Digitalization Among the Quantity Surveyors: Strategies to Embracing the Change

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Abstract

Quantity Surveyors all around the world have been adopting digital technologies due to their tremendous benefits. However, digitalization among quantity surveyors in Malaysia is slow due to low technology adoption. Therefore, this study aims to identify the barriers to digitalization in the quantity surveying profession and recommend strategies to minimize those barriers. A quantitative approach was applied with questionnaires serving as the data collection instrument. The questionnaires were distributed to 671 registered quantity surveyors in Malaysia, which were obtained through the random sampling method. About 134 of the response received and the findings were analyzed using descriptive analysis. Findings revealed the top four categories of barriers are: (1) financial constraints (2) lack of education (3) technical inadequacy and (4) time restrictions. A total of 11 strategies were proposed to minimize the respective barrier to increase the adoption of digitalization. Findings from this study provide insight into the barriers faced by the QS in implementing digitization, which lead to the proposal of strategies to embrace the change. The proposed strategy can act as a foundation for QS to prepare themselves, upgrading and planning the suitable step to thrive in tomorrow's construction industry. The research has expanded the existing studies on digitalization in the quantity surveying profession, particularly in Malaysia, and assisted researchers, construction industry practitioners, and policymakers, especially in developing countries views.

Keywords: *digitalization, digital technologies, barriers, strategies, quantity surveying profession, quantity surveyor*

1. INTRODUCTION

The digital economy has revolutionized the industrial sector. Whether or not industry practitioners are aware of it, it produces significant upheaval in every industry (Lee, 2020). The construction industry is already evolving due to technological advancements. Many construction industries from developed-country have reacted to the disruption brought by the digital era (Radley, 2019). However, Koutsogiannis (2019) suggested that the construction industry's digitalization in terms of technological adoption is still in its infancy. Manyika *et al*. (2015) validated this point of view with their research showing that the construction industry was ranked second to last among other industries in the McKinsey Global Institute industry digitization index.

In the construction industry, quantity surveyors are construction experts who guarantee that the industry's resources are utilized to the greatest possible benefit of society. They advise clients, builders, and planners on the most cost-effective financing method for projects and offer cost-consulting assistance throughout the construction process (Reddy, 2017; RISM, 2020). Besides, quantity surveyors also assist in procurement management, and contractual administration matters throughout the entire project (Reddy, 2017). These work were eased by using the traditional office suite software (i.e., Word, PowerPoint, Excel, Explorer, and, Outlook) and later, the new norm technologies (i.e., BIM, IoT, drone, E-tender, etc.) (Ashworth, et *al*., 2013).

Recently, the quantity surveying profession has been transformed by digitalization, leading to better performance and resource utilization in the construction industry (Akinshipe, Aigbavboa, Oke and Sekati, 2021). According to Autodesk (2021), digitalization uses technology and digitized data to change the way people work, change how customers and organizations interact, and develop new income streams. It occurs when the processes are re-engineered based on everything that is already digitized. On the other hand, digitization only involves the transformation of atoms into bits and keeping actual data electronically, which is converting physical things into digital formats. Furthermore, digital technology is electronic instruments, equipment, systems, or resources that use the digits 0 and 1 to create, transmit, store, or process data in binary code (Zafar Anjum, 2021).

The quantity surveying profession can reap numerous benefits by incorporating digitalization into its service delivery (Akinshipe *et al*., 2021). For instance, using IT

software and tools can improve measurement accuracy (Reddy, 2017), implementing E-tendering can eliminate paper-based tender submissions (Baharin, 2020), the development of Building Information Modelling (BIM) can reduce the reliance on conventional drawings on paper (Yaakob *et al.*, 2016), Internet of Things (IoT) can be used to reduce issues with data sharing and communication (Mahmud *et al.*, 2018), and drone technology can replace physical site visits (Tkac and Mesaros, 2019).

Previous research has highlighted a slew of advantages associated with the introduction of digitalization in the quantity surveying profession. However, several studies have shown the uptake of digital technology such as BIM, IoT, drones, E-tendering, etc., by Malaysian quantity surveyors remains slow (Othman, 2018; Mahmud *et al.*, 2018; Lim, 2020). This situation indicates a lack of information that responds to the issue of why the quantity surveying profession has lagged in digitalization despite the advantages of digital technologies. Therefore, it is imperative to explore the barriers to implement digitalization in the Malaysian quantity surveying profession, followed by developing strategies to minimize those barriers.

2. LITERATURE REVIEW

2.1. Research gap

It is undeniable that the advancement of technologies has brought many benefits to the quantity surveying profession. However, it still poses challenges for quantity surveyors in their area of expertise, as automation will eventually take over their conventional roles (Sawhney, 2016; Tee and Kamal, 2021). Quantity surveyors have been urged to improve their digital skills by using BIM to provide more precise and automated cost estimates (Kim and Park, 2018). Sawhney (2016) also emphasized that quantity surveyors have to be able to adapt quickly to emerging technology to guarantee their future jobs. If not, unemployment will eventually become a problem among quantity surveyors (Tee and Kamal, 2021). Quantity surveyors also risk falling behind other professions if they do not keep evolving and lead the way in technology development (Seidu *et al.*, 2020). Or else, they will certainly be forced out of the industry's competition (Tunji-Olayeni *et al.*, 2019).

Malaysian construction professionals, especially the younger generation, are well aware of the industry's digital trends. They recognize the threat of not embracing digitalization and are expecting to cope with the change (Lee, 2020). Ismail *et al*. (2019) found

that most quantity surveyors in Malaysia showed high awareness of BIM. However, not all of them are using BIM in their current roles.

Previous research focused on the Malaysian construction industry has highlighted the importance for construction firms to incorporate digitalization (Tunji-Olayeni *et al.*, 2019), the impacts if quantity surveyors do not adapt to the digital trend (Tee and, 2021), and the Malaysian construction industry's readiness for digitalization (Lee, 2020). However, these studies do not address the inherent barriers to implement digitalization in the quantity surveying profession in Malaysia. In addition, most of the studies only focused on BIM areas, disregarding the availability of others. This shows a knowledge gap, whereby this study aimed to address. Therefore, this study seeks to identify the barriers that hinder the implementation of digitization in the quantity surveying profession. Understanding the barriers will enable the researcher to propose successful strategies to embrace the change.

2.2. Application of digital technologies in the quantity surveying profession.

As financial and development advisors, quantity surveyors are critical members of the construction industry. However, the traditional method utilized by quantity surveyors has proven to be less efficient and often associated with human errors. Therefore, quantity surveyors must evolve using digital technology and software (Akinshipe *et al.*, 2021). Digital technologies that can assist quantity surveyors in delivering their services include BIM, drones, IoT, and other quantity-surveying-related software.

2.2.1. Building Information Modelling (BIM).

According to Tahir *et al.* (2018), BIM is a fully integrated and holistic tool for managing technical and managerial aspects of construction projects. Principally, BIM is more than simply a type of software; it is a method of combining human labour with the right software to create a digital model of a building's physical and functional elements. The most often utilized BIM software among construction practitioners includes iTWO costX, Revit, Navisworks, etc. (Yaakob *et al.*, 2016). BIM is anticipated to be used by quantity surveyors to improve the efficiency of construction activities in terms of value and cost (Kim and Park, 2016). BIM technology allows the Bill of Quantities (BQ) to be generated automatically, extract quantities accurately, etc. (Alashmori *et al.*, 2020). Quantity surveyors can also recognize and link how each building area contributes to the entire project cost as BIM facilitates the identification of quantity versus cost and location relationships. This simplifies,

accelerates, and improves the accuracy of traditional BQ generation and cost estimates (Broquetas, 2010). When there are any design changes, the quantities will be automatically updated based on the amended model. This eliminates the need for quantity surveyors to re-measure the drawings (Kim and Park, 2016). Furthermore, BIM can provide a more thorough and detailed drawing than traditional 2D drawings, avoiding misunderstandings and false assumptions (Broquetas, 2010). The application of BIM enables effective information management throughout the building lifecycle (Elgewely *et al*., 2021).

2.2.2. Internet of Things (IoT)

IoT, according to Ramasamy (2021), IoT is regarded as a technology that serves as an instrument that facilitates communication between humans and smart devices. This is done through networks, actuators, sensors, etc. by sharing or transferring data into digital information, which is necessary for successful monitoring, measuring, and optimizing the industry's production (Rad and Ahmada, 2017; Mahmud *et al*., 2018; Tang *et al*., 2019). IoT has the potential to aid quantity surveyors in project management. With the application of IoT, quantity surveyors can track the whole project's progress digitally by scanning the building's and facilities' structural state (Batrawi, 2017). The digitalization of 3D models enables quantity surveyors to use better project resources, track project progress, conduct schedule and cost management, and perform clash detection (Moreno *et al*., 2019; Boje *et al*., 2020).

2.2.3. Drone

Unmanned aerial systems (UAS), unmanned aerial vehicles (UAVs), and remotely piloted vehicles (RPVs) are all terms used to describe drone technology. Such technology has a wide range of possible uses in several surveying-related industries, including building surveys, geospatial surveying mapping, environmental monitoring and agriculture, etc. (Kinghan, 2019). With the use of drone technology, data on-site can be collected regularly, which allows progress on-site to be tracked accurately with no lag time (Tkac and Mesaros, 2019). This indicates that drone technology can assist quantity surveyors in performing interim payment valuations where the progress of work on-site needs to be tracked. Additionally, using drones for site inspection is considerably safer as they reduce the need to enter potentially unsafe regions on the construction site while inspecting. The aerial images captured are high quality and can be promptly sent to the project team. Due to the ease of drone technology, site inspections may

be done more often (i.e., daily, weekly, or monthly) and cover a broader region. Through this, quantity surveyors can perform site inspections faster and at lower risks (Tkac and Mesaros, 2019). As everything is being automated, there is also a great possibility that the need for physical site visits will be eliminated.

2.2.4. E-tendering

E-tendering is described as performing tendering activities using a web-based application through the Internet where all the tender documents are prepared in electronic format (Tan and Kamarudin, 2016; Al-Yahya and Panuwatwanich, 2018). As a result, all processes, including advertising the tender notice, purchasing tender documents, submitting a tender, contract download, etc., are carried out via an online platform and electronic format. Any updates or exchange of information regarding the tender must be done through the web-based system itself or via email. In the traditional tendering system, the tender documents are printed on paper (Tan and Kamarudin, 2016). Quantity surveyors might have to scan, print, and verify the documents upon receiving the tenderers' bids. In comparison, when employing the E-tendering system, the electronic tender documents can be downloaded into the quantity surveyor's laptop or computed in just a few minutes. Quantity surveyors can also edit the items or their quantity easily (Lou and Alshawi, 2009). Furthermore, the tenderers only have to enter the item's rate into the E-tendering system and the system itself will automatically perform the calculation (Yap, 2021). This can improve the accuracy of work and make the arithmetical check process carried out by quantity surveyors faster and smoother.

2.2.5. Quantity-surveying-related software

A set of software programs have been developed from digital technology to assist quantity surveyors in performing their tasks. The software suite widely used in the quantity surveying profession includes Cubicost, iTWO costX, Revit, BuildSpace, WinQS, etc. This software could effectively assist quantity surveyors in performing most of the quantity surveying services such as cost estimates, cost analysis, BQ, progress evaluations, financial reviews, tender analysis, final accounts, etc.

2.2.6. Barriers to implementing digitalization in the quantity surveying profession.

The quantity surveying profession, like many other industries, is undergoing a digital transformation. Digitalization holds the promise of increased efficiency, improved accuracy, and streamlined processes. However, the implementation of digitalization in the

quantity surveying profession faces several barriers. These barriers can vary depending on the organization, region, or specific circumstances. To perceive the strategies, it is important to understand the barriers to implementing digitalization in the quantity surveying professions. The thorough literature review has yielded a total of 16 barriers to implementing digitalization in the quantity surveying profession, as tabulated in Table 1.

.**Table 1.** Barriers to implementing digitalization in the quantity surveying profession

No.	Barriers	Sources
1.	Lack of software support personnel	Hong *et al*. (2016), Haupt and Naidoo (2016), Eze and Ugulu (2021)
2.	Lack of software user-friendly guidance	Agyekum *et al*. (2015), Hong *et al*. (2016), Reddy (2018), Jamal *et al*., (2019)
3.	Quantity surveyors rely on traditional method	Agyekum *et al*. (2015), Jamal *et al*., (2019), Eze and Ugulu (2021)
4.	Management personnel oppose software advancement	Reddy (2018), Eze and Ugulu (2021), Akinshipe *et al*. (2022),
5.	Lack of training on digitalization for quantity surveyors	Cartlidge (2006), Agyekum *et al*. (2015), Zainon (2018)
6.	High cost to hire employees with technical capabilities	Reddy (2015), Agyekum *et al*. (2015), Zainon (2018)
7.	High cost to set up digital equipment and systems	Reddy (2015), Emmanuel *et al*. (2018), Haupt and Naidoo (2016)
8.	High operational cost	Zainon (2018), Reddy (2018), Taher (2021)
9.	Lengthy period is required for quantity surveyors to understand the entire procedure	Cartlidge (2006), Zainon (2018), Eze and Ugulu (2021)
10.	Digitalization has not been adequately integrated into university curricular	Agyekum *et al*. (2015), Emmanuel *et al*. (2018), Taher (2021)
11.	Lack of data protection and privacy	Emmanuel *et al*. (2018), Agyekum *et al*. (2015), Hussain (2016), Khanna and Sharma (2019)
12.	Fear of over-investing	Granjal *et al*. (2015), Luthra *et al*., (2018), Eze and Ugulu (2021)
13.	Long payback period	Granjal *et al*. (2015), Ryan and Watson (2017), Luthra *et al*., (2018)
14.	Lack of software compatibility	Reddy (2018), UPITDC (2020), Haupt and Naidoo (2016),
15.	Inability of software to collaborate with other systems	Stanley and Thurnell (2014), Al-Yahya and Panuwatwanich (2018), Jamal *et al*. (2019)
16.	Inability of software/hardware to keep up with operating system updates	McGraw-Hill Construction (2012), Stanley and Thurnell (2014), Zainon (2018), UPITDC (2020)

2.3. Strategies to enhance digitalization in the quantity surveying profession.

Improving digitalization in the quantity surveying profession has the potential to transform traditional practices and yield significant benefits. Quantity surveyors can streamline their workflows, automate repetitive tasks, and improve the accuracy of their calculations and estimations by embracing digital tools and technologies. As a result, efficiency increases, human error decreases, and project outcomes improve. However, successful digitalization implementation goes beyond simply adopting new technologies. It necessitates the implementation of effective strategies tailored to the quantity surveying profession's unique needs and challenges. These strategies address issues such as workforce training and upskilling, perception, awareness, and understanding of the potential barriers and challenges. Only by putting these strategies into action will the full potential of digitalization be realised. The comprehensive literature review identified 9 strategies that could be implemented to enhance digitalization in the quantity surveying profession, as shown in Table 2.

Table 2. Strategies to enhance digitalization in the quantity surveying profession

No.	Strategies	References
1.	Government provides guidelines for technology adoption	Latiffi *et al*. (2016), Chen *et al*. (2021), Seah (2021)
2.	Include employees in the decision-making process	Wasserman *et al*. (2008), Shore *et al*. (2010), Mor Barak (2015)
3.	Changing top managerial negative perceptions on digitalization	Latiffi *et al*. (2016), Kok (2018), Somani (2019)
4.	Introduce practical training on digitalization for quantity surveying students	Kekana *et al*. (2015), Kok (2018), Manzo *et al*. (2018)
5.	Incorporate digitalization as a subject in academia	Manzo *et al*. (2018), Meno (2020), Akinshipe *et al*. (2022)
6.	Raising quantity surveyors' awareness of digitalization	Olatunde and Okorie (2016), Jamal *et al*. (2019), Somani (2019)
7.	Firms provide employees with software training	Owolana and Booth (2016), Hong *et al*. (2018), Chan *et al*. (2019)
8.	Firms maintain up-to-date software and hardware	Zainon (2018), Chan *et al.* (2019), Sinoh *et al*. (2020)
9.	Government provides financial support	Chan *et al*. (2019), Chen *et al*. (2021), Akinshipe *et al*. (2022)

3. METHODOLOGY

This study adopted the quantitative research approach with a questionnaire survey serving as the data collection instrument. A thorough literature review was conducted as the first step in this study to identify the study field and comprehend the current knowledge on the subject. Since there was a dearth of information on barriers to implement digitalization in the quantity surveying profession, the review of literature also considered barriers to implement digitalization in the construction industry and barriers to implement information technology among quantity surveyors. The review covered articles that were published in a variety of databases such as ScienceDirect, Scopus, SAGE Journals, and Emerald, conference papers, newspapers, dissertations, and the Government's official websites. The articles were searched using specific keywords like digitalization, digital technologies, and quantity surveyors, with the Boolean search commands "and" and "or". In the subsequent data extraction and analysis, Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) were employed.

Findings from the thorough literature review were used to design the questionnaire survey. The questionnaire survey was separated into four sections. Section A concerns the demographic profile of the respondents. Section B required the respondents to select digital technologies that they use to deliver quantity surveying practices. Multiple-choice answers were provided and the respondents were allowed to choose more than one option. Section C employed 5-point Likert scales to allow the respondents to rate the significance of barriers to implement digitalization in the quantity surveying profession. The 5-point Likert scale used was 1, "not at all significant" to 5, "very significant". Similarly, section D used a 5-point Likert scale to enable the respondents to rank the effectiveness of strategies to enhance digitalization among quantity surveyors in Malaysia. The Likert scale's scale points used were 1, "not at all effective" to 5, "very effective". Open-ended sections were provided for sections B-D to enable the respondents to fill in additional digital technologies they used, barriers, or strategies that were not listed.

The targeted respondents were the registered quantity surveyors in the Malaysian construction industry. Based on the Board of Quantity Surveyors Malaysia (BQSM), the number of registered QS is 5,400. According to the Krejcie and Morgan Table (1970), the sample size should be 361. The sample for this research was selected using a simple random

sampling method, meaning that all the registered quantity surveyors within the sample frame have the same probability of being chosen.

The questionnaires were disseminated through email. The respondents' email addresses were gathered from online sources such as LinkedIn and ZoomInfo or by calling the quantity surveying firms. The questionnaire survey recorded a low response rate of about 20.0% (134). Although the data collected does not match the number of expected quantity surveyors to be sampled, Manley (2004) claims that a response rate between 15.0% and 20.0% would be reasonable for research conducted in the construction industry. Following that, Cronbach's alpha was used to measure the scale items' internal consistency. The questionnaire showed an excellent internal consistency with Cronbach's alpha of 0.845. To determine the significance of the barriers to implement digitalization in the quantity surveying profession as well as the effectiveness of the strategies to enhance digitalization among quantity surveyors, each item's mean and standard deviation were computed. According to their mean, the items were ranked from highest to lowest. When items with the same mean were present, the item with the lower standard deviation was given a higher rank than the item with the larger standard deviation.

4. RESULTS

4.1. Respondents' demographics.

The respondents in this study come from a variety of backgrounds, as shown by their age, working experience, and the location of the company.

The age of the respondents is illustrated in Figure 1. 75.4% of the respondents aged between 21 to 30 years old, 18.7% of the respondents aged between 31 to 40 years old, 3.7% of the respondents aged between 41 to 50 years old, and 2.2% of the respondents aged above 50 years old. When it comes to a greater age range, the number of respondents decreases. This suggests that younger quantity surveyors are more concerned about digitalization and are more willing to participate in the questionnaire.

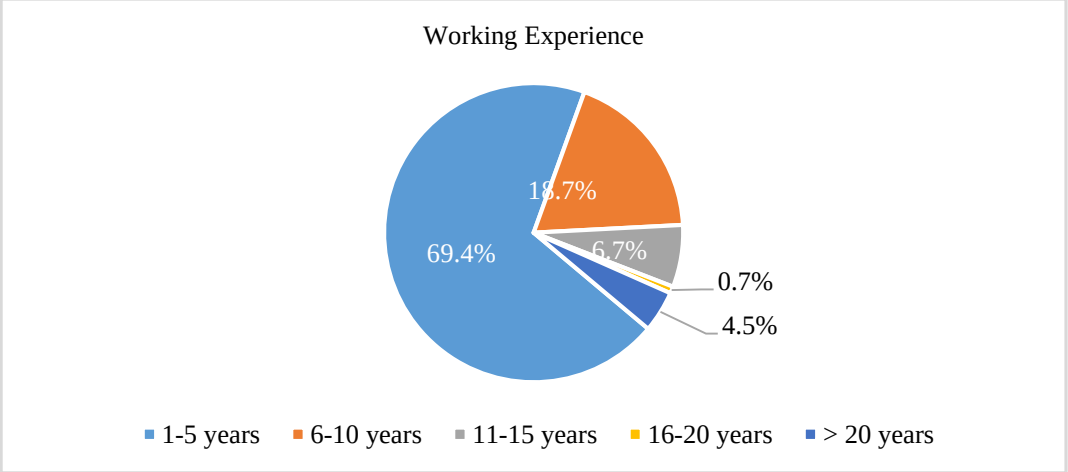

Figure 1. Classification of respondents by age

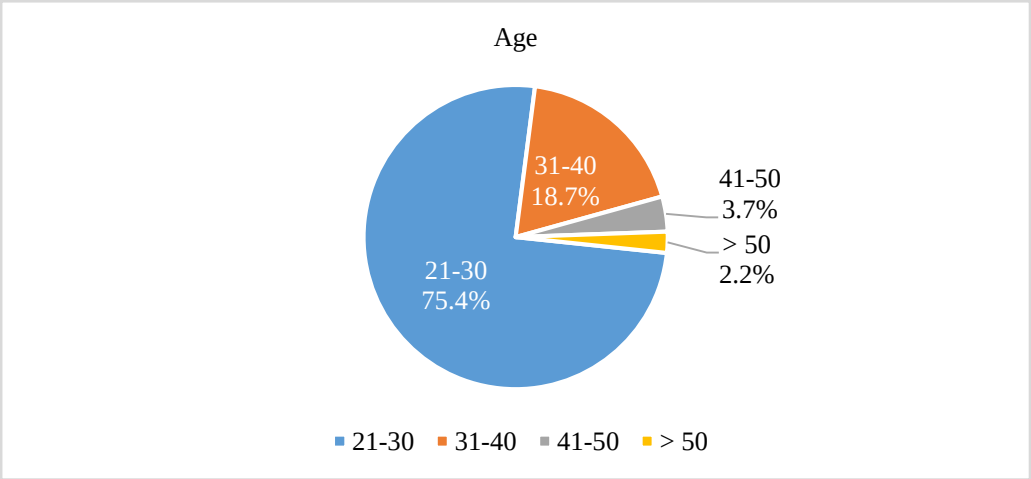

Figure 2. Classification of respondents by working experience

The working experience of the respondents is shown in Figure 2. 69.4% of the respondents have 1 to 5 years of experience, 18.7% of the respondents have 6 to 10 years of experience, 6.7% of the respondents have 11 to 15 years of experience, 0.7% of the respondent has 16 to 20 years of experience, and 4.5% of the respondents have more than 20 years of experience. Quantity surveyors who are new to the industry are more likely to be exposed to digitalization and are more attracted to participate in the survey.As depicted in the pie chart in Figure 3, the respondents were from various locations. 32.1% of the respondents, which is the most, are from the Federal Territory of Kuala Lumpur, followed by 26.9% of the respondents from Selangor, 17.2% of the respondents from Sarawak, 6.0%) of the respondents from Johor and Penang respectively, 5.2% of the respondents from Sabah, 2.2% of the respondents from Kelantan, 1.5% of the respondents from Perak, and 0.7% of the respondents from Malacca, Negeri Sembilan, Pahang, and Terengganu respectively. No one from the Federal Territories of Labuan or Perlis responded.

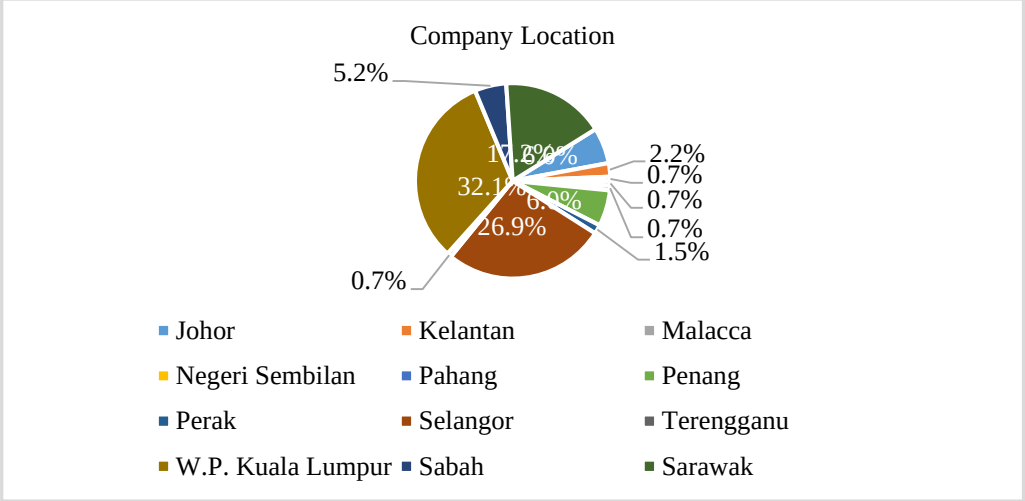

Figure 3. Classification of respondents by company location

4.2. Current state of digitalization among quantity surveyors in Malaysia.

The percentage of digital technologies used by the respondents in delivering their services was recorded in Table 3. The services include feasibility study, preliminary estimate, bill of quantities (BQ), cost plan, procurement, tendering, contract documents, interim payment valuation, variation work valuation, site visit, and document sharing.

Table 3. Percentage of each digital technology used by the respondents in delivering services

Digital technologies	Quantity surveying services										
	Feasibility study	Preliminary estimate	Bill of Quantities	Cost plan	Procurement	Tendering	Contract documents	Interim payment valuation	Variation work valuation	Site visit	Document sharing
Building information modeling (BIM)	41.10%	21.70%	19.20%	0.70%	27.81%	15.77%	23.95%	20.83%	21.00%	16.48%	16.27%
Microsoft Office	20.25%	14.15%	16.52%	39.68%	28.40%	15.35%	32.34%	30.36%	24.00%	6.82%	-
Revit	-	12.74%	8.48%	-	7.69%	4.98%	8.38%	-	5.50%	-	5.74%
iTWO costX	11.04%	8.49%	7.14%	25.87%	11.83%	5.39%	8.38%	-	6.50%	-	3.35%
Buildspace Pro	9.82%	4.25%	7.59%	0.70%	9.47%	6.22%	10.18%	-	-	-	4.78%
Manual	6.13%	3.30%	2.68	12.59%	5.92%	2.90%	-	10.71%	8.00%	23.86%	2.87%
WinQS	3.68%	0.94%	1.34%	9.79%	3.55%	0.83%	2.99%	2.38%	-	-	1.91%
Cubicost (Glodon)	1.84%	32.08%	29.91%	5.59%	2.37%	21.58%	1.20%	1.19%	19.50%	-	-
AutoCAD	1.84%	-	-	-	-	-	-	-	-	-	-
Google Drive	1.23%	-	-	-	-	-	-	-	-	-	6.22%
Soeasy Software	0.61%	0.94%	0.89%	1.40%	0.59%	0.41%	1.20%	0.60%	0.50%	0.57%	-
Project P6	0.61%	-	-	0.70%	-	-	-	-	-	-	-
Buildsoft	0.61%	-	2.23%	0.70%	0.59%	-	-	-	-	-	-
Bluebeam	0.61%	-	-	-	-	-	-	-	-	-	-
Bina Link	0.61%	0.94%	1.79%	-	-	0.83%	-	-	-	-	-
CAD	-	0.47%	0.45%	-	-	-	-	1.19%	1.00%	-	-
Atlespro	-	-	0.89%	0.70%	0.59%	0.41%	1.20%	0.60%	0.50%	-	-
Dimension X	-	-	0.45%	0.70%	0.59%	-	-	0.60%	0.50%	-	-
Tekla Structures	-	-	0.45%	-	-	-	-	-	0.50%	-	-
VU360	-	-	-	0.70%	-	-	-	-	-	-	-
SAP	-	-	-	-	0.59%	0.41%	1.20%	0.60%	0.50%	-	-
Ariba	-	-	-	-	-	0.41%	-	-	-	-	-
JCloud	-	-	-	-	-	0.41%	1.20%	-	-	-	0.96%

NiuAce E-tender	-	-	-	-	-	0.41%	-	-	-	-	-
E-Contract	-	-	-	-	-	-	1.20%	-	-	-	-
Internet of Things (IoT)	-	-	-	-	-	-	-	18.45%	-	18.18%	23.92%
Drone	-	-	-	-	-	-	-	12.50%	12.00%	33.52%	1.91%
Video conference	-	-	-	-	-	-	-	-	-	0.57%	-
E-tendering	-	-	-	-	-	23.65%	-	-	-	-	17.70%
Email	-	-	-	-	-	-	-	-	-	-	7.66%
Office server	-	-	-	-	-	-	-	-	-	-	2.39%
Aconex	-	-	-	-	-	-	-	-	-	-	1.44%
One Drive	-	-	-	-	-	-	-	-	-	-	0.96%
WhatsApp	-	-	-	-	-	-	-	-	-	-	0.96%
Dropbox	-	-	-	-	-	-	-	-	-	-	0.96%
Outlook	-	-	-	-	-	-	-	-	-	-	0.96%
SMFT	-	-	-	-	-	-	-	-	-	-	0.96%

4.3. Significance of barriers to implement digitalization in the quantity surveying profession.

The mean score of each barrier is tabulated in Table 4. Three new barriers were identified from the questionnaire survey: 'system crashing', 'transformation into digitalization takes time', and 'insufficient time to learn'.

Table 4. Mean score for the significance of barriers to implement digitalization in the quantity surveying profession

Code	Barriers	Mean
B1	Lack of software support personnel	4.14
B2	Lack of software user-friendly guidance	4.10
B3	Quantity surveyors rely on traditional ways of delivering their services	4.31
B4	Management personnel oppose software advancement	3.81
B5	Lack of training on digitalization for quantity surveyors	4.23
B6	High cost to hire employees with technical capabilities	4.12
B7	High cost to set up digital equipment and systems	4.49
B8	High operational cost	4.36
B9	Requires lengthy period for quantity surveyors to understand the entire procedure	3.93
B10	Digitalization has not been adequately integrated into university curricular	4.04
B11	Stakeholders lack technical knowledge of digitalization	4.09
B12	Lack of data protection/data privacy	3.69
B13	Long payback period	3.90
B14	Fear of over-investing	4.16
B15	Inability of software/hardware to keep up with operating system updates	4.03
B16	Inability of software to collaborate with other systems	4.11

4.4. Effectiveness of strategies to enhance digitalization in the quantity surveying profession.

Table 5 tabulated the mean score of each strategy. From the questionnaire survey, two new strategies were discovered. This includes 'software developers lower software costs' and 'software developers to fix software inadequacies before releasing'.

Table 5. Mean score for the significance of barriers to implement digitalization in the quantity surveying profession

Code	Strategies	Mean
S7	Firms provide employees with software training	4.47
S6	Introduce practical training on digitalization for quantity surveying students	4.45
S5	Incorporate digitalization as a subject in academia	4.45
S8	Firms maintain up-to-date software and hardware	4.43
S9	Government provide financial support	4.41
S4	Organize seminars to raise quantity surveyors' awareness of digitalization	4.26
S3	Changing top managerial negative perceptions on digitalization	4.23
S1	Government provides guidelines for technology adoption	4.22
S2	Inclusion of employees in the decision-making process	4.07

5. DISCUSSION

5.1. Current state of digitalization among quantity surveyors in Malaysia.

According to Abdul Majeed Mahamadu (2020), BIM, iTWO costX, Cubicost, E-tendering, Buildspace Pro, IoT, and drones are recognized as digital technology. On the other hand, Microsoft Office and manual methods are traditional ways that have been practiced for many years (Ashworth, 2013). Therefore, in this study, only digital technologies are considered to have a role in digitalization. Based on this, quantity surveyors can be classified into two main groups: those using digital technologies and those practicing traditional methods. Table 6 shows the percentage of the respondents using either digital technologies or traditional methods in delivering their services.

Table 6. Summary of the percentage of the respondents using digital technologies or traditional methods

Quantity surveying services	Percentage of respondents using digital technologies (%)	Percentage of respondents using traditional methods (%)
Feasibility study	73.55	26.45
Preliminary estimate	82.55	17.45
Bill of Quantity (BQ)	80.80	19.20
Cost planning	47.55	52.45
Procurement	65.68	34.32
Tendering	81.75	18.25
Contract documents	59.28	40.72
Interim payment valuation	58.93	41.07
Variation work valuation	68.00	32.00
Site visit	69.32	30.68
Document sharing	77.98	22.02

Despite there is still a significant number of respondents continue to rely on traditional methods, the majority of the respondents have implemented digitalization in delivering their services. This finding is in line with the research by Mahmud *et al*. (2018), Ismail (2019), Cheong (2020), Lim (2020), and Ibrahim *et al*. (2021), who found quantity surveyors in Malaysia are slow to implement digitalization. However, it can be expected that quantity surveyors to implement a digitalization is gradually on the rise. Those who have yet to implement digitalization may face some barriers, which will be discussed in the following.

5.2. Significance of barriers to implement digitalization in the quantity surveying profession.

The identified barriers were categorized into four major categories: technical inadequacy, lack of education, financial constraints, and time restrictions.

The average mean score for each category of barriers was computed to determine the most significant barrier category. The average mean score and ranking of each category of barrier are illustrated in Table 7.

Table 7. Ranking of the categories of barrier to implement digitalization in the quantity surveying profession

Categories	Barriers	Mean	Average mean	Rank
Financial constraints	High cost to hire employees with technical capabilities	4.12	4.21	1
	High cost to set up digital equipment and systems	4.49		
	High operational cost	4.36		
	Fear of over-investing	4.16		
	Long payback period	3.90		
Lack of education	Lack of training on digitalization for quantity surveyors	4.23	4.10	2
	Digitalization has not been adequately integrated into university curricular	4.04		
	Lack of software support personnel	4.14		
	Stakeholders lack technical knowledge of digitalization	4.09		
	Quantity surveyors rely on traditional method	4.31		
	Management personnel oppose software advancement	3.81		
Technical inadequacy	Inability of software to collaborate with other systems	4.11	3.98	3
	Inability of software/hardware to keep up with operating system updates	4.03		
	Lack of data protection and data privacy	3.69		
	Lack of software user-friendly guidance	4.10		
Time restrictions	Lengthy period is required for quantity surveyors to understand the entire procedure	3.93	3.93	4

Financial constraints ranked first with an average mean score of 4.21, indicating that this category is the most significant barrier. This suggests that the majority of the quantity surveyors in Malaysia are facing financial difficulties in implementing digitalization. Implement technology or software involves a huge financial commitment and is hard to afford. It includes the cost to set up the digital equipment, operation cost, cost of hiring employees, etc. Due to financial constraints, most firms avoid using digital technology, which inhibits quantity surveyors from using more technology (Zainon *et al.*, 2018). The

uncertain payback duration and the risk associated with digital transformation prevent firms from implementing digitalization. Quantity surveyors will find it difficult to use digitalization in their work unless their firms adopt it (Granjal *et al.*, 2015; Luthra *et al.*, 2018).

Lack of education is the second most significant barrier category with an average mean score of 4.10. The technology is meaningless if quantity surveyors do not obtain theoretical knowledge about digitalization and practical training on how to utilize digital technologies. Lack of education will probably hinder technology adoption as quantity surveyors tend to employ the traditional method (Agyekum *et al.*, 2015).

With an average mean score of 3.98, technical inadequacy is the third most significant barrier. This viewpoint is supported by Hong *et al*. (2016), who discovered that technology shortcomings prohibited quantity surveyors from fully utilizing the software. In most cases, software developers just release the "half-cooked" software and rely on feedback from quantity surveyors to enhance it. However, quantity surveyors do not utilize the software due to their insufficiency.

With the lowest average mean score of 3.93, the study's finding revealed that time restriction is the least significant barrier category. This is likely as without solving the previous categories of barriers, there is no means to allocate a lot of time for quantity surveyors to receive training on digitalization. However, it does not mean that this barrier category is not significant as the average mean score is not low. This barrier category will become more apparent when the previous ones have been addressed.

5.3 Effectiveness of strategies to enhance digitalization in the quantity surveying profession.

The strategy 'firms provide employees with software training' is ranked first. The study's finding is in line with those of Hong *et al*. (2018), who found that staff training is critical for quantity surveyors to implement digitalization successfully. The respondents may believe that they will be able to master the system or software faster with the training provided. There is a probability of a change in perception of the quantity surveyor where they become aware that implementing digitalization is not as difficult as they thought.

A strategy that is ranked second was 'introduce practical training on digitalization for quantity surveying students'. This could be attributed to the fact that respondents who are new to the workplace realized their limitations in terms of practical digitalization abilities. If

they had undergone training in educational institutions, it would be easier for them to catch up with digital technology when working. Likewise, respondents at the managerial level may have the same concerns, as fresh graduates require additional digitalization training. This finding is backed up by Manzo *et al.* (2018), who highlighted that students should be offered practical training through curricula. It would be easier for students to catch up when they enter the work market if they are equipped with fundamental practical skills.

Incorporate digitalization as a subject in academia' is the third-ranked strategy. Making digitalization a subject ensures that students gain a thorough theoretical understanding of digitalization before applying it in practice. This finding supports CEEMET's (2016) suggestion that digitalization should be taught as a subject in higher education. Students must also be given appropriate assistance to master the knowledge.

The strategy that is ranked fourth was 'firms maintain up-to-date software and hardware'. Earlier research by Chan *et al*. (2019) suggested that the firm should invest in and upgrade its digital technology to ensure that its technology is current. Most respondents agree that this strategy is effective as they could only use whatever the firm provides.

'Government provides financial support' is the fifth-ranked strategy that can be adopted. Government subsidies would be a key motivator for businesses to begin implementing digital technologies (Chan *et al*., 2019). Quantity surveyors believed that government intervention could help companies overcome their financial barriers to digitalization.

5.4 Proposed strategies to minimize barriers to implement digitalization in the quantity surveying profession.

Figure 4 depicts the respondents' rate of digitalization implementation for each quantity surveying service, the barrier categories to implement digitalization in the quantity surveying profession, and strategies to minimize such barriers. The green colour shaded area denotes the percentage of respondents who have used digital technologies to provide services. Conversely, the red colour shaded area represents the percentage of respondents who are still using the traditional methods: Microsoft Office and manual method. On the other hand, the purple colour arrow shows the significance of barrier category increases from time restrictions to financial constraints. Whereas the blue colour arrow indicates the increase in the effectiveness of the strategy for each barrier category.

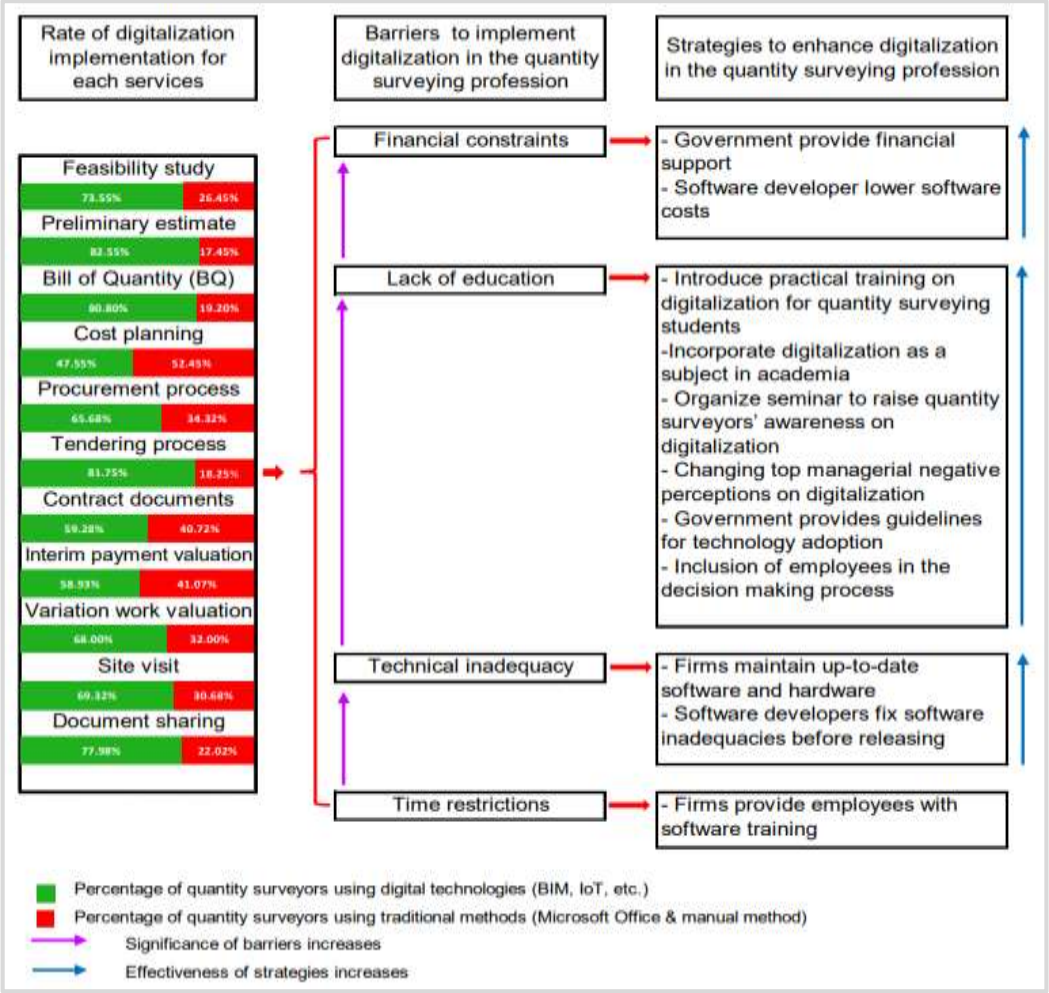

Figure 4. Proposed strategies to minimize barriers to implement digitalization in the quantity surveying profession

By referring to the rate of digitalization implementation for each service, it can be seen that there is still a significant number of quantity surveyors who have yet to utilize digital technologies. Therefore, it can be inferred that these quantity surveyors are facing barriers to implement digitalization. As previously discussed, the four major categories of barriers that the quantity surveying profession faces in implementing digitalization are financial constraints, lack of education, technical inadequacy, and time restrictions. Each category of barrier can be minimized by adopting several strategies.

Financial constraint is the most significant barrier category that impedes the quantity surveying profession from implementing digitalization and should be addressed as a priority. Barriers under this category are most likely to be alleviated with the government providing financial support. The government should have sufficient financial resources to invest in the construction industry's digitalization. Through this, the firms might

have enough funds to set up a digitalization system for the sake of their employees as well as quantity surveyors (Chan *et al.*, 2019). On the other hand, software developers can minimize financial constraints by reducing the cost of the software. The lower price could raise firms' interest to install or set up digitalization systems in their firms. The strategy 'government provide financial support' can be considered first as its higher mean score implied that this strategy is more effective than 'software developer lower software costs'.

Lack of education is another significant barrier category that needs to be resolved after the financial-related barriers have been mitigated. Higher education institutions are where digitalization knowledge is first delivered. They should introduce practical training on digitalization for students and incorporate digitalization as a subject in academics to provide quantity surveying students with both theoretical and practical knowledge (Manzo *et al.*, 2018). For quantity surveyors that have been in the workplace, firms can organize seminars to raise their awareness about digitalization. In addition, this barrier can be mitigated by firms changing top managerial negative perceptions about digitalization. With this, quantity surveyors' mindset can be altered as the managerial personnel's behaviour will significantly influence the firm's workforce (Kekana *et al.*, 2015; Latiffi *et al.*, 2016). Additionally, the government also plays a role in minimizing education-related barriers by providing quantity surveyors guidelines for technology adoption. The guideline could assist quantity surveyors to adopt proper ways while utilizing software to perform their work, allowing them to slowly pick up digital technologies (Latiffi *et al.*, 2016; Seah, 2021). Similar to the previous barrier category, the strategy that is rated more effective should be considered first.

Barriers under the category of technical inadequacy can be minimized by firms maintaining up-to-date software and hardware. Regular updates could prevent quantity surveyors from unnecessary technical issues that could have been avoided if the software developers had fixed them. It is the firm's responsibility to invest in and upgrade the digitalization system to maintain software compatibility (Chan *et al.*, 2019). In addition, software developers can reduce technical inadequacy by fixing software flaws before releasing them to quantity surveyors. This could reduce the technical issues quantity surveyors face while implementing the software or systems. Based on the mean score, 'firms maintain up-to-date software and hardware' is

more effective and should be taken into account first when facing barriers under technical inadequacy.

Lastly, the comparably less significant category of barrier, which is time restrictions, should be handled when other categories of barriers have been mitigated. The barriers under this category can be minimized by firms provides software training to their employees. Through this, reasonable time would be allocated for software training even if quantity surveyors are busy with their work. Additionally, with proper guidance and regular practice, quantity surveyors will be able to take up digital technologies quickly.

6. RESEARCH IMPLICATIONS

These findings have contributed to the body of literature on digitalization research among quantity surveyors in Malaysia, as there is currently little research in this field. As a result, it can complement the existing studies on digitalization in the quantity surveying profession. Future research could employ this study as a foundation for research on related topics. Practically, the results of this study allowed the relevant parties in the construction industry to comprehend the significant barriers and prompted them to take action to enhance digitalization among quantity surveyors. The strategies proposed for enhancing digitalization in the quantity surveying profession could guide the relevant parties to prescribe the most appropriate method to overcome the barriers. In addition, this study can raise quantity surveyors' awareness on the importance of digitalization, urging them to leave their comfort zone and catch up with the digital trend.

7. CONCLUSION

This research studied the current state of digitalization among Malaysian quantity surveyors, as well as its implementation barriers and enhancement strategies. The key finding of this research shows that quantity surveyors in Malaysia were moving toward digitalization, but at a slower pace. Some of them have yet to implement digital technology in delivering their services. Besides, this study collected and compiled 16 barriers to implement digitalization in the quantity surveying profession. The barriers were grouped into four major categories, with the most significant one being financial constraints, followed by lack of education, technical inadequacy, and time restrictions. Subsequently, a total of 11 strategies were proposed to tackle the corresponding category of barriers.

Despite the above contributions, the study faced limitations. The first limitation of the study was the low response rate of only 20.0%. This was due in part to the short survey

administration period of only three weeks. This study was primarily concerned with recognizing the barriers the quantity surveying profession faces in implementing digitalization as a whole. There was no distinction made between quantity surveyors employed by consulting firms, contractors, or developers. Future research can consider investigating barriers to implement digitalization in different groups of quantity surveyors, to understand better how the difference in their job scope and role affects the type of barriers encountered. Qualitative research can be conducted to evaluate the significance of barriers to implement digitalization in the quantity surveying profession. This is required to overcome the quantitative research's deficiency, as there may be some important factors that were not considered when the questionnaire was designed.

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