Available online at
http://journal.uitm.edu.my/ojs/index.php/BEJ

e-ISSN: 2637-0395

Built Environment Journal Vol. 21 (Special Issue) 2024, 59 – 69.

Built Environment Journal

# Digitalisation Adoption toward National Construction Policy 2030 in the Malaysian Construction Industry

Cornelia Jasmine Anak Sajat[1*], Har Einur Azrin Baharuddin[2] , Fitriyadi Ghazali[3]

[1]*Undergraduate, Centre of Studies for Quantity Surveying Universiti Teknologi MARA, 48050 Shah Alam, Selangor*
[2]*Centre of Studies for Quantity Surveying Universiti Teknologi MARA, 48050 Shah Alam, Selangor*
[3]*Civil & Structural Engineer, Facility Management, Sarawak Energy Sdn. Bhd., 93050 Kuching, Sarawak, Malaysia*

ARTICLE INFO

*Article history:*
Received 26 July 2024
Revised 30 August 2024
Accepted 30 August 2024
Online first
Published 30 September 2024

*Keywords:*
Digitalisation adoption
Digitalisation transformation
Consultant firms
NCP2030

*DOI:*
10.24191/bej.v21iSI.2446

ABSTRACT

The National Construction Policy 2030 (NCP2030) serves as a cornerstone for fostering sustainable development in Malaysia by 2030. However, the Malaysian construction industry encounters obstacles in embracing digitalisation, including a lack of knowledge, resistance to change, and contradictory research findings. This research aims to investigate the readiness of the Malaysian construction industry to adopt digitalisation in construction aligned with the NCP2030. The objectives of this research are to identify the readiness of Malaysian consultant firms to adopt digitalisation in their construction process and to explore the challenges of digitalisation adoption in the Malaysian construction industry. Furthermore, to examine the way forward of Malaysia's construction toward digitalisation transformation. This study employed a simple random sampling survey as a research instrument with a total of 35 respondents replying to the survey and was analyzed through IBM Statistical Package for Social Sciences (SPSS) statistics (Version 29). The findings reveal a moderate level of readiness in the Malaysian construction industry, aligned with the NCP2030. Despite facing challenges, such as resistance to change, the industry demonstrates a proactive commitment by providing digital literacy training and embracing digital tools. In addition, most consultant firms are now using various digitalisation strategies in their work process, including Internet of Things (IoT) and Data Analytics in their projects. This commitment is exemplified by the industry's quick adoption of digital technologies, ranging from basic software to advanced solutions. It is significant for the project personnel to utilise digital tools to promote sustainable and efficient construction practices.

[1*] Corresponding author. *E-mail address*: corneliasajat@gmail.com
https://doi.org/10.24191/bej.v21iSI.2446

## INTRODUCTION

The construction industry in Malaysia, like many others globally, is undergoing a shift towards digitalisation. The implementation of NCP2030 underscores the importance of digitalisation in enhancing the industry's efficiency, sustainability, and competitiveness, aligning with Malaysia's economic development goals, which the government emphasis the importance of digitalisation in driving the efficiency and growth of the construction industry. It aligns with the Twelfth Malaysia Plan (RMK12), which is related to and complements each other in creating a better path and driving the Malaysian construction industry towards sustainability and economic growth by 2030. RMK12 establishes the overall structure for national development, whereas NCP2030 focuses more on shifting the construction industry to comply with broader objectives and goals. The RMK12 emphasises the future of all industries and the construction industry regarding digitalisation (RMK12 (BM), 2021). As stated in the NCP 2030, the Malaysian Government did acknowledge that the construction sector can significantly enhance the economic growth and strives to follow the nations like China and Japan in terms of development growth. They believe this policy would align Malaysia's construction industry with the NCP2030 by moving it into the digitalisation era (Shakirah, 2023). Despite the policy's emphasis on digitalisation, challenges hinder its adoption, including a lack of knowledge and awareness of digitalisation technology, refusal to change, and contradictory research results. According to the research conducted by Nicole and Low et al. (2021), it was discovered that many of the key players in Malaysia's construction industry are less familiar with the importance of digitalisation due to a lack of knowledge on the adoption of digital technology (IR4.0) in a construction project. This statement was further supported by Phil Hart (2022). He advocated that most construction firms are prone to implement a conventional way of completing their work, such as by adopting Excel sheets, physical A3 drawings, and clipboards just to manage all the construction projects. Osunsanmi et al. (2018) also stated that the construction industry has been slow in implementing a technological advance, which is digital technology, compared to other industries, which implies that the construction industry has a low adoption of digital technology. This study aims to investigate the readiness of Malaysia's construction industry to adopt digitalisation and align with the NCP2030, focusing on consultant firms professionals in various discipline such as architects, engineers, and quantity surveyors. The objectives include identifying the readiness of Malaysian consultant firms to adopt digitalisation in their work construction process, exploring the challenges in adopting digitalisation in construction in Malaysia and examining the way forward of Malaysia's construction toward digitalisation transformation.

## LITERATURE REVIEW

### National Construction Policy 2030 (NCP2030)

The Malaysian construction industry is acknowledged at a low level on the technological development. Therefore, the government introduced and developed a National Construction Policy 2030 to digitalise and evolve the Malaysian construction industry, which was believed to be one of the drivers to achieve the Shared Prosperity Vision 2030 (WKB2030). In addition, it led to the introduction of the NCP2030 policies that were published as a key reference model to have more sustainable development by 2030. Nine (9) pillars of IR4.0 were introduced in the NCP2030 and these nine (9) pillars of IR4.0 will guide the construction key players in implementing the digital technologies. This pillar contains Data analysis, Augmented reality, the Internet of Things, Cloud computing, 3D Printing, Cybersecurity, System integration, Virtual simulation, and robotic automation. The Internet of Things is the type of tool that can be implemented in construction work just to increase the quality of the construction process (Santos and Assayag, 2022). Data analytics is a procedure that transforms unprocessed data into more valuable information from various techniques like data mining and predictive modeling (Coursera, 2023). According to Berryman (2021), Augmented reality is a tool or technology that superimposes digital transformation into a real-world object or location to enhance user experience. As stated by Mashable (2014), 3D printing is a

https://doi.org/10.24191/bej.v21iSI.2446 

manufacturing procedure that can create a complex and large geometries in a 3D form from a 3D computer-aided design without the help of any instrument and fixtures. Cloud computing is a tool that let the user to have access to computation, storage and data services which this tool will move service, computation and data for cost and business advantages (Singh, 2019). As stated by Ajankar and Nimodiya (2021), Cyber security is software that acts as a safeguard to protect computer systems and networks against information disclosure, theft, or damage to the hardware, software, and electronic data. Virtual simulation is a powerful learning tool that utilises specialised hardware and software technology to provide simulation-based training (Foronda, 2021). According to Vasava and Joshi (2023), implementing robotic automation in the construction industry offers many benefits, including enhanced worker safety, improved quality, and cost-effectiveness, and increased productivity and job efficiency. Another reason this NCP2030 is developed is to change or improve the challenges in changing the future of Malaysia's construction industry as well as the megatrends in the industry.

**Digitalisation in Construction in Malaysia**

Based on Merriam-Webster, digitalisation is the transformative process of converting information into a digital format. Currently, Malaysian construction is still in digitalisation transformation as the government has introduced a new policy, the National Construction Policy 2030, which aims to digitalise the Malaysian construction industry (Shakirah, 2023). Even though the Malaysian construction industry is moving towards digitalisation transformation, implementing digital technologies in Malaysia has been slower (Roslan, Baslan, & Safura, et al, 2020). As stated by Nurul & Mohammad (2022), the Malaysian construction industry was still in the medium range in implementing IR4.0 to the construction works. Due to the COVID-19 outbreak, the industry was impacted and experienced a slow pace in digitalisation transformation. The study carried out by Alaloul et al. (2020), which did revealed a significant gap in Malaysia regarding the understanding of digital transition in the construction industry, which causes digitalisation is still now common in the Malaysian construction industry finding found that 53% of respondents are unfamiliar with the adoption of IR4.0 within the construction sector and 41% of the respondents are contractors. Hence, the government's efforts in transforming the construction industry are crucial, as modern strategies offer undeniable benefits to the construction lifecycle, industry, and economic growth. However, transitioning to Digitalisation is complex and requires a deep understanding of digital technologies. Over the past years, a lot of efforts have been made by the government to slowly transform the construction industry into a construction digitalisation such as the CIDB short-term plan which is the Construction 4.0 (CR4.0), as well as the new policy, NCP2030 (Shakirah, 2023). The transformation the government is working on is highly relevant because the modern strategy has an undeniable benefit to the construction life cycle, the construction industry, and the economic growth of the country. Even so, transforming the construction industry's current state into digitalisation will be complicated as digital transformation requires a thorough understanding of digital technology before the construction industry can be implemented.

**Challenges of Digitalisation Adoption**

According to Arifin et al. (2022), a digital transformation will surely impact the construction industry. However, the findings stated that construction has a much slower pace in adopting digitalisation tools than in any other industry (Ariffin et al., 2022). In this construction digitalisation era, Building Information Modeling (BIM) is a digital tool currently improved and popular among the construction industry. Adapting to the new changes through transforming into the digitalisation construction is not easy for the construction industry. However, according to Lat et al. (2021), many construction firms and professionals have gradually embraced the concept of IR4.0 since the covid outbreak pandemic. To elaborate, due to the outbreak of COVID-19, some construction firms have disrupted traditional construction practices since they tried to seek more innovative ways of doing work. Even so, the construction industry still faces challenges and barriers in using more innovative digitalisation tools in their construction process, leading to slow

https://doi.org/10.24191/bej.v21iSI.2446 

improvement. This can be proven by the statement made by Alaloul (2018), who found that the industry has seen insufficient improvements and has remained almost flat for the past 5 decades. The challenges faced by the stakeholders of the construction industry mostly are insufficient training and reskilling, lack of skilled workforce, resistance to change, high cost, limited awareness of the digitalisation tools, data security concerns, the top management commitment, lack of infrastructure, and legal and legal contractual uncertainty. Therefore, when wanting to transform to digitalisation construction or adopt digital technologies in construction, all these barriers and challenges need to be acknowledged so that the industry can find a way to overcome them.

## METHODOLOGY

The research methodology employs a quantitative approach through a questionnaire survey distributed among consultant professionals, which include Quantity Surveyors, Engineers, and Architects in Malaysia. Questionnaires were sent and distributed through Google form links via various communication mediums such as social media platforms, emails, and phone calls. The questionnaire comprises 4 sections to gather demographic information, assess awareness and understanding of digitalisation concepts, explore adoption challenges, and identify future strategies. Secondary data is gathered from sources such as journal articles and published papers to support the primary data analysis. The population sampling based on simple random sampling were focused on consultant professionals in Malaysia. Hence, data analysis is conducted using IBM SPSS Statistic (version 29) to analyse the data gathered. The Likert scale is utilided to indicate respondents' agreement and understanding of the variables for every objective of the study. This survey was distributed to a total of 388 professionals registered with the professionals' bodies, which lasted for 3 weeks. However, due to the time constraint and limitation to reach the respondents individually, only 35 gave their feedback, which is considered a relatively low response. Moreover, these respondents primarily concentrated in Klang Valley and Sarawak. Noting that, certain firms cited a policy against participating in student's survey. Which contributed to an even lower response rate.

## ANALYSIS AND FINDINGS

### Respondent Involved in the Study

The survey was distributed to 388 consultant professionals. This professional was identified through professional bodies' websites such as Board of Engineers Malaysia, Board of Quantity Surveyors Malaysia, and Board of Architects Malaysia. However, only 35 responded to the survey, making the completion rate 9.02%. As stated in Table 1, most respondents involved 51% Quantity Surveyors, 26% Architects, 11% Engineers, 6% Designed Coordinators, and 3% respectively for Planner and Draughtman. The respondents' average age was 25 – 34 years old.

Table 1. Role of the respondent in the firm

| Role of respondent in the firm | Percentage |
|---|---|
| Architect | 26% |
| Engineer | 11% |
| Quantity Surveyor | 51% |
| Designed coordinator | 6% |
| Planner | 3% |
| Draughtman | 3% |

https://doi.org/10.24191/bej.v21iSI.2446 

## Awareness and Familiarity of the NCP 2030 Concept

Table 2 shows the various digitalisation tools have been listed based on the 9 Pillars of IR4.0, as stated in the NCP2030. The survey utilised a Likert scale to assess the respondents' level of awareness regarding the influence of digitalisation tools. According to the table below, it is evident that the data analysed pertains to the respondents' level of awareness regarding the impact of digital tools on the construction process.

Table 2. Mean score and Standard Deviation of the Awareness of the influence of the 9 Pillars of IR4.0 concept on the Construction Process

| Digitalisation Tools | Mean | Standard Deviation | Rank |
|---|---|---|---|
| Data Analytics | 3.51 | 2.24 | 4 |
| Augmented Reality | 3.14 | 2.00 | 7 |
| Internet of Things | 3.83 | 2.44 | 2 |
| Cloud Computing | 3.54 | 2.26 | 3 |
| 3D Print | 3.34 | 2.13 | 6 |
| Cybersecurity | 3.51 | 2.24 | 4 |
| System Integration | 4.08 | 2.60 | 1 |
| Virtual Simulation | 3.40 | 2.17 | 5 |
| Robotic Automation | 3.40 | 2.17 | 5 |
| Grand Total | 31.77 | 20.27 | |

The results reveal that respondents have varying levels of awareness regarding the influence of digitalisation tools on the construction process. System Integration emerges as the most familiar tool, with a mean score of 4.08, indicating moderate awareness among participants. System integration is the detailed process of ensuring all systems' components function seamlessly. This method is critical for effectively executing projects (Whyte & Davies, 2021). In other words, it is an intricate process of combining two (2) or more systems or components into a unified, cohesive system that operates as a single entity (Harisson, 2023). From a construction perspective, system integration is the process of developing sophisticated information systems that involves various tasks like designing or constructing a tailored architecture application, integrating it with new or existing hardware, and establishing an effective communication channel. Hence, to maintain the strong focus on project outcomes or objectives.

Moreover, utilising diverse software and hardware systems further adds to the intricacy of the construction process (Shen et al., 2010). Based on the outcome from the findings, it is believed that system integration tools could support the entire project planning from operation to maintenance. This could be achieved because all the data and information have been loosely integrated using software agents and web service technologies.

The second rank is IoT, with a mean score of 3.83. In this finding, IoT is the second highest in awareness and familiarity among the respondents. Ibrahim (2021) stated that the adoption of IoT in Malaysian construction is steadily improving. As technology rapidly evolves, the construction industry has been exposed to the latest advancement, including IoT which is a crucial component of Construction 4.0. Although Malaysia's adoption of IoT aligns with global technological trends, Ibrahim (2021) emphasised that continuous improvement is necessary to ensure the country's construction industry remains competitive on a global scale. The third rank in assessing awareness of digitalisation is Cloud Computing, with a mean score of 3.54. In the construction industry cloud computing was really important as it allows the construction process to have a good productivity and organisation and acts as the central repository for construction data (Bello et al, 2021).

https://doi.org/10.24191/bej.v21iSI.2446 

Conversely, Augmented Reality (AR) ranks lowest with a mean score of 3.14, suggesting limited awareness among respondents regarding its impact on construction likely due to its low adoption rate and ongoing research stage. According to Mascarenas et al, (2020), the slow adoption of AR technology can be attributed to factors such as high installation and maintenance cost, low confidence levels among decision makers and the construction community's familiarity with traditional visual inspection. Low adoption rates of AR tools in construction contribute to limited awareness among industry players.

## Challenges in Digitalisation Adoption

The challenges in digitalisation adoption were themed into five (5) main categories: Training and Skills, User Behaviour, Cost, Safety and Security, and Legal Issues. The data analysis reveals several challenges encountered by professional consultants during the adoption of digitalisation tools, as shown in Table 3.

Table 3. Mean score and Standard Deviation on the challenges encountered when adopting digitalisation

| Challenges | Mean | Standard Deviation | Rank |
|---|---|---|---|
| **1)** Training And Skills | | | |
| Insufficient Training And Reskilling | 3.46 | 2.21 | 8 |
| Lack Of Skilled Workforce | 3.69 | 2.35 | 6 |
| Limited Awareness On The Digitalisation Tools | 3.80 | 2.42 | 5 |
| **2)** Users Behavior | | | |
| Resist To Change Due To Overreliance On Conventional Way | 4.17 | 2.66 | 1 |
| Users Struggle To Comprehend The Complex Procedures And Outputs Of Digital Tools | 3.97 | 2.53 | 3 |
| Lack Any Digitalisation Planning From Top Management | 3.66 | 2.33 | 7 |
| **3)** Cost | | | |
| High Cost In Digitalisation Tools And Software | 4.03 | 2.57 | 2 |
| Budget Contraints | 3.86 | 2.46 | 4 |
| Lack Of Infrastructure | 3.43 | 2.19 | 9 |
| **4)** Safety And Security | | | |
| Data Security Concern | 3.17 | 2.02 | 12 |
| Complexity | 3.80 | 2.42 | 5 |
| Cyber Attacks | 3.29 | 2.10 | 11 |
| **5)** Legal Issues | | | |
| Legal And Contractual Uncertainty | 3.40 | 2.17 | 10 |
| Breach Of Privacy | 3.40 | 2.17 | 10 |

Based on the data gained, the challenges encountered by professional consultants during the adoption of digitalisation reveal, "resistance to change due to over reliance on conventional methods" as the primary obstacle, scoring a mean of 4.17. These challenges were categorised under "Users Behaviour". The finding shows that the primary obstacle that emerges is resistance to change due to overreliance on the conventional way. A substantial number of respondents choose this, impeding the sector's ability to fully embrace digitalisation. Most of the respondents resisted change due to their overreliance on the conventional ways of doing their tasks and the challenges they faced when using digital tools. Many people resist Digitalisation because they heavily rely on traditional work methods (Singh et al. 2022), resistance to change when using traditional technologies (Eze at al., 2023). This resistance suggests that most respondents are hesitant to

 

embrace digital tools due to their dependence on traditional approaches. Eze et al. (2023) emphasised that this resistance and unwillingness to embrace change have been primary issues in the construction industry, hindering the diffusion and adoption of innovative ideas, methods, and materials.

Despite the primary challenge posed by resist to change due to overreliance on conventional methods, the construction industry is still making a significant stride towards digitalisation. Also, the result indicated that the respondents are using a few elements highlighted in the IR4.0 to solve their work. Although a complete use of digital tools may not have been achieved, this still signifies a significant advancement for the construction sector as it moves towards a more digitally integrated construction. Nurul & Mohammad (2022) determined that the Malaysian construction industry was still in the medium range on the degree of implementing IR4.0 in construction works. The second rank belongs under "Cost" categories with the challenges that "high cost in digitalisation tools and software" with the mean score of 4.03. As using digital tools can be quite costly, it limits the application of digital tools and information systems in construction. Thus, hinder the construction industry ability to meet the modern requirements and standards upheld by advanced sectors (Jelodar & Shu, 2021). For construction organisations to make informed decisions about using digital tools, they need a systematic framework to evaluate the potential benefits and factors that contribute to successful implementation especially on the cost needed for the organisation to spend on the digitalisation. While there are costs involved in adopting these tools in the construction industry, there is also a growing recognition of their potential benefits. Therefore, it is crucial to conduct a thorough and methodical evaluation (Radman et al., 2021). The third rank in challenges in digitalisation adoption is "users struggle to comprehend the complex procedures and outputs of digital tools," with a mean score of 3.97. By adopting digital technologies to the work process, various benefits to the project life cycle could be held. However, the shortage of a skilled workforce is a factor that needs to be addressed to assist the country in achieving full digitalisation. Supported by Zabidin et al. (2019), with the rapid advancement and convergence towards IR 4.0, there is a pressing need for new talent, knowledge, and skills to meet the demands of the present and future workforce. In addition, Kamaruzaman et al. (2019) stated that technological modernisation had introduced numerous new job opportunities across all sectors, rendering current work practices inadequate. As such, developing sophisticated technology has revolutionised job practices and setting.

## Way Forward of Malaysia Construction towards Digitalisation

Digital literacy is important for professionals to ensure they can cope with the latest technology in their daily tasks. Therefore, the respondents were asked for their recommendations on better-using construction digitalisation, as stated in Table 4.

Table 4. Mean Score and Standard Deviation on the recommendation towards better use of construction digitalisation.

| Recommendations | Mean | Standard Deviation | Rank |
|---|---|---|---|
| 1) Digitalisation strategy and planning | | | |
| Industry players to commence by formulating a well-defined digitalisation strategy that delineates their objectives, priorities, and timeline for implementing digitalisation | 4.09 | 2.61 | 6 |
| 2) Technology literacy and training | | | |
| Invest in training and upskilling workforce to effectively utilise digital tools | 4.14 | 2.64 | 4 |
| Providing training facilities and outsourcing training for the optimal utilisation of digital tools | 4.09 | 2.61 | 6 |
| Invest in construction-specific software and tools that cater to the needs of the projects | 4.09 | 2.64 | 4 |
| 3) Technology approach | | | |
| Invest in BIM software as one of the powerful tools to optimise designing team works | 4.20 | 2.68 | 2 |

 

| | | | |
|---|---|---|---|
| Utilise data analytics and AI to antilock valuable insights into project performance, and optimise resource allocation | 4.11 | 2.62 | 5 |
| Ensure robust cybersecurity measures are in place to protect sensitive project data and systems | 4.09 | 2.61 | 6 |
| Utilise cloud-based platforms to facilitate real-time collaboration and document sharing among teams | 4.11 | 2.62 | 5 |
| Utilise cloud-based platform to improves communication and reduces errors among stakeholders | 4.11 | 2.62 | 5 |
| The utilization of AR and VR technologies assist in design reviews, training, and on-site visualisation | 4.00 | 2.55 | 8 |
| The use of drones for site surveying, progress tracking, and inspections (cost-effective and efficient way to gather data) | 4.00 | 2.55 | 8 |
| 4) Team sustainability and stakeholder collaboration | | | |
| Utilise digital tools to enhance resource utilisation, minimise waste and make environmentally friendly choices in construction processes | 4.29 | 2.73 | 1 |
| Having long term planification and digital planning | 4.06 | 2.59 | 7 |
| Promote effective collaboration among all project stakeholders, encompassing contractors, architects, and subcontractors (to ensure everyone is on the same page) | 4.11 | 2.62 | 5 |
| Continuously assess the impact of digitalisation and remain receptive to implement enhancements based on the data and feedback | 4.17 | 2.66 | 3 |
| Enhance efficiency in acquiring permits and licenses for construction projects by utilising digital technology | 4.11 | 2.62 | 5 |
| Stay informed about any government initiatives and policies related to construction and digitalisation | 4.11 | 2.62 | 5 |
| Grand Total | 69.89 | 44.62 | |

The data gained from the respondents' agreement regarding the recommendations that could be made to enhance the adoption of digitalisation in construction. The first rank is to utilise digital tools to enhance resource utilisation, minimize waste, and make environmentally friendly choices in the construction phase. A study by Jemal et al. (2023) reveals that European countries have identified best practices and digital tools for construction and demolition waste management, which can serve as examples for other nations. Malaysian construction would benefit from adopting these practices, propelling it towards digitalisation and improving its overall efficiency. The second rank is related to investing in BIM software as one of the powerful tools to optimise designing teamwork. As BIM is one of the widely used digital technologies in construction, these technology capabilities offer an exchange of data features for the BIM models, and the other advantages for the organisation in construction are rarely used. Sinenko, Poznakhiko, and Amir (2021) specified that most construction firms implementing BIM in their works mainly work on digital technologies related to 3D models. The third rank is regarding "continuously assessing the impact of digitalisation and remaining receptive to implement enhancements based on the data and feedback." It assesses the extent to which construction firms in Malaysia are embracing digitalisation and supporting the staff's digital literacy development. The findings indicate that while most respondents acknowledge the importance of digital tools, only a few firms have fully integrated them into their work processes. The data results indicate that the Malaysian construction industry has made significant strides in aligning with the National Construction Policy 2030, demonstrating a collective eagerness to embrace digitalisation of construction.

## CONCLUSION

The construction industry in Malaysia exhibits moderate readiness for digitalisation, as evidenced by its proactive stance towards embracing digital technologies. It is aligned with the objectives outlined in the NCP2030. Despite facing challenges such as resistance to change, the industry demonstrates a strong commitment to overcoming these hurdles through investments in digital literacy training and the gradual

https://doi.org/10.24191/bej.v21iSI.2446 

adoption of digital tools. The high level of awareness and positive progress in implementing digital solutions, from basic software to BIM and cloud-based solutions, indicate a promising path towards a technologically integrated future. While there are obstacles to address, the data strongly suggests that the construction industry in Malaysia is on track toward digital transformation in line with the NCP2030 objectives. Challenges, particularly resistance to change, indicate obstacles to face. However, it is important to note that these hurdles are manageable. The industry's proactive approach in investing in digital literacy training and gradually adopting digital tools is a strong commitment to overcoming these hurdles and propelling a more technologically integrated future. This research has shown that the construction industry in Malaysia has been quick to embrace digitalisation in construction, and this trend has been in great momentum. In conclusion, this study emphasises crucial recommendations for moving forward with the digitalisation of Malaysia's construction firms. By implementing these recommendations, the Malaysian construction sector can be propelled towards a more technologically integrated and sustainable future, which will align with the policy and aim of the NCP2030.

## RECOMMENDATION

This study has accomplished all of its objectives. However, future research studies could include several other topics that offer significant benefits. One recommendation for future study is to explore how the consultant's professional experience using digitalisation tools in their work process. It would be very valuable to investigate how the usability and user-friendliness of the digitalisation tools that were aligned with the NCP2030 impact their implementation and the effectiveness across various roles and positions of the Consultants in the construction industry, such as Architects, Engineers, Quantity Surveyor, et al.

Furthermore, to delve into this topic, this study should explore the level of readiness of the construction industry towards digitalisation in line with the NCP2030, including the perspectives of both the contractors and consultant professionals. By considering the perspectives of both the contractors and consultant professionals involved in the execution of construction projects, the study may gain a better and more accurate understanding of the industry's readiness to walk towards the digitalisation of construction.

## ACKNOWLEDGEMENTS/FUNDING

The authors would like to acknowledge the support of Universiti Teknologi Mara (UiTM), Cawangan Shah Alam, Studies of Quantity Surveying, College of Built Environment, Universiti Teknologi MARA Shah Alam, Selangor, Malaysia for providing the facilities and financial support on this research.

The authors also would like to express the deepest thanks to all the participants who willingly took part in the study. Their involvement and contribution have made this research possible, and their willingness to share their insights and experiences has enriched the findings of this study.

## CONFLICT OF INTEREST STATEMENT

As the authors of this study, we acknowledge that completing scholarly work requires transparency and integrity. We also agreed that none of the authors have benefited financially from any organizations and companies involved in this research. Furthermore, none of the authors have any connection that would prejudice the research study's results. Although few authors are affiliated with a construction company in Malaysia, this did not influence the study's integrity. Consequently, there was no possibility of bias during the research process, ensuring the study's credibility.

 

## REFERENCES

Ajankar, S. S., & Nimodiya, A. R. (2021). Cyber Security : Techniques and Perspectives on Transforming - A Review. *International Journal of Scientific Research in Science and Technology*, 473–480. https://doi.org/10.32628/ijsrst218670

Alaloul, W. S., Liew, M. S., Zawawi, N. a. W. A., & Kennedy, I. B. (2020). Industrial Revolution 4.0 in the construction industry: Challenges and opportunities for stakeholders. *Ain Shams Engineering Journal, 11*(1), 225–230. https://doi.org/10.1016/j.asej.2019.08.010

Berryman, D. (2012). Augmented Reality: a review. *Medical Reference Services Quarterly, 31*(2), 212–218. https://doi.org/10.1080/02763869.2012.670604

Bello, S. A., Oyedele, L. O., Akinade, O. O., Bilal, M., Delgado, J. M. D., Akanbi, L. A., ... & Owolabi, H. A. (2021). Cloud computing in construction industry: Use cases, benefits and challenges. *Automation in Construction, 122*, 103441. https://doi.org/10.1016/j.autcon.2020.103441

Coursera. (2023). Data Analytics: definition, uses, examples, and more. Coursera. https://www.coursera.org/articles/data-analytics

Eze, E. C., Sofolahan, O., & Omoboye, O. G. (2023). Assessment of barriers to the adoption of sustainable building materials (SBM) in the construction industry of a developing country. Frontiers in Engineering and Built Environment, 3(3), 153-166. Fah, C. C., Phui, F. W., & Felicia, Y. (n.d.). DIGITALISATION OF THE CONSTRUCTION INDUSTRY: ARE WE READY? ResearchGate. Conference: PAQS 23rd Congress, Kuching, Sarawak, Malaysia. https://doi.org/10.1108/FEBE-07-2022-0029

Ibrahim, F. S. B., Esa, M., & Rahman, R. A. (2021). The adoption of IOT in the Malaysian construction industry: Towards Construction 4.0. *International Journal of Sustainable Construction Engineering and Technology, 12*(1). https://doi.org/10.30880/ijscet.2021.12.01.006

Jemal, K. M., Kabzhassarova, M., Shaimkhanov, R., Dikhanbayeva, D., Turkyilmaz, A., Durdyev, S., & Karaca, F. (2023). Facilitating circular economy strategies using digital construction tools: framework development. *Sustainability, 15*(1), 877. https://doi.org/10.3390/su15010877

Lat, D. C., Noor, S. N. a. M., Rahman, N. S. A., & Razali, R. (2021). Construction industry towards IR 4.0-A review. Nucleation and Atmospheric Aerosols. https://doi.org/10.1063/5.0044217

Lee, N. C. K., Chen, N. M. S., Zainudin, N. N. M., Fauzi, N. M. A., & Toh, N. T. C. (2022). TRANSFORMATION OF INDUSTRIAL REVOLUTION 4.0 IN THE CONSTRUCTION INDUSTRY: UNDERSTANDING DRIVERS & BARRIERS WITH DEMATEL ALGORITHM. *International Journal of Industrial Management, 16*(1), 31–43. https://doi.org/10.15282/ijim.16.1.2022.9010

Mashable. (2014, May 8). What is 3D printing and how does it work? | Mashable explains [Video]. YouTube. https://www.youtube.com/watch?v=Vx0Z6LplaMU

Mann, K. (2021, September 9). Digitization of the Construction Industry. Linkedln. https://lnkedin.com/pulse/digitization-construction-industry-kerry-mann

Nicole, W. Z. Y., Lee, W. W., Wong, S. Y., & Wong, K. S. (2022). IMPACT OF PERFOMANCE AND BARRIERS TOWARDS INDUSTRIAL REVOLUTION 4.0 IMPLEMENTATION IN MALAYSIAN CONSTRUCTION PROJECTS. *Malaysian Journal of Sustainable Environment*, Vol9.No1 (2021) 243-266. https://doi.org/10.24191/myse.v9i1.17302

Nurul, I. S., & Mohamad, T. I. (2022). Industrial Revolution 4.0 (IR4.0) Readiness Among Industry Players: A systematic literature review. *Artificial Intelligence and Applications*. https://doi.org/10.47852/bonviewAIA2202336

 

Radman, K., Jelodar, M. B., Lovreglio, R., Ghazizadeh, E., & Wilkinson, S. (2022). Digital technologies and data-driven delay management process for construction projects. Frontiers in Built Environment, 8. https://doi.org/10.3389/fbuil.2022.1029586 Rankohi, S., & Waugh, L. (2013). Review and analysis of augmented reality literature for construction industry. *Visualization in Engineering, 1*(1). https://doi.org/10.1186/2213-7459-1-9

RMK12 (BM). (2021). https://www.ekonomi.gov.my/sites/default/files/flipping_book/RMKe-12/mobile/index.html

Roslan, A. F., Baslan, N., & Safura, N. (2020). Construction 4.0 to Transform the Malaysian Construction Industry. Construction Research Institute of Malaysia, 88.

Santos, R. S. D., & Assayag, E. S. (2022). INTERNET OF THINGS (IOT) APPLIED IN CONSTRUCTION INDUSTRY: A SYSTEMATIC REVIEW. International Journal of Engineering Technologies and Management Research. https://doi.org/10.29121/ijetmr.v9.i12.2022.1272

Shakirah, S. (2023, May 2). National Construction Policy (NCP 2030). CIDB HQ. https://www.cidb.gov.my/national-construction-policy-ncp-2030/

Shen, W., Hao, Q., Mak, H., Neelamkavil, J., Xie, H., Dickinson, J., ... & Xue, H. (2010). Systems integration and collaboration in architecture, engineering, construction, and facilities management: A review. *Advanced engineering informatics, 24*(2), 196-207. https://doi.org/10.1016/j.aei.2009.09.001

Sinenko, S., Poznakhirko, T., & Tomov, A. (2021). Digital transformation of the organization of construction production. E3S Web of Conferences, 258, 09020. https://doi.org/10.1051/e3sconf/202125809020

Singh, S. (2019). Cloud Computing : An Overview. International Journal of Scientific Research in Science, *Engineering and Technology*, 63–70. https://doi.org/10.32628/ijsrset196120

Whyte, J., & Davies, A. (2021). Reframing Systems Integration: A process Perspective on projects. *Project Management Journal, 52*(3), 237–249. https://doi.org/10.1177/8756972821992246