

# Digital Transformation in Construction: Assessing E-Tendering Adoption in Malaysia's Industry Landscape

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DOI: <https://doi.org/10.51244/IJRSI.2024.11120084>

Received: 16 December 2024; Accepted: 20 December 2024; Published: 23 January 2025

## ABSTRACT

As digital transformation becomes increasingly crucial for enhancing efficiency in construction projects, the adoption of E-Tendering has emerged as a significant trend within the industry. The uptake of E-Tendering has accelerated since the Covid-19 pandemic, driven by the Malaysian Movement Control Order. Typically, developers or clients decide whether to implement the E-Tendering System, but it is the quantity surveyors (QS) who manage the entire tendering process. This research, therefore, explores the benefits, challenges, and potential strategies for overcoming barriers to E-Tendering adoption from the QS perspective. The study analyzes quantitative data collected through a questionnaire survey of QS professionals in Klang Valley, Malaysia. Of the 370 questionnaires distributed, 113 valid responses were included in the analysis. The findings reveal that the key benefits of E-Tendering include paper and cost savings, improved document storage, and time savings in the collection and submission of tender documents. The main challenges identified are software limitations, software reliability, and e-security concerns. The results also highlight the shared responsibility of the government, organizations, and software suppliers in promoting and addressing the challenges of E-Tendering adoption. Ultimately, this research provides both academic insights and practical recommendations to support digital transformation and improve efficiency in the construction industry.

**Keywords:** Tendering, E-Procurement, E-Tendering, Quantity Surveyors, Construction Industry

## INTRODUCTION

Traditionally, the construction industry has relied heavily on paper-based data management, resulting in inefficiencies due to the fragmented and complex nature of the work, which slows down progress and reduces accuracy. In this context, the McKinsey Global Institute suggests that digital transformation could boost construction productivity by 14-15% and reduce costs by 4-6% [27]. In response to these challenges, the Malaysian government launched the "My DIGITAL initiative" to propel the country toward becoming a digitally-driven, high-income nation, positioning Malaysia as a regional leader in the digital economy through the Malaysia Digital Economy Blueprint [16]. An example of this is the National E-Tendering Initiative (NeTI), launched by the Ministry of Public Works and the Construction Industry Development Board (CIDB) on March 23, 2009. NeTI was introduced to facilitate online tendering in the construction industry, aiming to enhance efficiency, save approximately RM200 million annually from 5,000 government projects, and reduce the tendering process from four months to just four weeks [30]. However, Tan and Suhana [56] found that Malaysia has only a moderate level of experience with the E-Tendering System. Their study revealed that 57% of respondents had experience with E-Tendering, while 43% had no exposure to the system, indicating that E-Tendering adoption is still limited in the construction sector. Additionally, Kajendran [19] did not address strategies for improving the implementation of E-Tendering in their review. Therefore, this study aims to:

1. Explore the benefits of implementing the E-Tendering System in the construction industry.
2. Identify the challenges associated with adopting the E-Tendering System in the construction sector.
3. Examine strategies for overcoming the barriers to E-Tendering adoption.

A comprehensive literature review is conducted to gather insights on the benefits, challenges, and strategies for addressing the barriers to E-Tendering in the construction industry. Following this, a quantitative survey is administered to collect the views and opinions of practising quantity surveyors (QS) in Malaysia regarding the benefits, challenges, and potential strategies for overcoming obstacles to the adoption of E-Tendering system.

## LITERATURE REVIEW

### A. Tendering Process in the Construction Industry

Tendering involves a leading party (such as clients or developers) inviting multiple bidders to submit proposals for a project, product, or service, and selecting the most appropriate contractor [53]. Although the terms "tendering" and "procurement" are often used interchangeably, they refer to distinct processes. E-procurement consists of six stages: e-sourcing, e-tendering, e-informing, e-MRO (maintenance, repair, and operating materials), web-based ERP (enterprise resource planning), and e-collaboration [26]. In essence, tendering is the process of obtaining bids from contractors that align with the client's requirements and budget within the construction procurement framework [51].

### B. Traditional Tendering Process

The traditional tendering process, also known as paper-based tendering, involves extensive administrative work and lacks environmental efficiency. It relies on manual procedures, where contractors must purchase, collect, and submit tender documents within a tight deadline [51]. In contrast, web-based tendering systems offer 24/7 availability for submissions before the deadline [11]. Additionally, traditional tendering requires contractors to complete tender documents by hand, increasing the likelihood of human errors. On the other hand, e-tendering systems can automate calculations within the tender documents, minimizing discrepancies in the final contract sum [14].

### C. Electronic Tendering (E-Tendering) Process

E-Tendering has gained significant awareness, particularly following the Covid-19 pandemic, a notable increase compared to previous decades. Examples of E-Tendering systems implemented in Malaysia include SAP Ariba, Cubicost E-Tendering, BuildSpace, NiuAce, L10 Pro, BIM 360, and Zycus [57]. The shift toward digital tendering is viewed as an emerging trend, as highlighted by Okereke et al. [46], who argue that without modernization, the construction industry will continue to experience declining project performance due to the inefficiencies of traditional tendering methods.

According to Syed et al. [54], E-Tendering refers to the process of conducting tender activities online using Information and Communication Technology (ICT) and the internet. This encompasses the entire tendering process, from advertising the tender to awarding the contract, with all relevant documents exchanged through the e-tendering platform [32], [54]. E-Tendering can be implemented either partially or fully online, covering various stages from the issuance of the tender to the contract award.

Fig. 1: Phases in NeTI [56]

Phases	Descriptions
• Phase 1 – Tender Advertisement	• The government or registered agencies would advertise the tender notice on the official tendering website which is <a href="http://www.tender.gov.my">www.tender.gov.my</a> . The tender notice shall include the tender reference, tender title, registration category required, closing date, document fee, and all the necessary info
• Phase 2 – Registration and purchase tender	• Subsequently, the contractors can view and register with the tender the interested with. After that, the contract can purchase the tender from agency counter using registration code. Contractors with the registration code can download and view the documents online anytime during the tendering period.
• Phase 3 – Pricing and Upload BQ	• After completely download the documents, the contractors can start pricing the BQ. All the documents are in electronic format. The contractors can then submit the BQ online.
• Phase 4 – Open tender box	• Once the tender is close. The registered agency will log in as tender admin. Agency will download the documents submitted by the contractors and evaluate the tender. The contractors are able to view the tender result through e-Notice Board.

Tan and Suhana [56] describe E-Tendering System as having four phases, each corresponding to different stages in the tendering process that involve online activities (see Fig. 1). In Phase 1, the tender advertisement is posted online, including the tender title, qualifications for bidders, opening and closing dates, and any relevant fees. Phase 2 involves online activities such as advertising, registration, and the purchase of tender documents. In Phase 3, the process from Phase 2 is extended to include pricing and the uploading of Bills of Quantities (BQ) by the bidders. Finally, Phase 4 includes the online management of the tender process, including the opening, evaluation, and award of the tender. Currently, Malaysia has advanced up to Phase 2 of E-Tendering implementation.

In summary, the level of E-Tendering implementation whether fully or partially online—depends on the recommendations of the client or the quantity surveyor consultant. The contractor's E-Tendering process may vary depending on the specific requirements and characteristics of each project.

#### **D. Benefits of E-Tendering System**

**Papers and Costs Saving:** The E-Tendering System promotes environmental sustainability by eliminating the need for paper printing and ink usage, as documents are digitized [38]. This reduction in paper usage leads to a decrease in associated costs such as printing, copying, and postage, as well as the staff time and overhead required for handling these processes [29]. The cost savings from E-Tendering are substantial, with paper consumption reduced by over 90% through e-Documentation [35].

**Better Documents Storage (Physical Storage Saving and Fewer Document Loss):** In the E-Tendering System, tender documents are stored digitally, typically in easily navigable PDF files, reducing the need for physical storage space [35]. Electronic documents are less susceptible to damage or loss compared to paper documents [56]. Additionally, a variety of document formats can be stored and organized in different files, enhancing document management and reducing the risk of document loss [50].

**Ease of Access and Navigation:** Digitized tender documents are stored online, making it easy for all stakeholders to access and download the documents via the internet, without geographical limitations. This system can save up to 80% of the time typically spent collecting tender documents from a quantity surveyor's office [35]. Furthermore, electronic media such as memory sticks, email, or web-based technologies (like NiuAce E-Tender software) facilitate seamless information transmission [51]. PDF files also offer the advantage of a clickable table of contents for easy navigation between sections [38].

**Time-Saving (Collection, Submission and Evaluation):** The E-Tendering system significantly reduces the time required for tender collection, submission, and evaluation by streamlining calculations and report assessments [15], [38]. For example, many web-based systems can automatically flag incomplete or incorrect contractor submissions, eliminating the need for additional communication to clarify missing information during the analysis phase [29].

**Lower Administration Cost:** E-Tendering reduces administrative costs by minimizing arithmetic errors. When tender documents are provided in formats such as Excel sheets, figures entered can be automatically transferred to the appropriate collection pages, reducing the risk of calculation mistakes [38]. Additionally, the E-Tendering platform streamlines administrative tasks by requiring only a single upload of each tender document [29]. This eliminates the need for multiple copies, allowing bidders and contractors to access the information directly from the system after purchasing the tender, saving time for both quantity surveyors and clients in the early stages of the tender process [6].

**Transparency:** The E-Tendering System maintains an audit trail for both clients and contractors in their internal system to enhance transparency [29]. As every purchase and submission automatically generating a receipt, this provides a more systematic and accurate record for auditing purposes [35]. The audit trail functions as a secure, time-stamped record of all actions, with archiving capabilities that help address concerns related to corruption, supplier collusion, and fairness in the tendering process [53].

**E-Security:** E-Tendering offers superior security compared to traditional paper submissions. According to

Mehdipoor et al. [38], bids cannot be altered by unauthorized parties because any incorrect password attempts will freeze the documents. Additionally, access to E-Tendering information is granted on a "need-to-know" basis, providing clients and quantity surveyors complete control over which details are shared with each tenderer [35]. These features of confidentiality and secure document exchange have significantly improved both tenderers' and clients' trust in the system, enhancing their satisfaction with its implementation [53].

**Improved Business Opportunities and Competitiveness:** Lee et al. [31] suggest that E-Tendering systems are an innovative way to improve an organization's competitiveness and expand its business opportunities. This is because, according to respondents in their study, the system frees up employees from time-consuming administrative tasks such as entering tender rates and performing arithmetic checks, allowing them to focus on more value-added activities. Furthermore, E-Tendering enhances operational efficiency, speeds up processes, and improves data accuracy, all of which contribute to better business management through ICT. The adoption of such technologies opens up opportunities for smaller, regionally-based businesses to expand their networks and compete more effectively in the marketplace [35].

### **E. Challenges of Implementing an E-Tendering System**

**Lack of Commitment from Top Management:** The commitment of top management is crucial when introducing new technologies like the E-Tendering System. However, many Small and Medium Enterprises (SMEs) show reluctance to invest in this technology [44]. This resistance is partly because E-Tendering is still a relatively new concept in the construction industry, and many organizations lack established relationships with the system providers [56]. Despite the availability of government and private sector platforms like e-Perolehan, NiuAce, SAP Ariba, and Cubicost E-Tendering, many companies remain unfamiliar with these systems, causing top management to delay or reject their adoption [3].

**Employee Resistance to Change:** The construction industry has long been reliant on paper-based tendering processes, and the shift to E-Tendering can be challenging for individuals who are accustomed to these traditional methods. People with long-standing professional cultures can find it difficult to adapt to new systems [56]. For example, older, more experienced quantity surveyors (QS) are often more resistant to change compared to their younger counterparts, as identified by Lavelle and Bardon [29]. Consequently, younger employees are forced to conform to the existing organizational culture, even if they are more comfortable with digital systems [7]. Additionally, many senior managers, who are typically older and less familiar with digital technology, may not be motivated to learn how to use the E-Tendering system. As a result, they may lack the necessary skills to make critical adjustments to tender submissions at the last minute [25].

**Resources Constraint (Software, Time and Skilled Professional):** While the E-Tendering System can significantly improve employee productivity, it poses challenges when selecting software that is compatible with an organization's existing IT infrastructure. This often leads to the need for custom software development, which is time-consuming and costly due to the lack of industry benchmarks to guide the process [39], [44]. Furthermore, compatibility issues may arise if the client's or tenderer's computers cannot access the submitted tender documents or evaluation reports, particularly when different software versions or types are used [25]. This necessitates ensuring that all stakeholders use compatible software before proceeding with a tender, adding to the complexity. Moreover, there is a shortage of skilled professionals in the industry, which limits the ability of organizations to effectively manage and operate E-Tendering systems [3].

**Technological Issues (IT Infrastructure Availability and Software Reliability):** E-Tendering systems rely heavily on information and communication technology (ICT) infrastructure to function smoothly. For example, broadband availability can affect the speed and reliability of the system, impacting its effectiveness [39]. In regions with unreliable infrastructure, such as intermittent electricity or weak telecommunications networks, the implementation of E-Tendering is even more challenging [25]. Moreover, concerns over the reliability of the E-Tendering system persist, as both clients and tenderers worry about the system's functionality, its long-term performance, and the frequency of required maintenance to avoid disruptions [56].

**Low Industry and Market Demand:** In practice, paper-based documentation remains the preferred method for many in the construction industry, especially when addressing contract discrepancies. Many in the sector,



particularly those from older generations, still consider paper documentation as the only valid form of official records due to its long history in the industry [17]. Additionally, some legal and contractual documents, such as contracts, may not accept e-signatures due to concerns over the authenticity of digital signatures. There is a perception that electronic signatures could be easily copied or forged, leading to potential misuse by unethical individuals or competitors [25].

**Inadequate Government Policies and Legislation Impacting Security Concerns:** The lack of comprehensive legal frameworks to support the E-Tendering System is a significant obstacle to its widespread adoption. Respondents in Hashim et al.'s [17] study attribute this issue to the insufficient regulatory oversight by statutory bodies such as CIDB, JKR, or BQSM. This absence of robust legislation creates security vulnerabilities, as there are no clear rules to govern the various steps in the E-Tendering process. In particular, the lack of guidelines makes it difficult to address issues arising from electronic contract breaches or other legal disputes [7]. As a result, when security threats such as virus attacks or hacking occur, the lack of adequate legal protection undermines confidence in the E-Tendering System. If the chosen platform lacks strong security features, sensitive documents, including pricing and contractual information, are at risk of being leaked, further hindering the system's adoption [56].

## **F. Strategies to Overcome Challenges of Adopting E-Tendering System**

To address the challenges of adopting the E-Tendering System, three key parties play a crucial role: the government, construction organizations, and software suppliers.

**Government to Increase Awareness:** Carleton [12] suggests that the fear of the unknown (FOTU) can cause anxiety and resistance to change, which may prevent people from adopting new technologies like the E-Tendering System. To overcome this, the government should actively promote the benefits and opportunities associated with E-Tendering, particularly to private sector contractors, consultants, and clients [20]. The Malaysian government has already introduced E-Tendering platforms such as TendersOnTime, E-Perolehan, and JKR extender for public sector projects. The successful operation of these systems can serve as concrete examples to demonstrate their effectiveness and reliability, thereby encouraging construction industry stakeholders to embrace the platform. Once clients, consultants, and contractors experience the advantages of using E-Tendering, they are more likely to become advocates for the system, recommending it to their partners, stakeholders, and peers.

Another effective way to raise awareness about E-Tendering is through collaboration between the government and industry associations like RICS, CIDB, and CIOB. By organizing periodic workshops and seminars for construction industry professionals, the government can present valuable information on the benefits of E-Tendering to a wide audience. These events provide a platform for discussing E-Tendering concepts in-depth, tailored to the specific needs of different groups within the industry. This targeted approach will ensure that the construction sector understands the system and its potential, motivating stakeholders to consider adopting the E-Tendering System for their projects [58].

**Government to Strengthen E-Security:** Digitalization has undeniably improved work efficiency but has also introduced cybersecurity risks. As of the third quarter of 2023, Malaysia was ranked eighth in terms of the number of data breaches, with over 494,000 accounts leaked [61]. To address this growing concern, strengthening security measures is essential to the successful implementation of the E-Tendering System. Alsagoff et al. [4] argue that industry players will be more confident in using the system if there are clearly defined and unified policies, laws, and standards governing E-Tendering platforms. The government should establish a comprehensive cybersecurity policy to mitigate risks related to document exchange, data confidentiality, and leakage [53]. Malaysia took an important step in 2006 by recognizing the importance of cybersecurity, which led to the creation of the National Cyber Security Policy (NCSP). This policy aims to develop a framework of measures to ensure effective cybersecurity controls, including those relevant to the construction sector [43].

In addition to implementing unified policies, the government should focus on building trust and improving collaboration with industry players to strengthen the overall governance of the cybersecurity ecosystem. Since E-Tendering is an internet-based process involving the exchange of tender documents and contract awards [53],

construction players are often required to use multiple platforms with different features for each project. This can increase the risk of data leakage. To address this, the government should encourage industry stakeholders to work together under the initiatives outlined in the Malaysia Cyber Security Strategy 2020–2024. By fostering collaboration and ensuring that the construction industry participates in these cybersecurity initiatives, the government can help create a more secure environment for the E-Tendering process [43].

**Government to Improve Accessibility of E-Tendering System:** The effectiveness of the E-Tendering System relies heavily on its online accessibility, which depends on a stable internet connection and available ICT infrastructure. However, limited internet coverage in rural or remote areas restricts access for potential bidders and hinders the overall adoption of the system. To overcome this barrier, the government must prioritize expanding and improving internet coverage in these underserved areas [41]. This would ensure that construction companies across Malaysia, regardless of their location, can seamlessly adopt and utilize the E-Tendering System. For example, the government's JENDELA program, launched in 2021, is a collaborative initiative aimed at improving digital connectivity. Phase 2 of this program (2023-2025) seeks to achieve 100% internet coverage in populated areas, supporting the broader adoption of digital solutions like E-Tendering [37].

**Construction Organization to Provide Training for Employees:** As part of Malaysia's efforts to embrace the Fourth Industrial Revolution (National 4IR Policy), which aims to elevate the nation to high-income status, the government has emphasized the importance of technology adoption. To align with this goal, construction companies must transition to digital workflows, including adopting online tendering systems. To facilitate this shift, companies should invest in training their employees on the use of E-Tendering systems. By equipping their workforce with the necessary skills, companies will gradually build a culture of digital adoption, enabling long-term growth and efficiency [45].

**Construction Organization to Improve Capability and Usability of E-Tendering software:** Each E-Tendering software offers different features, capabilities, and usability, making it essential for organizations to select a system that aligns with their needs. Given the high costs associated with implementing new technology, organizations can mitigate risks by taking advantage of free trials and demos offered by software suppliers. This allows companies to test the software before committing to a purchase. It is crucial that top management, who are responsible for overseeing the tendering process, choose software that is compatible with the organization's existing systems and is easy for them to use [25]. This ensures that they are fully equipped to manage the process, thereby boosting confidence in the system's effectiveness across the organization.

**Construction Organization to Overcome Employee Resistance to Change:** Research consistently highlights the critical role of leadership in successfully adopting IT systems and transforming organizational culture [3], [5], [60]. Specifically, top management support is key to shaping employees' perceptions of E-Tendering software and its adoption outcomes. The successful implementation of the E-Tendering System depends on the company's overall attitude toward digital transformation. Top management must set the tone by actively learning about and adopting the system, as their actions will guide the rest of the organization. When senior leaders take the lead in embracing E-Tendering, it sends a strong message to middle managers and employees, reinforcing the importance of the system and encouraging buy-in across the company. Furthermore, the strategic decisions made by top management will influence the organizational culture, creating a conducive environment for the system's adoption [28]. Studies by Ke and Wei [23] suggest that leaders who foster a culture of learning and actively model the system's use are more likely to see successful implementation of IT systems, including E-Tendering. This approach is critical to accelerating the widespread use of E-Tendering in Malaysia's construction sector.

**Software Supplier to Provide Training:** According to Lavelle and Bardon [29], younger, less experienced Quantity Surveyors (QS) are more inclined to embrace technological change, as they are more familiar with digital tools and recognize their efficiency. In contrast, older QS professionals may resist digitalization due to their traditional views and reluctance to change. To address this, E-Tendering service providers could offer free training sessions to younger, potential users, encouraging them to introduce the system within their companies. This proactive approach can increase acceptance and promote wider adoption of the E-Tendering System, ultimately leading to a larger user base in the future [8].

**Software Supplier to Strengthen E-Security:** Software suppliers play a crucial role in overcoming challenges

related to E-Tendering System adoption by ensuring robust security measures are built into the software. They should design the E-Tendering platforms with comprehensive security protocols to prevent unauthorized access to sensitive information [42]. For example, suppliers can implement stronger password requirements and multi-factor authentication for user accounts. By bolstering the security features, software suppliers can build user confidence, encouraging the wider adoption of the E-Tendering System.

Software Supplier to Improve Capability and Usability of E-Tendering Software: Similar to other types of software, the functionality and ease of use of E-Tendering systems are key factors in successful adoption. By improving customer satisfaction, software providers can gain a competitive edge and ensure long-term profitability [24]. Suppliers should remain proactive in addressing user inquiries to ensure smooth usage of the E-Tendering platform. Additionally, gathering user feedback to refine the software—particularly its security features—is essential. Ongoing support and communication from the software supplier will help retain existing users and attract new ones [40]. This approach is crucial in overcoming the challenges associated with implementing E-Tendering in the construction industry.

## RESEARCH METHODOLOGY

This study adopts quantitative methods, utilizing both close-ended and open-ended questions. Section A of the survey focuses on capturing the demographic profile of the respondents, while Sections B, C, and D aim to explore the benefits, challenges, and strategies for overcoming the impacts of the E-Tendering System in the construction industry respectively, from the perspectives of quantity surveyor experts. A total of 300 questionnaires were distributed, and 113 valid responses were received (see Table 3.1). The demographic profile of the respondents serves as an initial step in validating the responses, as it is essential to ensure that participants are actively involved in quantity surveying practices. The overall response rate of 31.35% (113 out of 370 respondents) is deemed acceptable and reasonable. According to Masson [36], a response rate above 30% is considered excellent, and previous studies by Takim et al. [55], Adnan et al. [2], and Bosher et al. [10] reported response rates of 20.9%, 20%, and 28%, respectively.

As shown in Table 3.1, respondents are classified into two groups based on whether or not they have E-Tendering experience. This classification helps examine whether the quantity surveyors' experience, or lack of experience, with E-Tendering affects their responses. Moreover, the preliminary analysis of the reliability and validity tests demonstrates significant internal consistency. With a Cronbach's Alpha exceeding 0.88, it indicates a strong internal correlation between the items, well above the 0.80 threshold for all three objectives. Furthermore, all variables show proportionate correlations, as the total score of each item within their respective objectives reveals positive correlation coefficients. The results and discussion on the findings are presented in the subsequent sections.

Table 3.1: Summary of Respondents' Profiles

	Respondents' characteristics	No. of respondents (Total=113)	%
Gender	Male	55	48.7%
	Female	58	51.3%
Age Range	< 21 years old	0	0.0%
	21 - 30 years old	87	77.0%
	31 - 40 years old	23	20.4%
	41 - 50 years old	1	0.9%
	≥ 51 years old	2	1.8%
Serving Company	Developer Firm	15	13.3%
	Main-Contractor Firm	38	33.6%
	QS Consultancy Firm	47	41.6%
	Sub-Contractor Firm	7	6.2%

	Others	6	5.3%
Quantity Surveyor Qualification	Assistant Administrator - Contracts	1	0.9%
	Chartered QS, MRICS	1	0.9%
	Consultant QS	18	15.9%
	Junior QS	6	5.3%
	Professional QS	12	10.6%
	Provisional QS	68	60.2%
	Quantity Surveying Technologist	7	6.2%
Education Qualification	Bachelor Degree	99	87.6%
	Diploma	2	1.8%
	Master	12	10.6%
Yearsofworking experience as a Quantity Surveyor	≤ 5 years	77	68.1%
	6 - 10 years	25	22.1%
	11 - 15 years	8	7.1%
	16 - 20 years	0	0.0%
	≥ 21 years	3	2.7%
E-Tendering Experiences	No	40	35.4%
	Yes	73	64.6%
Number of projects the respondents have been involved in that adopt the E-Tendering system	0	40	35.4%
	1 - 5	55	48.7%
	6 - 10	10	8.8%
	11- 20	2	1.8%
	≥ 21	6	5.3%
Interest of respondents in participating in E-Tendering projects in the future	No	3	2.7%
	Yes	110	97.3%
Respondents' preferred type of tendering system	E-Tendering System	105	92.9%
	Traditional Paper-based Tendering System	8	7.1%

## FINDINGS AND DISCUSSION

This section presents data categorized into two groups: one includes responses from all participants, regardless of whether they have experience in E-tendering, and the other includes responses from only those with E-tendering experience.

### A. Benefits of Using E-Tendering System in the Construction Industry

Among the benefits listed in Tables I and II, "Papers and Costs Saving" and "Physical Storage Saving" under better document storage are the most strongly agreed-upon advantages in both the overall respondent group and the group with E-Tendering experience. This is because all respondents believe that "Papers and cost savings" significantly impact the choice of tendering method. E-Tendering promotes a paperless approach, while traditional tendering relies on hardcopy documents. Therefore, E-Tendering contributes to environmental sustainability by being a green solution [38]. As a result, it not only benefits the environment but also reduces overall construction costs, particularly during the tendering phase, by cutting paper, printing, postage, and related administrative and overhead costs [29].

The second and third most significant benefits of E-Tendering, as shown in Tables I and II, are "time-saving in the collection of tender documents" and "submission of tender-related information." These results align with



Affendy [3], who notes that the E-Tendering System reduces processing time and eliminates unnecessary expenses during the bidding process, particularly when all tender documents and drawings are stored in digital format and uploaded into the system [6]. One respondent commented, “Since all the work, including submitting and collecting tender documents, is done online, it reduces the need for physical transportation and mailing,” highlighting that this approach saves considerable time for contractors and quantity surveyors.

**Table I. Benefits of Using the E-Tendering System in the Construction Industry from All Respondents (N=113)**

	Benefits	N	Mean	Std. Deviation	Rank
Papers and Costs Saving	B1	113	4.58	.788	1
Better Documents Storage	B2	113	4.58	.754	1
	B3	113	4.24	.993	5
Ease of Access and Navigation	B4	113	4.26	.962	4
	B5	113	4.15	.966	6
Time-Saving	B6	113	4.44	.876	2
	B7	113	4.35	.954	3
	B8	113	4.13	1.031	8
Lower Administration Cost	B9	113	4.12	1.016	9
	B10	113	4.09	.996	10
Transparency	B11	113	4.14	.934	7
E-Security	B12	113	3.96	1.068	12
Improve Business Opportunities and Competitiveness	B13	113	4.05	.885	11

**Table II. Benefits of Using the E-Tendering System in the Construction Industry from QS with E-Tendering Experiences (N=73)**

	Benefits	N	Mean	Std. Deviation	Rank
Papers and Costs Saving	B1	73	4.60	.759	1
Better Documents Storage	B2	73	4.59	.796	2
	B3	73	4.33	.929	5
Ease of Access and Navigation	B4	73	4.25	.925	7
	B5	73	4.10	.974	11
Time-Saving	B6	73	4.42	.927	3
	B7	73	4.38	.907	4
	B8	73	4.26	.943	6
Lower Administration Cost	B9	73	4.16	.943	8
	B10	73	4.01	1.074	13
Transparency	B11	73	4.15	.953	9
E-Security	B12	73	4.12	1.013	10
Improve Business Opportunities and Competitiveness	B13	73	4.08	.909	12

**Notes:** B1-Papers and Costs Saving; B2-Physical Storage Saving; B3-Fewer Document Loss; B4-Ease of Access in Softcopy; B5-Ease of Navigation to Respective Headings with Table of Content; B6-Time-Saving in Collection of Tender Documents; B7-Time-saving in Submission of Information; B8-Time-saving in Evaluation of Tender Documents; B9-Reduce Arithmetic Errors; B10-Save Administration Cost; B11-Transparency in Audit Trail; B12-High Security of Document Access; B13-Improve Business Opportunities and Competitiveness

Quantity surveyors also emphasized that the efficiency of the tender submission process aids them in revising their calculations, as the revised tender documents can be immediately sent through the E-Tendering System platform [32]. In contrast, the E-Tendering System does not demonstrate significant efficiency in the time-saving of tender document evaluations compared to other time-saving benefits. This may be because, in practice, evaluation work is done by manually entering rates and prices into Excel, while the E-Tendering System primarily serves as a platform for posting advertisements and storing and sharing information and documents, as outlined in the phases of NeTI [56].

Furthermore, few respondents believe that the E-Tendering System offers high security for document access, ranking the security feature the lowest with a score of 3.96 in Table I, but placing it 10th with a score of 4.12 in Table II. This discrepancy may be due to those without E-Tendering experience lowering the average score. In contrast, respondents with E-Tendering experience (as shown in Table II) may recognize, based on Section 62(2) of the Digital Signature Act 1997 and Section 6 of the Electronic Commerce Act, that a document signed with a digital signature is legally binding, thus reducing concerns about e-security [18]. Additionally, respondents with E-Tendering experience may trust the system's security, as Malik [33] suggests that E-Security in the E-Tendering System can be enhanced with Public-Key Infrastructure (PKI), which ensures confidentiality, access control, data integrity, authentication, and non-repudiation through public-key encryption and digital signature services. Moreover, blockchain technology has the potential to improve financial settlements and document exchanges during the tender process as well [49].

Furthermore, respondents with E-Tendering experience (as in Table II) rated "Save Administration Cost" as the least beneficial, a ranking that differs from Table I, which compiles responses from all respondents. This discrepancy in rankings could be attributed to the real-world experience of quantity surveyors, who may not perceive the E-Tendering System as significantly contributing to the reduction of administration costs. This finding aligns with the work of Tan and Suhana [56], where low administration cost was also ranked as one of the least important benefits of the E-Tendering System. However, it contradicts Lee et al.'s study [31], which views E-Tendering as a "cost-cutting tool" that helps eliminate administrative tasks.

Lastly, several benefits ranked in the middle among all 13 listed benefits, including "Fewer Document Loss," "Ease of Access in Softcopy," "Ease of Navigation to Respective Headings with Table of Contents," "Time-Saving in Evaluation of Tender Documents," "Reduce Arithmetic Errors," "Transparency in Audit Trail," and "Improve Business Opportunities and Competitiveness." These results suggest that while these benefits may enhance the E-Tendering System, they are not the primary drivers for adopting the system.

## **B. Challenges of Implementing the E-Tendering System in the Construction Industry**

The greatest challenge in adopting the E-Tendering System, based on Tables III and IV, is "Software Constraint" in the category of resource constraints. This is because the efficient implementation of the E-Tendering System requires a significant amount of start-up capital [25]. The high cost of purchasing software presents a major risk for companies, particularly Small and Medium Enterprises (SMEs), which may already be operating with limited financial resources and need to safeguard their systems and data [48]. Respondents also agree with this concern, with many believing that "ensuring a standardized process can be difficult with multiple stakeholders."

Another significant concern is E-security, particularly the lack of adequate government policies. E-security ranks as the second-highest challenge, with a mean score of 3.96 from the 113 overall respondents, and third place among respondents with E-Tendering experience, as shown in Tables III and IV. Betts et al. [9] note that E-Tendering must address key issues such as integrity, confidentiality, authentication, and non-repudiation in electronic communications to strengthen the legal framework and prevent disputes like fraud during the adoption of the system. Without regulatory standards, a gap remains for disputes that are not covered by legal acts [59].

Examples of inadequate data security include risks such as hacking, virus attacks, data loss, confidential information falling into the wrong hands, lack of trust in electronic documents, document tampering/online crime, and authentication issues [22].

As technology advances, more E-Tendering software has been developed, and "Reliability of the E-Tendering software" has become a growing concern. This issue is ranked as the third-highest challenge in the category of technological issues in Table III and second-highest in Table IV. This concern arises because, with the global adoption of the E-Tendering System, users carefully assess the functionality, performance, and lifespan of the software before making a decision [53].

**Table III. Challenges of Implementing the E-Tendering System in the Construction Industry from All Respondents (N=113)**

	Challenges	N	Mean	Std. Deviation	Rank
Lack of Commitment from Top Management	C1	113	3.86	.953	5
Employee Resistance to Change	C2	113	3.78	1.100	7
Resources Constraint	C3	113	3.98	.991	1
	C4	113	3.77	1.027	8
	C5	113	3.79	1.097	6
Technological Issues	C6	113	3.48	1.261	10
	C7	113	3.91	1.065	3
Low Industry & Market Demand	C8	113	3.70	1.149	9
Inadequate Government Policies and Legislation Impacting Security Concerns	C9	113	3.87	1.022	4
	C10	113	3.96	1.109	2

**Table IV. Challenges of Implementing the E-Tendering System in the Construction Industry from QS with E-Tendering Experiences (N=73)**

	Challenges	N	Mean	Std. Deviation	Rank
Lack of Commitment from Top Management	C1	73	3.75	1.024	4
Employee Resistance to Change	C2	73	3.63	1.184	7
Resources Constraint	C3	73	3.89	1.048	1
	C4	73	3.74	1.041	5
	C5	73	3.67	1.179	6
Technological Issues	C6	73	3.42	1.322	9
	C7	73	3.85	1.151	2
Low Industry & Market Demand	C8	73	3.60	1.199	8
Inadequate Government Policies and Legislation Impacting Security Concerns	C9	73	3.67	1.081	6
	C10	73	3.78	1.193	3

**Notes:** C1-Lack of Commitment from Top Management to adopt E-Tendering system due to Market/ Client Demand; C2-Employee Resistance to Adapt to a New Software (E-Tendering system); C3-Software Constraint; C4-Time Constraint; C5-Skilled Professional Constraint; C6-IT Infrastructure Availability; C7-Software Reliability; C8-Low Industry and Market Demand; C9-Inadequacies in Government Policies and Legislation; C10-E-Security Concerns due to Lack of Adequate Government Policies

Respondents also shared concerns, with one stating, "The server for the E-Tendering System went down, especially near the submission deadline." Kazaz et al. [22] similarly noted that when the submission deadline is near, system crashes can prevent tender submissions. Another respondent mentioned, "The E-Tendering System may become obsolete over time." This suggests that a wide range of considerations is necessary when implementing an E-Tendering System, as Pincirolì [47] highlights that software selection should depend on factors such as availability, integrity, modifiability, robustness, safety, security, usability, and verifiability.

According to Tables III and IV, the lowest-ranked challenge is "Availability of IT Infrastructure." This challenge is considered weak, as internet coverage in Malaysia, according to a study by Siddhartha [52], reached 94% of the population by 2022. This indicates that internet coverage in Malaysia is sufficiently comprehensive to support the use of E-Tendering software. Moreover, not all E-Tendering systems require specific software, like Glodon and NiuAce, as some rely on cloud collaboration for sharing information. Mehdipoor et al. [38] suggest that all tender documents, drawings, and specifications can be stored in PDF files, meaning no special software is needed to open files generated by the E-Tendering system. Additionally, some respondents agreed that E-Tendering systems may not require specific software, commenting, "Recently, online E-Tendering was implemented where no software installation is required, but we need to register as a vendor and pay an annual subscription fee to activate the account." This indicates that the "Software Constraint" challenge in E-Tendering depends on the implementation method, whether through specific software, cloud collaboration, or simple electronic transmission.

Lastly, challenges such as "Lack of Commitment from Top Management to adopt the E-Tendering system due to Market/Client Demand," "Employee Resistance to Adapt to a New Software (E-Tendering System)," "Time Constraints," "Skilled Professional Constraints," "Low Industry and Market Demand," and "Inadequacies in Government Policies and Legislation" were not rated as major challenges in the implementation of E-Tendering, based on respondent scores. While these challenges should be addressed to increase the adoption of E-Tendering, they do not appear to be the primary reasons for the low rate of E-Tendering implementation.

### C. Strategies to Overcome the Challenges in Adopting the E-Tendering System

Among all the strategies proposed by the government, construction organizations, and software suppliers to overcome the challenges in adopting the E-Tendering System, the top three strategies are evenly distributed across the three parties. These include "Increase internet coverage to the whole of Malaysia, including urban areas" from the government strategy, "Integrate the use of E-Tendering software into the company's working environment with top management serving as role models for the implementation of the software" from the construction organizations, and "Software suppliers providing E-Tendering software training." This highlights the importance of collaboration among all parties to successfully address the challenges associated with the adoption of E-Tendering System.

Based on Table VI, respondents with E-Tendering System experience ranked similar strategies in the top three across the three parties. Additionally, these respondents believed that "Software suppliers should actively respond to customer service inquiries with professionalism, patience, and a 'people-first attitude'" should also be ranked second among the top three strategies. Therefore, the top strategy remains the government's initiative to "Increase internet coverage to the whole of Malaysia, including urban areas," while "Software suppliers providing E-Tendering software training" ranks equally in third place.

**Table V. Strategies to Overcome the Challenges in Adopting the E-Tendering System from All Respondents (N=113)**

Party	Strategies	N	Mean	Std. Deviation	Rank
Government	S1	113	4.17	.944	10
	S2	113	4.32	.782	6
	S3	113	4.23	.886	9
	S4	113	4.12	1.050	11
	S5	113	4.38	.919	3



Construction Organisation	S6	113	4.33	.891	5
	S7	113	4.25	.987	8
	S8	113	4.42	.822	1
Software Supplier	S9	113	4.39	.860	2
	S10	113	4.30	.885	7
	S11	113	4.37	.815	4

**Table VI. Strategies to Overcome the Challenges in Adopting the E-Tendering System from QS with E-Tendering Experiences (N=73)**

Party	Strategies	N	Mean	Std. Deviation	Rank
Government	S1	73	4.08	1.024	9
	S2	73	4.29	.808	5
	S3	73	4.15	.953	8
	S4	73	4.07	1.084	10
	S5	73	4.36	.977	3
Construction Organization	S6	73	4.32	.926	4
	S7	73	4.22	1.003	7
	S8	73	4.44	.799	1
Software Supplier	S9	73	4.36	.918	3
	S10	73	4.26	.943	6
	S11	73	4.38	.860	2

**Notes:** [Government: S1-Increase Awareness by Promoting Benefits and Opportunities of E-Tendering; S2-Increase Awareness by Collaboration with Industry Associations (RICS, CIDB, CIOB) for occasional Construction Workshops and Seminars; S3-Strengthen E-Security by Establishing A Unified Policy, Laws and Standards for E-Tendering Platforms; S4-Strengthen E-Security Within the Cyber Ecosystem; S5-Improve Accessibility of E-Tendering System by Increasing the internet coverage to the whole of Malaysia including urban areas]. [Construction Organization: S6-Provide Training by Sending Employees to E-Tendering Training; S7-Improve Capability and Usability of E-Tendering software by Taking Advantage of the E-Tendering System Free Trials and Demos; S8-Overcoming Resistant to Change by Adopting an E-Tendering System in the Organization with Top Management Support]. [Software Supplier: S9-Provide Training by Offering Free E-Tendering Software Training; S10-Strengthen E-Security by Allocating more Software Security Features; S11-Improve Capability and Usability of E-Tendering software by Providing Excellent Customer Support].

First and foremost, the government effort that ranked in the top three is "Increase internet coverage to the whole of Malaysia, including urban areas." Mohd Nawi et al. [39] also suggest that the widespread use of electronic technologies depends on the availability of sufficient broadband coverage. This is crucial because internet access varies by area, as Alsagoff et al. [4] note that internet penetration and connectivity are poor in rural areas. As a result, urban areas sometimes do not have strong and fast internet connections, making it difficult to access cloud-stored data. Consequently, site contractors may have little incentive to switch to E-Tendering, as the investment in new software can be costly. Therefore, ensuring smooth internet connections, even in urban areas, would encourage companies to transition to an E-Tendering System.

Next, based on the top three rankings in Tables V and VI, respondents selected the strategy to "Overcome resistance to change in the construction organization environment by encouraging top management support" to increase E-Tendering System implementation. This approach suggests that top management can drive change and foster a supportive environment for adopting new technologies by clearly communicating and reinforcing organizational values through a shared vision [3], [34]. As a result, more employees would be likely to follow the example of top management in embracing the E-Tendering System [28].

Last but not least, among the top three strategies to overcome the challenges of adopting the E-Tendering System, software suppliers should "Offer free E-Tendering software training" to more construction players. During these training sessions, interactions between users and software suppliers increase, strengthening the relationship between buyer and supplier firms [13]. Additionally, this engagement allows software suppliers to gain a deeper understanding of the issues their customers face. As noted by the Aberdeen Group [1], early involvement of software suppliers in customer feedback helps refine the software.

On the other hand, another strategy highlighted by respondents with E-Tendering experience, based on Table VI, is for software suppliers to "Improve the capability and usability of the E-Tendering software based on customer feedback by providing excellent customer support." According to Kanovska [21], the greater the organizational commitment to service innovation, the more likely a company is to challenge its basic business assumptions and discover new sources of value. This suggests that continuously enhancing the software's functionality will not only increase the benefits for users of the E-Tendering System but also encourage further adoption of the software.

## CONCLUSION AND RECOMMENDATIONS

This research has explored the growing trend of digitization, particularly the E-Tendering System, within the Malaysian construction industry. While E-Tendering practices are still in progress, they are not yet widespread or fully integrated into the market. This study provides valuable insights into the perceptions of quantity surveyors regarding the adoption of E-Tendering, focusing on the benefits they have gained and the challenges they have encountered. While previous research has explored the awareness, benefits, and challenges of E-Tendering, there has been limited focus on the strategies to boost adoption rates. This study addresses that gap by identifying strategies from three key stakeholders: the government, organizations, and software suppliers.

Additionally, this research contributes to the academic understanding of E-Tendering within the Malaysian construction sector and offers practical recommendations for accelerating the industry's digital transformation. These recommendations are in line with national digital initiatives and aim to enhance the construction industry's ability to leverage the efficiencies and competitive advantages offered by modern technological solutions. Ultimately, it is hoped that this study will inspire future research on strategies to increase the adoption rate of E-Tendering in the Malaysian construction industry, and further refine the approaches to facilitate its broader implementation.

Future studies could expand on this research by incorporating interviews and gathering detailed opinions from various stakeholders in the construction industry, including government representatives, private construction firms, and software suppliers. This approach would provide a more in-depth understanding on how each group contributes to or hinders the successful implementation of E-Tendering, highlighting the unique challenges and opportunities they face. By focusing on the distinct responsibilities and impact of different construction players, future research could offer more tailored strategies to enhance the uptake and effectiveness of the E-Tendering System within the sector.

## ACKNOWLEDGMENT

This study was supported by the Faculty of Built Environment, Tunku Abdul Rahman University of Management and Technology under the Centre for BIM research.

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