary challenges is the technological complexity associated with digital tools. Rapid technological advancements may overwhelm stakeholders, making it challenging to choose and implement the most suitable digital tools for their projects [18]. Moreover, insufficient understanding and familiarity with digital tools among construction professionals may hinder effective adoption and utilisation [19]. Stakeholders, including project managers and workers, may resist departing from established traditional practices, leading to reluctance to embrace digital tools [20]. Another significant challenge is the financial burden associated with acquiring and implementing digital tools. The initial costs, including software licenses and training, may pose a financial burden on construction companies, particularly smaller firms [21]. Additionally, a lack of compatibility and interoperability among different digital tools can create challenges in establishing a seamless and integrated project management ecosystem [22].

1.3. Proposed strategies

The construction industry constantly looks for ways to enhance project outcomes, reduce costs, and improve efficiency. One way to achieve these goals is by implementing digital tools. However, integrating technology in the construction industry can be difficult due to several factors, including resistance to change, lack

of awareness, and difficulties integrating new tools with existing workflow [18, 20]. Developing a comprehensive strategy that addresses all aspects of digital tool implementation is crucial to overcome these challenges. Such a plan should include educating stakeholders and training programs to ensure that all parties involved in construction projects understand the benefits of digital tools and can use them effectively [19]. Digital tools should be selected based on a thorough assessment of project requirements, focusing on user-friendly interfaces and seamless integration with existing workflows [22].

Pilot programs should be conducted to test the effectiveness of these tools, and incremental adoption should be allowed based on feedback received from the pilot programs [23]. Collaborative platforms should be implemented while addressing interoperability issues to facilitate real-time communication and information sharing among stakeholders [24]. Technological infrastructure should also be upgraded to support the implementation of digital tools, including robust internet connectivity and secure data storage solutions [25]. To address data security and privacy concerns, robust cybersecurity measures should be implemented, and stakeholders should be educated on cybersecurity best practices and compliance with industry standards and regulations [26].

Advocating government policies that support and incentivise the adoption of digital tools in the construction industry should be a priority, and regulatory frameworks that promote digital technologies should be established [27]. Continuous monitoring and evaluation mechanisms should also be established to assess the performance of the tools and identify areas for improvement [28]. Finally, facilitating knowledge-sharing platforms and communities should encourage the exchange of experiences, best practices, and lessons learned from implementing digital tools [29]. By implementing such a comprehensive strategy, construction companies in Malaysia can embrace digital transformation and reap the benefits of improved efficiency, reduced costs, and enhanced project outcomes [30].

1.4. Integration of digital tools in project management practices

The construction industry in Malaysia holds a significant position in the country's economy [31]. However, it has been plagued by issues such as low productivity, inefficient processes, and a general reluctance to embrace digital tools [32]. Despite the widespread adoption of digital tools in project management across various sectors, the Malaysian construction industry has been slow to undergo this digital transformation. This reluctance is primarily due to the industry's continued reliance on traditional manual processes and systems, making it challenging to seamlessly integrate digital tools into existing project management practices [33].

Given the potential consequences of falling behind its global counterparts, the Malaysian construction industry's hesitance to embrace digital tools for project management is a cause for concern. Failing to adapt to technological advancements could result in decreased competitiveness, operational inefficiencies, and an inability to meet the evolving needs of clients and stakeholders [34]. Furthermore, the industry's slow uptake of digital tools represents a missed opportunity to leverage their myriad benefits, including heightened efficiency, enhanced collaboration, data-informed decision-making, and more streamlined project delivery processes.

The integration of digital tools into project management practices within the Malaysian construction industry is encountering several notable challenges. These challenges encompass a lack of awareness about the benefits of digital tools, resistance to change from established practices, concerns about the perceived high costs of implementing digital technologies, and a shortage of skilled professionals who can effectively leverage these tools [35]. Furthermore, the industry's deeply entrenched culture and long-standing practices may pose significant barriers to successfully incorporating digital tools. Hence, it is imperative to thoroughly examine the status of digital tool utilisation in the Malaysian construction industry.

This investigation should identify the challenges associated with their implementation and devise effective strategies to surmount the impediments that hinder their seamless integration into conventional project management methodologies. Tackling this issue holds immense significance as it bolsters the industry's competitive edge, enhances productivity, and elevates overall project execution capabilities. Ultimately, this paper will substantially contribute to the nation's economic advancement and progress. To promote the implementation of digital tools in project management practices in the Malaysian construction industry, the aim is supported by the following objectives:(i) to identify the current application of digital tools in project management phases, (ii) To investigate the challenges in implementing digital tools (iii) To propose strategies in enhancing the utilisation of digital tools in project management practices.

2. Research Method

The research methodology chosen for this paper is a qualitative approach, specifically utilising semi-structured interviews for primary data collection, supported by content and thematic analysis. Semi-structured interviews are considered suitable for this research because they allow for in-depth and precise information, offering detailed answers from experts in the field [36, 37]. This method is expected to yield a high response rate and a deeper understanding of digital project management practices [38]. 7 interviewees were carefully selected from a diverse range of contractor firms involved in construction projects across various states in Peninsular Malaysia, as well as in Sabah and Sarawak.

This strategic selection ensures that the respondents provide a comprehensive and representative view of the Malaysian construction industry. Before conducting the semi-structured interviews, specific criteria for respondents have been established. This research targets experienced project managers exclusively. Respondents must have a minimum of 5 years of experience in project management to ensure that insights are derived from experts with practical knowledge and experience in adopting digital tools in their practices. This criterion aims to capture accurate and detailed information, enriching the comparative analysis of traditional and digitally enabled project management approaches. Table 1 provides a detailed breakdown of the educational qualifications of the 7 interviewees who participated in the qualitative research.

Notably, more than half of the interviewees possess a bachelor's degree, with 3 of them also holding a master’s degree. Most participants interviewed for this research have extensive experience in the construction industry, with 16 to 20 years of experience being the most common. Specifically, 2 interviewees fall within this category. Additionally, there are 2 interviewees with 6 to 10 years of

experience, 2 with 11 to 15 years of experience, and 1 with 21 to 25 years of experience in the industry.

Table 1. Profile of interviewees.

No.	Position	Level of Education	Years of Experience in Project Management
001	BIM Manager	Degree	7
002	Director	Master	27
003	Project Manager	Degree	15
004	Project Manager	Master	20
005	BIM Manager	Degree	11
006	Project Manager	Master	18
007	Project Manager	Degree	6

3. Results and Discussion

3.1. Current application of digital tools in project management phases

Out of the seven interviewees, it was found that all expressed their awareness of the potential for implementing digital tools in project management practices within the construction industry. Due to these reasons, a variety of digital tools have been utilised in their past projects. Some projects combine multiple digital tools, such as BIM Software and Digital Twin, as well as BIM Software and Sensor-Based Monitoring. For the category of usage of BIM Software and Virtual Reality (VR) and Augmented Reality (AR), each has one interviewee. The combination of BIM Software and Digital Twin consisted of 2 interviewees with experience in the said category.

Lastly, three interviewees had experience combining BIM Software and Sensor-Based Monitoring in their previous projects. The primary technologies, including BIM Software, were used in the Planning Design Execution phase. VR, AR, Digital Twin and Sensor-Based Monitoring were used in the Planning Execution Monitoring phase. Generally, all interviewees believed that digital tools were beneficial in improving their management tasks. This is consistent with previous researchers who highlighted its significance in construction projects. For instance, Harris and Lee [25] and Evans [30] stated that it reduces the risk of lost or misplaced paperwork and ensures quick retrieval of project-related documents.

This situation will then help reduce the risk of errors and delays and ensure that project stakeholders have access to the information they need when needed [39]. Others give stakeholders real-time access to project updates, timelines, and milestones, promoting transparency and accountability throughout the project lifecycle [29]. This helps to ensure that all stakeholders are informed and engaged throughout the project, reducing the risk of misunderstandings and delays [26]. Overall, they acknowledged the significance of these tools in their previous projects. Despite their awareness of these tools, there is uncertainty regarding the extent to which they are being implemented in their projects (see Fig. 1).

3.2. Challenges in implementing digital tools

The five interviewees expressed that they faced no issues in learning and using digital tools. The learning process for them was smooth. However, two interviewees shared that it was very challenging to understand deeply as it was too technical, especially at the senior level. This is consistent with previous case studies where it is found that workers who are considered senior age compared to others in the company have difficulty with the current shift towards the implementation of digital era technologies. Interviewees conveyed that an open mindset is essential while learning digital tools.

People who resist change will either continue to complete work in the same manner or keep their current method, and they will never improve. It will not be difficult to pick up the basics if done step by step and with continuous practice. Figure 1 presents the interviewees' viewpoints concerning the challenges faced in implementing digital tools for project management practices in the industry. The interviewees stated that five main issues cause low adoption rates of digital tools: cost, time, technical integration, human resources, and change management.

Under the theme of cost, companies are faced with financial constraints, including high upfront costs for software and hardware acquisition, ongoing maintenance and subscription fees, and budget limitations [21, 40]. Advanced software would require specialised computers with a high level of processing power, and this indeed needs a bigger financial fund to achieve the purpose effectively. These cost-related challenges can hinder the adoption of digital tools, particularly for smaller firms operating with limited financial resources [41]. Training employees in attending software courses has become one of the constraints faced by project management companies. External trainers and a few employees are required to attend IT training to become familiar with the software.

Time emerges as another significant theme, with companies encountering implementation delays due to lengthy procurement and deployment processes, time required for employee training and adoption, and potential disruptions to ongoing projects during the transition phase. Integrating digital tools is not instantaneous [42], and companies must carefully manage their timelines to minimise disruptions and ensure a smooth transition. Technical Integration poses challenges such as difficulties integrating new digital tools with existing systems and software, lack of standardisation, and inconsistent file formats [22].

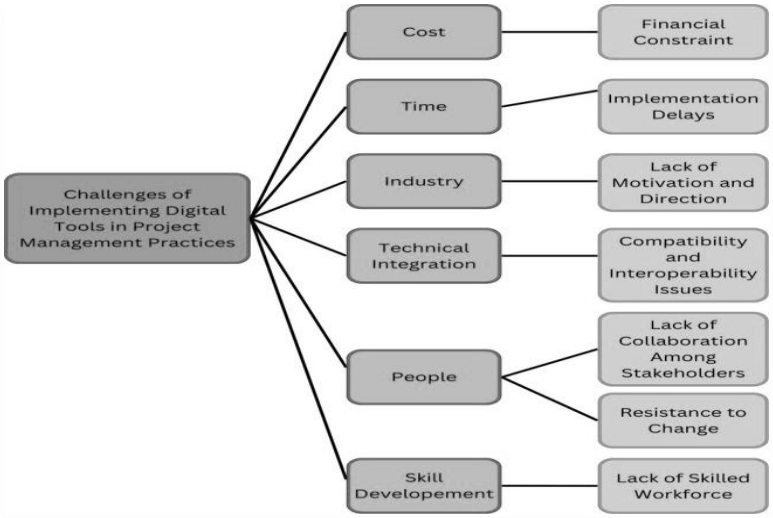

Fig. 1. Summary of the challenges in implementing digital tools.

Ensuring compatibility and interoperability among various digital tools and legacy systems are significant hurdles companies must overcome to fully leverage these technologies' potential benefits. People-related challenges, which refer to human resources and change management, are also prevalent. These include factors such as lack of buy-in from senior management or leadership, lack of stakeholder collaboration, reluctance to adopt new technologies and processes, difficulty changing established organisational cultures and mindsets, and senior employees' difficulties adapting to digital tools [43].

These challenges highlight the importance of change management, effective communication, and fostering a digital-friendly organisational culture. Companies also face challenges related to a shortage of employees proficient in using digital tools, insufficient training and upskilling programs, difficulty attracting and retaining skilled digital talent, and the absence of relevant courses in universities, leading to fresh graduates being deficient in required skills. Addressing these skill gaps and providing comprehensive training and development opportunities are crucial for successful digital tool implementation.

The theme of Industry also presents challenges related to the lack of initiative and motivation from both the consultant and contractor sectors and the absence of targets or directives to push employees towards digital transformation. This is because construction has been ranked as one of the most targeted industries that pose cybersecurity threats [44]. Moreover, some software imposes accessibility restrictions on part of the information, reducing the usability of its features. According to Van Tam et al. [32], a lack of industry-wide momentum and direction can impede the adoption of digital tools and hinder the overall digital transformation of project management practices within the construction sector.

3.3. Strategies for enhancing the utilisation of digital tools in project management practices

The potential strategies to overcome challenges faced in implementing digital tools in project management practices in the Malaysian construction industry are presented in Fig. 2. All seven interviewees prefer to use digital tools in their future projects for project management practices. This overwhelming preference for digital tools over traditional methods highlights the recognition of the potential benefits and advantages that these tools offer within the construction industry. Nevertheless, some areas should be taken into consideration.

The proposed strategies highlighted by interviewees can be categorised into seven main themes: collaboration/partnership (001, 002), individual project management (002, 003, 004), industrial expert (002, 005), policymakers (001, 002, 003, 004, 005, 006, 007), project stakeholders (005, 006), professionals/top management (001, 002, 003), and government agencies (003, 004, 005 and 007). Under the theme of *collaboration/partnership*, the strategies suggested involving providing financial support and exploring collaborative funding models. For Small and Medium-sized Enterprises (SMEs), which often face financial constraints, the government's financial assistance can be crucial in reducing the costs associated with setting up digital tools, including hardware and software [45, 46].

Minimising the cost of equipment through initiatives such as public-private partnerships and collaborative funding models can further alleviate the financial burden on construction firms [47]. The importance of top management buy-in and leadership commitment is highlighted in the theme of individual project management. Previous studies found that technology adoption would slow down if people were not passionate and afraid to take risks [48]. Besides that, implementing digital tools requires a cultural shift within organisations, and strong leadership is essential to drive this change. Additionally, implementing a pilot project can help demonstrate digital tools' benefits and best practices, fostering a more conducive environment for their adoption.

The theme of *professionals or top management* emphasises the need for skill development and training. Employing professionals to provide demonstrations and hands-on practice can enhance employees' digital tool proficiency [49]. Furthermore, offering training and education programs for industry players, whether through companies sending staff to workshops or centralised knowledge-sharing platforms, can contribute to building a skilled workforce capable of leveraging digital tools effectively. Nikas et al. [50] shared a similar finding, in which 285 organisations of all sizes revealed that the commitment of top management to employees' training and skills development is a key factor affecting the adoption of information technology.

These findings are also similar to those of previous studies [51]. Under the theme of *Industrial expert*s, strategies such as collaborating with technology providers and industry experts can facilitate knowledge sharing and dissemination [29]. By tapping into the expertise of technology leaders and industry veterans, construction firms can gain valuable insights and best practices for digital tool implementation [52]. According to CIDB [53], partnerships with technology providers have been shown to accelerate digital adoption by providing access to cutting-edge solutions and expert guidance. These collaborations can provide practical guidance and support, helping firms navigate the complexities of digital transformation.

The theme of *policymakers* highlights the role of policy support and financial incentives. Allocating budgets and providing policy support for companies to implement digital tools can encourage adoption [54]. Additionally, making the use of digital tools mandatory for large construction projects or lowering the project value threshold for mandatory adoption can drive the industry toward embracing these technologies. Regarding the theme of *project stakeholders*, software standardisation and version and file format standardisation across the industry are proposed. Ensuring compatibility and interoperability among digital tools can streamline processes and enhance collaboration among project stakeholders [55].

According to BREEAM [56], standardisation of software and file formats is essential for achieving interoperability and maximising the benefits of digital tools in construction projects. The industry can create a more integrated and efficient digital ecosystem by standardising software and file formats. Finally, under the theme of *government agencies*, government agencies should prepare a roadmap and guidelines since the Malaysian construction industry is still new to technology adoption like BIM. These resources can be a reference for firms navigating the digital transformation journey, ensuring a structured and informed approach [57]. For instance, a report by the RICS [58] emphasises the importance of having a clear BIM adoption roadmap and guidelines to ensure successful digital transformation in the construction industry.

4. Conclusions

The current application of digital tools in the Malaysian construction industry in project management practices is still moderately low. Through a rating system to obtain results of the current application of digital tools in the Malaysian construction industry, all interviewees rated below Six out of ten. Large construction firms in the construction industry have started utilising digital tools in their projects for the past few years. Projects such as MRT2 Putrajaya Line, Sunway Geo Avenue, and Temerloh Court are examples of projects implementing digital tools in Malaysia.

However, the implementation of digital tools in small and medium-sized enterprises (SMEs) is still low because there are obstacles that prevent them from entering the realm of digitalisation [59]. Despite the interviewees acknowledging the advantages of implementing digital tools in project management practices (i.e. Enhanced Collaboration, Mitigate risk, Cost Saving and improved Productivity), there are challenges in implementing digital tools in project management practices as follows These include financial constraints, and lack of motivation and direction, compatibility and interoperability issues, lack of collaboration, resistance to change, lack of skilled workforce.

Thus, the interviewees proposed a total of fourteen distinct strategies, which are financial assistance, minimise the cost of equipment, collaborative financing and resource sharing, organisational culture and leadership, gradual implementation, incentives and rewards, employee skill development, knowledge dissemination, policy support and financial incentives, existing provision amendment, software standardisation, training services and education, strategic planning, provide reference and guideline note. Future research should employ strategies to increase participant engagement. Sending multiple follow-up emails or reminders can encourage participation.

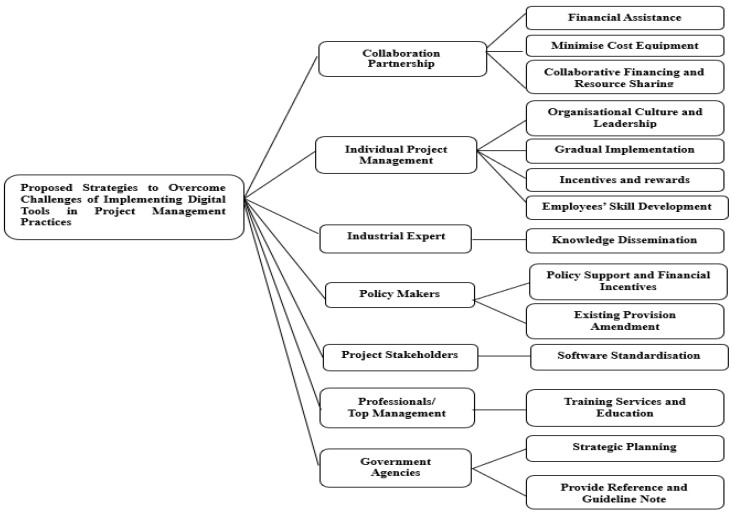

Fig. 2. Strategies for enhancing the utilisation of digital tools in project management practices.

Utilising professional networks, industry associations, and social media platforms to reach a broader audience and emphasise the importance of the research can also improve response rates. Besides that, conducting longitudinal studies can help observe changes and impacts over a more extended period, providing more comprehensive insights into the long-term benefits and challenges of digitalisation. A comprehensive view can also be gained by expanding the sampling frame to include various types of construction projects, ranging from small residential to large commercial and industrial projects.

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