

**EXPLORING APPLICATION OF E-TENDERING IN MALAYSIAN
CONSTRUCTION INDUSTRY DURING COVID-19 PANDEMIC**

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**A project report submitted in partial fulfilment of the
requirements for the award of Bachelor of Science
(Honours) Quantity Surveying**

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April 2022

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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ABSTRACT

Beginning in 2020, Malaysia declared a lockdown policy to restrict the spread of the Covid-19 virus. As everyone needed to work from home, the traditional tendering method was impossible to be carried out. Thus, the e-tendering system was used instead during this period. Previous research has mostly focused on implementing an e-tendering system and the effects of Covid-19 on the construction sector. However, there has been little research into how the tendering process was carried out during the Covid-19 pandemic. As a result, this study investigated the various tendering methods used in the Malaysian construction industry before and during the Covid-19 outbreak. This research also studied the critical success factors and obstacles of applying an e-tendering system in the Malaysian construction industry. The quantitative research method was used to collect data via the questionnaire survey. The data was collected from 99 quantity surveyors who are working in the Malaysian construction industry. The findings revealed that the traditional tendering method was mostly used before the Covid-19 pandemic, while the e-tendering system and email were used to conduct tendering processes during the Covid-19 pandemic. The five strongly agreed critical success factors of e-tendering system application were revealed as (1) reduce printing cost; (2) avoid crowd gathering; (3) avoid physical contact; (4) reduce physical storage; and (5) reduce time on duplicating tender documents. Lack of knowledge was a significant obstacle perceived by the quantity surveyors whose companies did apply the e-tendering system. Besides, the quantity surveyor whose companies did not apply the e-tendering system perceived the high initial cost to purchase software as the most significant obstacle. This research also carried out the inferential test and found significant differences between the respondent groups regarding the critical success factors and obstacles of e-tendering system application. According to the findings of this research, fewer construction firms were using the e-tendering system throughout the tendering process. It also outlined the trend of adopting an e-tendering system before and during the Covid-19 pandemic in the Malaysian construction industry. This research provided insights and awareness to the construction professionals on the importance of implementing the e-tendering system.

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LIST OF SYMBOLS / ABBREVIATIONS

BQ	Bills of Quantities
CIDB	Construction Industry Development Board
CMCO	Conditional Movement Control Order
Covid-19	Coronavirus disease-2019
FMCO	Full Movement Control Order
MCO	Movement Control Order
NeTI	National E-Tendering Initiative
RICS	Royal Institution of Chartered Surveyors
RMCO	Recovery Movement Control Order
WHO	World Health Organization

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The Covid-19 outbreak occurred in late 2019 and caused a massive impact on individuals around the globe. It had a significant impact on the global economy as well. To stop the virus from spreading, almost every country declared a lockdown. Some firms were unable to operate due to the lockdown policy, putting them in a precarious financial situation. During the epidemic, the construction industry was also impacted (Al Amri and Marey-Pérez, 2020).

Malaysia's Government attempted a variety of tactics between 2020 and 2021 to restrict the Covid-19 from spreading. MCO 1.0 referred to the Movement Control Order that was in effect from March to May 2020. Following MCO 1.0, Malaysia experienced daily losses of RM2.4 billion (Povera, 2021). The construction industry was also impacted by MCO 1.0. Analysts indicated in April 2020 that MCO induced substantial delays in mega project execution, such as Mass Rapid Transit Line 3(MRT3) and the Kuala Lumpur-Singapore High-Speed Rail (KL-SG HSR) (Ong, 2020). According to the research by Zamani, et al. (2021), the Covid-19 pandemic had various negative consequences in the construction industry, including project stoppage, workforce shortages, delay of the project, and increased development cost project.

In this 21st century, the world is being transformed by information technology (IT). IT is gaining traction in a variety of areas, including manufacturing, agriculture, and others. Jaafar, et al. (2007) stated that IT should also be applied in the construction industry, one of the primary contributors to economic growth. IT is a driving force in the construction industry to stimulate growth.

In the construction industry, the procurement process is involved when the employer wants to start the project's construction. There are a variety of procurement methods, and they are divided into traditional and non-traditional. The procurement method chosen is mostly determined by the project's size, characteristics, and duration of construction. Tendering is a critical stage in the

construction projects for traditional procurement. Several contractors are invited to tender the construction project. Through the tendering process, the contractor with a fair tender price and best value of work is awarded to construct the entire project or certain construction work packages (Davis and Stafford, 2016).

IT is involved in the pre-construction stage, construction stage, and project close-out stage. In the pre-construction stage, electronic tendering (e-tendering) is invented through IT. According to RICS (2010), the transmission and reception of tender documents electronically during the tendering period are referred to as e-tendering. E-tendering enables the entire tendering procedures to be conducted over the internet. E-tendering is the transformation of paper-based traditional tendering into electronic-based tendering. In e-tendering, fewer or no papers are used because all tender documents are delivered in the digital file.

Many countries had begun to use e-tendering in the construction industry to replace traditional tendering in the last decade. This is because e-tendering saves time and expense when compared to traditional tendering (Chilipunde, 2013). Similarly, in Malaysia, the Government had implemented e-Perolehan and NeTI to increase transparency and improve tendering processes. E-Perolehan is an electronic procurement (e-procurement) system that also offers e-tendering. NeTI serves as a platform for the e-tendering process in the construction sector (Ezanee, Norlila, and Norshuhada, 2003; Lou, 2007). Some organizations use their own e-tendering system in the private sector to streamline the tendering process and select the most suitable contractor to complete the construction project.

E-tendering system is applied widely in the worldwide due to its benefits to the users and construction industry. Many researchers had published much research to look into the critical success factors of using e-tendering systems in the construction industry. The majority of the researchers claimed that time and cost savings were the most important success factors. E-tendering system significantly cuts down the printing costs and shortens the tendering period (Tindsley and Stephenson, 2008). According to Sydorenko (2017), reducing costs in the tendering process was always the main objective of the governments and construction firms.

Aside from crucial success factors, there are also obstacles to deploying e-tendering systems in the construction industry that must be addressed. Because of these obstacles, certain countries are seeing a sluggish adoption of the e-tendering system (Chilipunde, 2013). Wimalasena and Gunatilake (2018) stated that an e-tendering system required massive initial capital expenditure, which some companies cannot afford. Lack of skilled staff was also an obstacle to applying an e-tendering system (Eadie, et al., 2009).

1.2 Problem Statement

Almost every industry in Malaysia must work from home, and the offices were closed during MCO, except for the necessities industry. Due to the arrangement of MCO, traditional tendering, which is required for the physical acquisition of tender documents, was no longer possible. As a result, Jabatan Kerja Raya (JKR) implemented online tenders to replace traditional tendering and developed online tenders procedures rules (Master Builders Association Malaysia, 2021).

According to the research in Indonesia by Hansen, et al. (2021), the e-tendering method was being used due to the Covid-19 pandemic. Everyone, including the construction company, had to "work from home" when countries were on lockdown. As the current Covid-19 mitigation measures, most employees were required to work remotely to prevent the spread of the Covid-19 virus. Gamuda Bhd., a Malaysian construction company, used SAP Ariba, a digital procurement system, to execute the e-tendering process (Gamuda Berhad, 2020). During the Covid-19 epidemic, SAP Ariba allowed the tendering process to continue as usual while working remotely. This was because e-tendering enables the tendering progress while maintaining the physical distancing practices during tender submission and avoiding crowd gathering during the tender opening. At this moment of the Covid-19 pandemic, e-tendering should be widely applied in the construction industry to prevent the spread of Covid-19 without delaying the construction project's progress.

There were many studies regarding e-tendering and the consequences of Covid-19 on the construction industry had been published. For example, Saiful and Anim (2015) and Tan and Suhaida (2016) looked into the benefits and drawbacks of implementing the e-tendering system in the Malaysian construction industry. Besides, Zamani, et al. (2021) studied the effect of Covid-

19 on Malaysian building construction projects. There are limited studies regarding the application of e-tendering in the construction industry during the Covid-19 pandemic. As a result, this research aimed to investigate the various tendering systems used by Malaysian construction firms prior to and during the Covid-19 epidemic, whether traditional or electronic. This was because the research intended to discover whether construction companies changed their tendering methods and how the Covid-19 pandemic influenced such changes. This research also studied the critical success factors and obstacles of applying the e-tendering system in the Malaysian construction industry during the Covid-19 pandemic. The intention was to establish why certain construction firms used the e-tendering system while others did not.

1.3 Aim and Objectives

The aim of this research was to study the application of e-tendering system in Malaysian construction industry during the Covid-19 pandemic. The objectives of this research were:

- (i) To compare the tendering system used prior to and during Covid-19 pandemic.
- (ii) To identify the critical success factors of e-tendering system application.
- (iii) To evaluate the obstacles of e-tendering system application.

1.4 Research Scope

This study focused on tendering systems used prior to the Covid-19 pandemic, which was before March 2020 and during the Covid-19 epidemic. The Covid-19 pandemic was divided into two phases: an early phase that lasted from March 2020 to October 2021, and a later phase that lasted from November 2021 to the present day. The research also looked into the critical success factors and obstacles to using an e-tendering system during the pandemic in the Malaysian construction industry. The target respondents for this research were quantity surveyors in the construction industry from developers, consultants and contractors companies. This was because the quantity surveyors are more familiar on the tendering process.

1.5 Research Methodology

There were three phases to this study. Figure 1.1 showed how the three phases were carried out in order to fulfill the objectives. Phase 1 was a literature review, which was used to determine the research problems and obtain information. The data from the respondents was collected in phase 2 using quantitative research. Questionnaire survey was used to collect the information. The research findings were presented in phase 3.

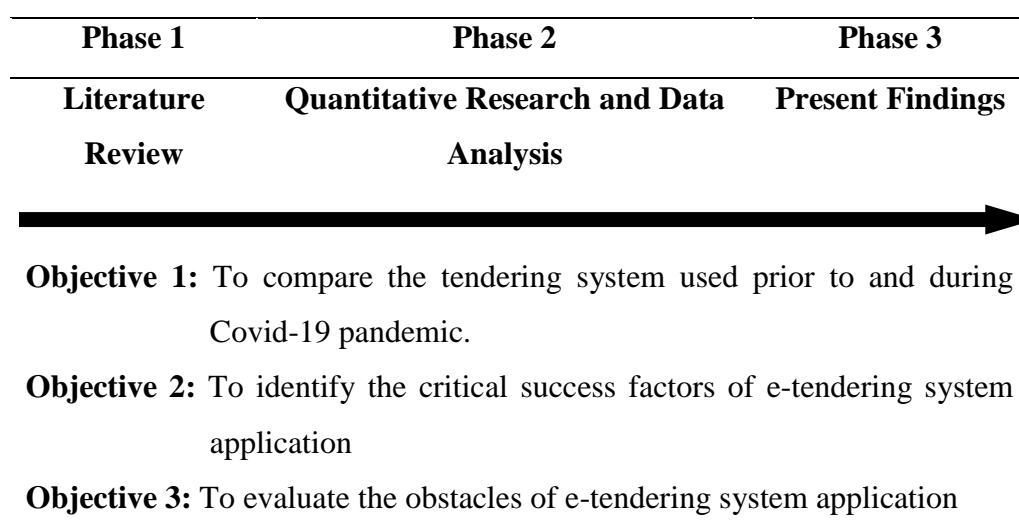


Figure 1.1: Three Phases of Research Methodology

1.6 Outline of the Report

This research consisted of five main chapters: Introduction, Literature Review, Research Methodology, Results and Discussion, and Conclusion and Recommendations.

Chapter 1 was an Introduction that described the genealogy of traditional tendering and e-tendering in the construction industry and the influences of the Covid-19 pandemic. This chapter consisted of the aim and objectives of the research, problem statement, research methodology, research scope, and outline of the report.

Chapter 2 examined previous research on the critical success factors and obstacles to applying an e-tendering system in the construction industry. In addition, the consequences of the Covid-19 outbreak on the construction industry's tendering procedure were depicted in this chapter.

Chapter 3 covered the research methodology applied for this research. This chapter described the research methods, data collection methods, sampling, instruments used for research, and data analysis.

Chapter 4 was the discussion and explanation of the results of this research. The data obtained from the questionnaire surveys were analysed by using different methods. The research's findings were explained along with the evidence in Chapter 2.

Chapter 5 was the final chapter of this research. This chapter was the summary of the entire study, including findings, limitations, and recommendations.

1.7 Summary

In short, the research intended to investigate the application of the e-tendering system in the Malaysian construction industry before and during the Covid-19 pandemic. The traditional tendering process is often carried out by physically transmitting tender documents. Malaysia declared MCO in March 2020 to avoid the spread of the Covid-19 virus throughout the country, and everyone was obliged to work from home. The physical transmission of the tender documents was halted as a result of this. Hence, Gamuda Bhd., one of Malaysia's most well-known construction companies, had adopted SAP Ariba, an e-tendering system, to complete the tendering process as usual while working remotely.

The goal of this study was to discover the tendering systems used before and during the Covid-19 pandemic. This was to understand the trend of using traditional tendering and e-tendering systems in the Malaysian construction industry in the time frame. Furthermore, this research also intended to determine the critical success factors and obstacles of applying the e-tendering system in the Malaysian construction industry, in order to raise awareness among construction stakeholders and expand the use of e-tendering systems.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The traditional tendering system has been applied in the Malaysian construction industry for many years. Beginning in 2020, the world is engulfed by the Covid-19 epidemic, which had an impact on the global economy. Traditional tendering is ineffective due to social distancing; nevertheless, during this epidemic, e-tendering is advised for use in the construction industry. E-tendering has a number of advantages, which are also crucial to the application's success. At the same time, there are also some obstacles to using e-tendering.

2.2 Traditional Tendering in Construction Industry

Runeson and Skitmore (1999) described tendering in the construction industry as a process that links the project's employer with the contractor. The Aqua group (2006) further explained this by describing the tendering as “A procedure to select a suitable contractor, at a time appropriate to the circumstances, and to obtain from him at the proper time an acceptable offer upon which a contract can be let” (O’Connell, 2010). It can also understand as when a client wants to construct a new building or renovate an existing building, and the tendering system is utilized to appoint a suitable and capable contractor (Finch, 2011). To summarise, tendering is a process in which qualified contractors are encouraged to submit tenders for specific construction projects, and the employer selects the best contractor for the job.

2.2.1 Tendering Methods

Tendering methods applied in the construction industry can be distributed into three main types which are open tendering, selective tendering, and negotiation tendering. For open tendering, the tenderers are invited through a public advertisement with no limit on the number of tenders received. In Malaysia, the majority of government projects will use open tendering, such as JRK projects. This statement was further demonstrated by Tun Dr. Mahathir Mohamad's suggestion in 2018 that open tendering should be adopted for public procurement because of its transparent tendering process

(Xavier, 2018). Under selective tendering, the project team or the client will compile a shortlist of known tenderers based on previous project experience. Only the tenderers on the list, which is normally three to six, are invited to tender. Selective tendering is generally used for client-repeated projects or specialist projects. While for negotiation tendering, there is only one tenderer who will negotiate with the client. This method is typically adopted for highly specialized projects where only one construction company has the necessary skillset and capacity to accomplish the works (Davis and Stafford, 2016; RICS, 2014).

2.2.2 Traditional Tendering Process in Construction Industry

Tender preparation should be completed before the start of the tendering process. The employer should confirm the procurement method of the construction project, whether it is a traditional or non-traditional method, such as package deal or design and build. The type of procurement method chosen will have a considerable impact on how the tender documents are prepared. Following the procurement method selection, the consultant quantity surveyor will compile a list of qualified contractors who will be invited to tender. Tender documentation depends on the procurement method. For instance, in a traditional procurement method, the bills of quantities (BQ), specifications, schedules of works, schedule of rates, and drawings are compiled in the tender document. The drawings are issued electronically in the form of CD-ROM or via email (Brook, 2004).

The next step is calling of tender. When the tender document is ready for private projects, the tenderers will receive a letter of invitation to tender. The letter specifies the project in terms of its nature and site location, the tender submission date and location, and the tender deposit and tender documentation fee. Tenders for government projects are advertised in newspapers and other forms of electronic media. The interested tenderers may purchase the tender documents (Cherif, Khalil and Waly, 2014). The tenderers should review the tender documents for completeness once they have received them. Tenderers are given a reasonable tendering period, usually two weeks, to price the BQ and prepare the tender. The tendering time will be extended if an addendum is issued at a later stage of the tendering period. Any adjustments to the designs or correction of mistakes in the tender document are usually considered an addendum. Tender meetings will be held to answer tenderers' questions and explain the main components of the tender (Davis and Stafford, 2016). All tenderers are treated

equally, and any answers to the questions should be formally sent to all tenderers who did not show up, along with the questions involved.

Tenderers must submit their tenders by the date, time, and location specified in the letter of invitation to tender. For security reasons, the tender should be sealed in an envelope. Before the tender is opened, a form for the opening of the tender will be generated. The employer and the project team members, including the consultant quantity surveyor, will attend the tender opening. Each tender will be opened, and the tender price will be recorded in the form that has been prepared. The parties present for the opening tender will next check and sign the form. During the tender evaluation, the consultant quantity surveyor has to evaluate the accuracy of pricing of BQ, the Form of Tender, and Summary of Tender to avoid any arithmetical errors. Following the evaluation of the tender, a tender report will be prepared. Each tender price will be documented and compared in the tender report to determine who submitted the highest offer and who submitted the lowest bid. Based on the evaluation findings, the consultant quantity surveyor will propose a recommendation for the most suitable tenderer to construct the project (Roy, 2017). The tender report will be submitted to the employer. The successful and unsuccessful tenderers will be notified in letter form after the employer approves the tender report. The successful tenderer will get a letter of award. The contract price, construction period date of commencement of the contract, and other relevant information are included in the award letter (Davis and Stafford, 2016; RICS, 2014). Figure 2.1 illustrated the process of traditional tendering.

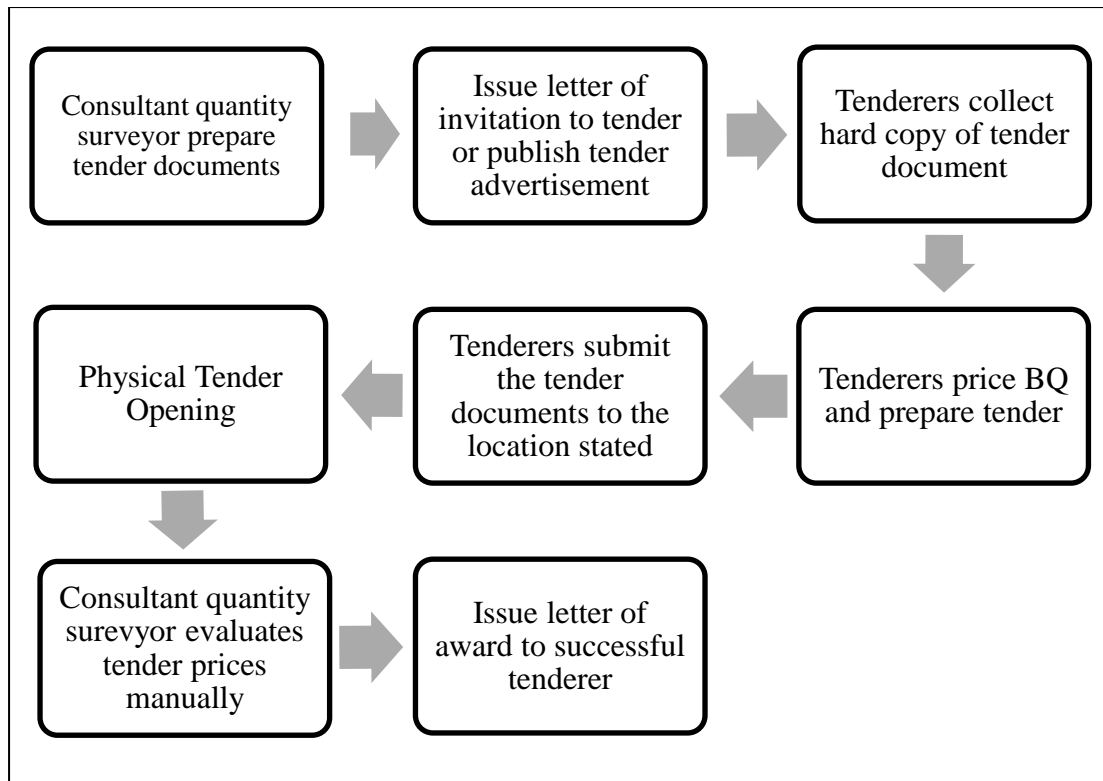


Figure 2.1: Tendering Process

2.3 E-Tendering

Westcott and Mayer (2002) defined e-tendering as the digital exchange of information and pricing between computers, excluding fax transmission, which means that the tendering procedure does not include any paperwork. Furthermore, e-tendering is described as the electronic conduct of a tender exercise, which includes advertising, communicating, accessing, collecting, and submitting tender documents using an internet-based system that speed up the procurement of a construction project and contract award (Kajewski, Weippert and Crawford, 2001; Lou, 2007; Sunmola and Shehu, 2020). The project's employer publishes the tender on the internet, and interested contractors receive, price, and submit tender documents online to win the tender. In short, e-tendering is a non-traditional tendering system that eliminates paperwork and conducts the entire process online, from tender advertisement to tender award, to provide a seamless procurement of construction work.

2.3.1 E-Tendering System in Malaysia

In 1999, the Malaysian Government launched e-Perolehan, an electronic procurement system under MYPROCUREMENT. The IT transformed the traditional services to online services effectively. Its goal was to increase service quality by automating government procurement processes. E-Perolehan is a multi-buyer, multi-supplier electronic procurement domain where government bodies serve as buyers and enterprises serve as suppliers. E-Perolehan enables government bodies to commence an electronic approval process and generate, upload, and collect purchase orders, delivery orders, and other associated documents. Supplier registration, centralized contractual, direct procurement, quote system, tender system, ministry contract, and e-tendering are the seven modules that make up e-Perolehan functionalities (Kaliannan, Suseela and Rugayah, 2010; Erne and Husnayati, 2013).

In addition, National E-Tendering Initiative (NeTI) was developed as IT-based project management and procurement system. According to Lou (2007), NeTI is a government program that combines and connects every procedure and element of the whole construction tendering supply chain onto an electronic or digital channel to overcome barriers such as geographical, time, economic, and human error. NeTI makes the tendering process faster and efficient, and profitable for the construction industry. The Star Online (2011) reported that Construction Industry Development Board (CIDB) prepared to implement NeTI as a platform for the Works Ministry to manage online job tenders. It allowed for the automation of the entire tender procurement process, from the tender advertisement to the tender evaluation. NeTI assists in making the Government's tendering process more transparent while also lowering the cost of tender preparations.

SAP Ariba, a digital procurement system that is used by Gamuda Bhd. and Sunway Bhd. It provides the employer and contractors to complete the contracting procedure electronically, with each step being tracked. The contractors can organize their company information in the system, and the employers can gain a better understanding of their contractor base. This shortens the procurement cycle and saves time for all parties. SAP Ariba also provides an e-tendering function that enables various tenderers to compete in a more transparent manner, resulting in a fairer tendering (Lim, 2018).

CubiCost E-Tendering was created by Glodon to ensure a secure and effective tendering procedure. It is a platform that allows the tenderers to submit the BQ to the

employer. The consultant quantity surveyor generates an unpriced BQ utilizing TBQ software during tender preparation, and the tender documents are subsequently compiled and posted to the platform (Li and Yu, 2019). Tender prices are automatically compared and evaluated in CubiCost once tenderers submit the bids. The analysis can be saved as an Excel spreadsheet (Vitharama, 2021).

2.3.2 Current Status of E-Tendering in Malaysia

According to the study by Alsagoff, Lou, and Zainon (2006), the Malaysian construction sector is willing to use e-tendering, which is NeTI as it improves the processing of tender data and payments. Since 2003, RM 25 million has been invested in the NeTI project, which has passed through five phases of fine-tuning in order to create an automated system that is easy to use and eliminates the need for tenderers to be concerned about the safety of the tender price submitted (EdgeProp, 2011).

From the year 2000 to 2012, the transaction activity of e-Perolehan increased. Until the year 2012, the transaction value appreciated by at least 10% per year (Mashitah, Azian and Zarina, 2013). E-Perolehan system completed 10.4 million transactions worth RM115.8 billion in 2017 (Farah, 2017). Shortly, the e-Perolehan system is widely used in Malaysia.

Sunway Bhd., a Malaysian property-construction giant, partnered with SAP Company to adopt SAP Ariba in order to streamline the procurement process since the year 2000 (The Paypers, 2014). Gamuda Bhd. had also adopted the SAP Ariba in order to begin the digitization journey in the construction industry during the year 2018. SAP Ariba, as a digital procurement platform, allows the client and contractor to complete the contractual process online. SAP Ariba also provides e-tendering services to manage the tendering process from invitation to award, allowing various tenderers to compete in a more transparent manner, resulting in more fair competition and cost savings (Lim, 2018).

JUBM Sdn. Bhd., a well-known consultancy firm in Malaysia, and its sister company, Arcadis (Malaysia) Sdn. Bhd., are among the first to use modern technology in QS professional work since the 1990s. Before the Covid-19 pandemic, the consultants already apply L10Pro, an e-tendering software in order to improve the tendering process's speed and accuracy (Aziz, 2019). Yeung (2017) also introduced the L10Pro software, which can automatically analyse and compare the tender prices and rates. The BQ is distributed to tenderers in L10Pro format during the tendering phase

for them to price. If a BQ addendum has been issued, the L10Pro system can merge it with the original BQ.

Jaafar, et al. (2007) investigated workers' technological preparedness in Malaysian construction firms and discovered that the Malaysian construction sector is actively using E-Tendering for building projects due to its benefits and conveniences. However, there was still some companies still remain using the traditional tendering system due to some reasons which will further discuss below.

2.3.3 E-Tendering Process

Technically, the e-tendering process is similar to the traditional tendering process, including a tender advertisement, tender submission, tender evaluation, and tender award. The tendering procedure is similar in all of the systems mentioned above. The typical tendering process can be categorized into six steps, which are a tender invitation, registration and purchase tender, pricing and upload BQ, open tender box, evaluate tender, and tender award. Every step is described accordingly.

2.3.3.1 Tender Invitation

After the tender documents have been prepared, the tender advertisement will be published. The drawings, specifications, BQ, and others documents are compiled in one folder and upload to the system or the website (Saiful and Anim, 2015). The tender documents' files are compressed to minimize the uploading time and storage space of the e-tendering system (Seah, 2008). In the open tendering, the employer will upload a tender notice on the website or the system to invite the contractors to bid. The tender notice contains all the relevant information such as tender title, client's details, documentation fees, and tender closing date (Tan and Suhaida, 2016). While in selective tendering, the pre-qualified tenderers will get notified to download the tender documents from the system.

2.3.3.2 Registration and Purchase Tender

The tenderers who notice a tender posted on the e-tendering website and are interested of the project can register in the system and purchase the tender documents online by using the registration code. The tenderers can use the registration code to access the system and download the tender documents. (Lou, 2007). The tenderers can also print the tender documents after downloading (Saiful and Anim, 2015). In selective tendering,

the tenderers are provided a user name and password to access the system and download the tender documents directly (Vitharama, 2021). The tender documents contain all pertinent information, such as the deadline for submission and the submission procedures.

2.3.3.3 Pricing and Upload BQ

After downloading the tender documents, the tenderers should confirm the completeness of the documents. Tenderers are responsible for informing the person in charge if any documents are missing. After the tenderers have completed their checks, they can begin pricing the BQ. The tenderers must submit the tender documents with a priced BQ to the system or the website before the date of closing tender (Betts, et al., 2006).

2.3.3.4 Open Tender Box

All tender documents are kept in a safe environment with a high level of protection. Only after the closing date, the employer or the consultant quantity surveyor will log in to the system to open the tender box (Betts, et al., 2006). There is no need for tenderers to be concerned about any unethical behaviour. During the tender opening, the consultant quantity surveyor will log in to the system to download the submitted tender documents (Tan and Suhaida, 2016).

2.3.3.5 Evaluate Tender

After the tender opening, the consultant quantity surveyor will evaluate the tender prices in order to prepare a tender report. Tender evaluation is a feature included in the CubiCost E-Tendering and L10Pro software. The tender prices are compared and analysed automatically. The tender prices can be arranged in ascending and descending order to distinguish between high and low-cost items (Vitharama, 2021). Tender evaluation can be automated to save time while preparing a tender report.

2.3.3.6 Tender Award

Notification of tender award results can be done electronically through the e-tendering system or some other agreed-upon procedure. The system releases the public notification of the project's successful tenderer (Betts, et al., 2006). Even when the e-tendering system posted the result, writing a formal email to the successful and

unsuccessful tenderers can be an additional channel (RICS, 2010). Finally, the client and the awarded tenderer sign the contract using e-signatures. Figure 2.2 illustrated the process of e-tendering.

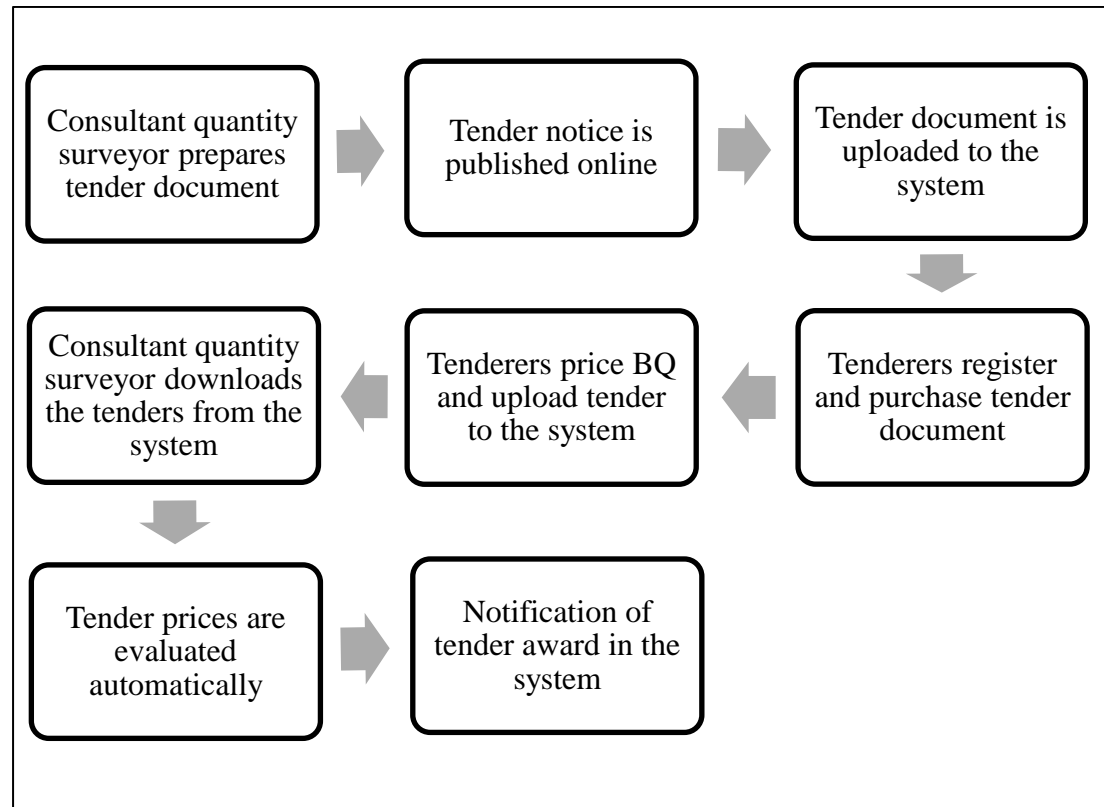


Figure 2.2: E-Tendering Process

2.4 Comparison of Traditional Tendering and E-Tendering

Traditional tendering and e-tendering both include the same steps in the tendering process, but the features and activities performed at each step are clearly different. Table 2.1 illustrated the comparison of traditional tendering and e-tendering systems.

Table 2.1: Comparison between Traditional Tendering and E-Tendering

Component	Traditional Tendering	E-Tendering
Tender Invitation	In the open tendering, the tender notice is advertised in the newspaper. In selective tendering, the tender invitation is sent to the pre-qualified tenderers via email or fax.	In the open tendering, the tender notice is advertised on the website or the e-tendering system. In selective tendering, the pre-qualified are notified and given access to the tender document in the system.

Table 2.1 (Continued)

Purchase Tender Documents	The tenderers can purchase and get the hard copy of the tender documents from the person in charge.	The tenderers can get access key to log in the e-tendering system and download the soft copy of the tender documents.
Tender meetings	The face-to-face meetings are conducted.	The virtual meetings are conducted via the internet.
Tender Addendum	The tender addendum is hand-delivered or emailed to the tenderer.	The tender addendum is uploaded to the e-tendering system.
Tender Submission	The tender documents are sealed and submitted to the location stated in the tender notice before the deadline.	The tender documents are uploaded to the system before the deadline.
Tender Evaluation	The consultant quantity surveyors evaluate tender prices manually.	Without having to evaluate manually, consultant quantity surveyors can download the submitted tender documents in a format suitable for evaluation.
Tender Award	The successful tenderers and unsuccessful tenderers are noticed via letter.	The notice of successful tenderers is published on the e-tendering system.

As shown in Table 2.1, the tenderers do not have to physically participate in the e-tendering. All processes are completed online by using an e-tendering system. However, in traditional tendering, the tenderers must purchase and collect the tender document, attend tender meetings and submit the tenders physically. There are no distinctions in the tendering process between traditional tendering and e-tendering, but there are differences in the manner data and documents are exchanged (Wimalasena and Gunatilake, 2018). Ezanee, Norlila and Norshuhada (2003) also explained another difference is that e-tendering uses less paper because the documents are read online, and only a soft copy is submitted to the system. The tender documents are saved in the system and can be accessed at any time, so there is no need to prepare physical storage. In brief, e-tendering is more convenient than traditional tendering.

2.5 Critical Success Factor of E-Tendering Application

According to Bulut and Yen (2013), e-tendering was being implemented worldwide, including Europe, Asia, America, and Africa. In recent years, e-tendering was gaining popularity in the construction industry due to its numerous advantages. Table 2.2 showed the critical success factor of the application of e-tendering by previous studies.

2.5.1 Cost Reduction

2.5.1.1 Reduce Printing Cost

Tindsley and Stephenson (2008) explained that printing costs were reduced as the tender documents were no longer printed. The tenderers could access tender documents in soft copy via the e-tendering system. According to the case study in Water Service Northern Ireland conducted by CITE in 2001 (as cited in Eadie, et al., 2009), electronic documentation saved a total 90% of cost compared to a paper version of the same contract.

2.5.1.2 Reduce Management Cost

Chilipunde (2013) indicated that by automating the tendering process, the e-tendering system might reduce the management cost of the tendering process. The tenderers received all tender documents and tender addendums from the system electronically, which eliminated the usage of paper and reduced the chance of errors. With online access to documents, the requirement to manage tenderer-requested documents manually was eliminated, resulting in even more resource savings (Saiful and Anim, 2015). Nawi, et al. (2017) also agreed with this statement and said that Government could save management costs by using an e-tendering system. Lou and Alshawi (2009) agreed with their assertion, saying that e-tendering improved the tendering process become less expensive while ensuring greater control and administration of the process.

Table 2.2: Critical Success Factors of E-Tendering Application

Critical Success Factors	Previous Studies												
	Egbu, Vines and Tookey (2003)	Betts, et al. (2006)	Tindsley and Stephenson (2008)	Eadie, et al. (2009)	Lavelle and Bardon (2009)	Lou and Alshawi (2009)	Eadie, Perera and Heaney (2010)	Chilipunde (2013)	Saiful and Anim (2015)	Tan and Suhaida (2016)	Nawi, et al. (2017)	Sydorenko (2017)	Sayed, et al. (2020)
Cost Reduction													
Reduce printing cost			✓	✓									
Reduce management cost						✓		✓	✓			✓	
Time Saving													
Reduce time on duplicating tender documents			✓										
Enable late adjustments			✓										
Reduce tendering period					✓			✓					
Improved Communication													
Quicker communication process						✓	✓						
Receive tender addendum immediately		✓											
Improved Transparency													
Improve transparency of tendering process					✓							✓	
Improve transparency of communication process	✓												✓
Storage of Tender Documents													
Reduce physical storage										✓			
Prevent data loss during transaction								✓					✓

2.5.2 Time Saving

Cost and time are frequently perks connected at the hip, as the public phrase "time is money" suggests. Hence, e-tendering also saves time comparing to traditional tendering.

2.5.2.1 Reduce Time on Duplicating Tender Documents

According to Tindsley and Stephenson (2008), the time spent duplicating and uploading tender documents had decreased because they were now created in digital formats and published online. Employees did not need to waste time printing and to copy a large number of tender documents on a printer because there was no need for a hard copy. The tender documents were posted to the system and were available for download by the tenderers.

2.5.2.2 Enable Late Adjustments

Tindsley and Stephenson (2008) explained that late adjustments could be included more readily in the tender. If a change was made to the tender, tenderers would be able to access it shortly.

2.5.2.3 Reduce Tendering Period

E-tendering enabled shortening the tender period (Lavelle and Bardon, 2009). Chilipunde (2013) followed up the statement and explaining that e-tendering allowed for a rapid and effective pre-qualification and evaluation process. With a fully automated e-tendering system, tender evaluation time could be reduced.

2.5.3 Improve Communication

2.5.3.1 Quicker Communication Process

In the tendering phase, technology advances communication by moving from a traditional method to an electronic one. Mail is the conventional method of communication, whereas emails and digital media are used for electronic contact. For instance, the issue of any tender addendums takes place electronically. The email was utilized to record and speed up the communication process (Lou and Alshawi, 2009). Eadie, Perera and Heaney (2010) collected data in Scotland and discovered e-tendering reduced internal and external communication cycle times. This was because mail with a longer delivery time

was no longer in use. Faster responses could be obtained from employers and tenderers through emails.

2.5.3.2 Receive Tender Addendum Immediately

Any tender addendum was uploaded to the e-tendering system (Betts, et al., 2006). Tenderers could directly obtain the tender addendum through the e-tendering system.

2.5.4 Improve Transparency

2.5.4.1 Increase Transparency of Tendering Process

The application of e-tendering was to increase the transparency of the tendering process as the employer, or the consultant quantity surveyor may oversee the tender's progress via an internal system (Sydorenko, 2017; Lavelle and Bardon, 2009). Transparency is a fundamental element of the government procurement process. The Malaysian Government launched e-Perolehan in 1999 to improve public procurement and, most importantly, increase transparency in the process. One of the functions of e-Perolehan is e-tendering. According to the study by Erne Suzila Kassim and Husnayati Hussin (2013), the implementation of e-Perolehan promoted more transparency. Besides, the Government of Punjab, Pakistan, adopted the e-tendering system to ensure the transparency of tendering process and reduce corruption (The News International, 2019).

2.5.4.2 Increase Transparency of Communication Process

According to Sayed, et al. (2020), e-tendering enabled the transparent communication process between various stakeholders. There was the automation of preparing paperwork such as contract documents, transparency was achievable (Egbu, Vines and Tookey, 2003). As a result, the chances of changing the information in the tender documents were decreased. Moreover, the acceptance of electronic contract documents as evidence in contract dispute proceedings was critical to promoting transparency.

2.5.5 Storage of Tender Documents

2.5.5.1 Reduce Physical Storage

Tender documents are made up of various documents, making them paper-heavy (Tan and Suhaida, 2016). It could be challenging to keep incoming tender documents when existing tender documents already took up space. The process could be paperless, and the transaction could be done electronically by using an e-tendering system. Tender documents could be saved and read in the e-tendering system. Hence, there was no need to prepare physical storage to keep the tender documents.

2.5.5.2 Prevent Data Loss during Transaction

In addition, an e-tendering system could guard against data loss as the tender documents were transferred electronically (Sayed, et al., 2020). The documents were exchanged manually in the traditional tendering, and the data in the documents was not secure. During transactions, data may be lost due to human error (Chilipunde, 2013). There was no need to be concerned about data loss or damage when tender documents were uploaded to the e-tendering system. Following the tender opening, the quantity surveyor consultant downloaded and saved the submitted tender documents on the computer. The data of the documents were secure.

2.6 Obstacles of E-Tendering Application

In line with the critical success factor, there were obstacles to e-tendering applications. Despite the fact that e-tendering had been around for a long time, it was still underutilized in the construction sector due to its characteristics and users' views. Table 2.3 indicated the obstacles to applying e-tendering in the construction industry.

2.6.1 Security and Policy Concern

2.6.1.1 Security of Sensitive Data

The tenderers were unwilling to use an e-tendering system because they were worried about the security of sensitive data such as the tender price and the confidentiality of tender documents being leaked, allowing competitors to obtain their tender price (Davila, Gupta and Palmer, 2003; O'Connell, 2010).

Table 2.3: Obstacles of E-Tendering Application

Obstacles	Previous Studies														
	Davila, Gupta and Palmer (2003)	Tindsley and Stephenson (2008)	Eadie, et al. (2009)	Lavelle and Bardon (2009)	O'Connell (2010)	Khu, Wahidah and Norlia (2012)	Chilipunde (2013)	Cherif, Khalil and Waly (2014)	Saiful and Anim (2015)	Balogun, Talukhaba and Opaleye (2016)	Tan and Suhaida (2016)	Nawi, et al. (2017)	Sydorenko (2017)	Izzati, Suhaida and Kam (2018)	Wimalasena and Gunatilake (2018)
Security and Policy Concern															
Security of sensitive data	✓				✓										
Inconsistency of government policy						✓						✓			
Cost of E-Tendering System															
High initial cost		✓					✓	✓							
High maintenance cost										✓				✓	
Limited Knowledge and Skill															
Elder generation fail to keep up			✓												
Limited training		✓								✓					
Lack of knowledge			✓	✓											✓
Resistant to Change															
Lack of awareness of employees									✓						✓
Comfortable with traditional tendering										✓		✓			✓

2.6.1.2 Inconsistency of Government Policy

The Malaysian construction industry's e-tendering application was hampered by inconsistencies in government policy and legislation (Khu, Wahidah and Norlia, 2012). An excellent example was a normal practice for the Government tendering process, in which the tenderers collect the hard copy of the tender documents from offices. This prevented the implementation of an e-tendering system and was a major setback for the Government's efforts to develop an e-tendering system (Nawi, et al., 2017).

2.6.2 Cost of E-Tendering System

2.6.2.1 High Initial Cost

The obstacle in implementing the e-tendering system was the high initial cost. Chilipunde (2013) conducted a survey and discovered that a significant sum of money was intended to develop and set up the e-tendering system at the outset. Cherif, Khalil and Waly (2014) agreed with the assertion and explained the initial costs, including the purchase of new computers, unique software, licenses, the recruitment of skilled employees, and organizing training courses. The employer must invest a huge amount of money in preparation before officially implementing the e-tendering system. Smaller businesses would be hampered by the high initial costs, as their capital may not be sufficient to develop an e-tendering system (Tindsley and Stephenson, 2008). To summarise, considerable initial capital, including IT and training expenditures, was required to engage in an e-tendering system, which was why small businesses are hesitant to do so.

2.6.2.2 High Maintenance Cost

IT technologies were prohibitively expensive and rapidly evolving. The cost of maintaining the e-tendering systems to ensure that they were always up to date would be prohibitively high (Tan and Suhaida, 2016). Izzati, Suhaida and Kam (2018) agreed with this assertion and emphasized that updating the software was also expensive. Without Malaysian government funding, small and medium-sized businesses may be unable to pay the expense of software upgrades on a regular basis.

2.6.3 Limited Knowledge and Skill

2.6.3.1 Elder Generation Fail to Keep Up

These obstacles originated from human issues, such as the older generation's failure to keep up with technological changes and reliance on the traditional tendering system (Eadie, et al., 2009). Technology advances at a breakneck pace, leaving the elder generation behind and unable to use the e-tendering system.

2.6.3.2 Limited Training

Balogun, Talukhaba and Opaleye (2016) stated that there was a shortage of IT support skills training for technical workers, which caused them to have limited skills in using the e-tendering system.

2.6.3.3 Lack of Knowledge

Lack of knowledge was one of the constraints to implementing e-tendering systems (Wimalasena and Gunatilake, 2018). Some of the tenderers did not have the e-tendering knowledge and were confused about how to utilise it because they had not touched it previously (Eadie, et al., 2009).

2.6.4 Resistant to Change

2.6.4.1 Lack of Awareness of Employees

According to Saiful and Anim (2015), the employees in Malaysian construction industry were unaware on using new items. This was due to a lack of awareness initiatives regarding the effectiveness of e-tendering (Wimalasena and Gunatilake, 2018). Employees will prefer to use traditional tendering over e-tendering due to unfamiliarity with it.

2.6.4.2 Comfortable with Traditional Tendering

According to the study by Tan and Suhaida (2016), the Malaysian construction industry had been using traditional tendering for a long period, and that people were more comfortable with it and did not want to use an e-tendering system that they were unfamiliar. Based on the statistics, Izzati, Suhaida and Kam (2018) concluded that the existing construction industry was sluggish to adapt changes to the e-tendering system since they were more experienced with traditional tendering.

2.7 Covid-19 Pandemic

In 2020 and 2021, the world was being shrouded by the Covid-19 pandemic. The origin of the Covid-19 pandemic is the outbreak of pneumonia cases caused by a newly found coronavirus in Wuhan, a city in China, in December 2019. The World Health Organization (WHO) had designated this pneumonia as coronavirus disease-2019 (Covid-19), the official name of this disease (Al Amri and Marey-Pérez, 2020; Gautam and Hens, 2020). In January 2020, there were confirmed cases in China's neighbour countries reported to WHO, Thailand, Japan, and Korea. After that, this disease became uncontrollable and was exported to European countries and the rest of the world (WHO, 2020). Covid-19 had become a global pandemic worldwide. The Covid-19 outbreak wreaked havoc on the national health care system. Many families had been torn apart by the death of dear ones as a result of Covid-19. According to WHO (2021), until June 2021, there were a total of more than 170 million confirmed Covid-19 cases and more than 3 million death cases in this world.

Most countries issued lockdown policies to enhance social distancing and avoid large-scale gatherings such as concepts to slow down the spread of Covid-19 worldwide. BBC NEWS (2021) reported that more than 100 countries worldwide, including Asia, European countries, the Americas, and even African countries, had instituted a full national lockdown or localized lockdown to prevent virus spread. To combat the rising number of Covid-19 cases in Malaysia, the Government enacted an MCO restricting movement nationally beginning March 2020. Except for necessary services, all government and business sectors were closed (Hazlin Hassan, 2020). Malaysia had implemented partial lockdowns, which were Conditional Movement Control Order (CMCO) and Recovery Movement Control Order (RMCO) when the Covid-19 epidemic was under control. However, after over 8000 cases were reported in a single day in June 2021, the Government issued a Full Movement Control Order (FMCO), often known as total lockdown (Malaysiakini, 2021). This Covid-19 pandemic affected billions of individuals' daily life. Due to the lockdown policy, most workers had to work from home, including the construction industry.

2.7.1 Construction Industry during Covid-19 Pandemic

The economic activities of countries were utterly halted due to the countries' lockdown, which had a detrimental impact on the global economy. According to the World Bank, Nepal's GDP growth will be reduced from 1.5 percent to 2.8 percent in the period of the lockdown as compared to 7.1 percent before the outbreak (Aryal and Mishra, 2021). The Gross Domestic Product (GDP) of the United Kingdom in Quarter 1 of 2021 was 8.7% lower than during the end of Quarter 4 of 2019, which was before this pandemic (Meyrick, 2021). As the construction industry was one of the significant contributors to the economy, a complete or partial stoppage of on-site construction led the worldwide economy to suffer. According to the survey conducted by Ogunnusi et al. (2020) in 16 countries including England, South Africa, Saudi Arabia, Indonesia, India and others, most of the projects were affected by the pandemic, both partially stop or complete stoppage, and the work progress had been hampered even as the lockdown was being eased. Some projects experienced entirely stopped at the initial stage of the construction process but turned into partially stopped later.

When the first MCO went into effect in March 2020, most economic and business activities were not allowed, Malaysia's GDP fall by RM 2.4 billion per day, and the economy declined by 5.6 percent, the worst since the Asian financial crisis in 1998 (Teoh, 2021). The Straits Times (2020) also reported that the construction industry suffered RM 18.5 billion in losses during the first MCO. This was because the majority of construction works including mega infrastructure projects and home renovations were halted during MCO, putting contractors in a financial bind due to a lack of cash flow. During CMCO and RMCO, even the construction activities were allowed to carry out, some of the construction sites were temporarily closed due to their financial issues. The Covid-19 pandemic had a negative influence on Malaysia's economy, and some construction projects were cancelled as a result. The Kuala Lumpur-Singapore High-Speed Rail (KL-SG HSR) project was one of the projects that was cancelled (Bunyan, 2021). Zamani, et al. (2021) also said that some projects were prohibited during MCO, resulting in the Malaysian Government only awarding a minimal number of new tenders. Briefly, most of the projects experienced stoppage during the Covid-19 pandemic.

Typically, every office-based construction employee was required to work remotely from their home during the lockdown period. In Malaysia, Zoom and Microsoft Teams were the most widely utilised applications for video conferencing when people work from home. WhatsApp was also commonly used by people who work from home to communicate with others and to alert someone to important cases (Birruntha, 2020). Gamuda Bhd. was able to maintain profitability and continue operations during the Covid-19 outbreak by applying security software such as Sharepoint, FieldView, and other video chatting technologies to work remotely (Gamuda Berhad, 2020). Social distancing is not a barrier to continue working together; rather, it is a path to discover new ways to collaborate and work remotely with clients and partners, thereby smoothing the working progress.

2.7.2 Impact of Covid-19 towards Tendering Process

Apart from the problems with construction project stoppages during Covid-19, Gosse (2021) stated that procurement, a traditionally tricky topic, had become even more complicated recently. Several construction tendering activities were suspended as the impact of the Covid-19 pandemic. In United States, Jones (2020) discovered that during April 2020, 10.3 percent of projects had prolonged their tender date, 9.7 percent had cancelled the tendering activity, and the rest had kept their tender date as scheduled to publish the tender advertisement. However, the tender date delays appreciated by 80% compared with the same period in 2019. Furthermore, according to Jones (2021), many construction projects in the planning or tendering stages were being put on hold, and the number was increasing. In short, Covid-19 seemed to have an impact on construction projects, both public and private, causing tender dates to be postponed or projects to be on hold.

According to Gosse (2021), the construction industry in Canada could not afford to stop completely; considering the lead times for project approval, design, award, and performance, there was a direct correlation between supporting industry and ensuring that viable procurement was not disrupted. In other words, the Government of Canada or the construction industry could continue to issue tender calls while making some alterations to apply social distancing during this pandemic. It was suggested that virtual meetings with the

tenderers be held via conference calls. In this regard, Doran and Dorling (2021) indicated that while a physical tendering event was not appropriate at this time, tenderers' interviews and evaluation sessions could be performed using Microsoft Teams and Zoom.

In Malaysia, Jabatan Kerja Raya (JKR) had innovated the traditional tendering system and was beginning to implement online tenders for consultants through open tenders and pre-qualification open tenders to aid the Government in rejuvenating the economy. The Standard Operating Procedures (SOP) on publishing advertisement, online selling of tender documents, and tender closing in a new way had also been announced by JKR (Master Builders Association Malaysia, 2021). Tenderers can view the tender advertisement on either the MyPROCUREMENT or the JKR websites. Tenderers can use the link in the ad to fill out the Borang Saringan Wajib in Google Form format. Tenderers eligible will receive an email with an account number and the Borang Pembayaran Pembelian Tender Secara Atas Talian for online payment of the tender documents. Online payment can only be made with an instant transfer. Eligible tenderers must complete and submit the Borang Pengesahan Bayaran Dokumen Tender online and send the receipt payment to Pejabat Memanggil Tender (PMT) on the same day that the instant transfer is made. Tenderers who submit the receipt will receive an email from PMT directing them to download the Tender Document from JCloud. Tenderers need to submit a hard copy of the Tender Document by hand or through the shipping company's services (Jabatan Kerja Raya, 2021). In brief, both calling tender and purchasing of tender documents are going through via the internet in order to prevent physical contact. The tenderers can obtain a soft copy of the tender documents by accessing the internet. Tenderers must, however, submit a hard copy of the tender documents to the location specified in the tender notice during the tender submission process. The online tenders are not truly e-tendering because a hard copy of the tender document must still be submitted.

Gamuda Berhad (2020), one of the largest construction companies in Malaysia, stated that the Covid-19 pandemic highlighted the necessity of digital readiness, which allowed businesses and living to go on as usual as much as feasible during the pandemic. The construction industry could continue to operate amid the Covid-19 pandemic thanks to digital technologies. Gamuda

Bhd. implemented digital procurement by sourcing products and services through SAP Ariba since year 2018. The company continued to use SAP Ariba to manage the e-tendering process from invitation to award during the Covid-19 epidemic in order to maintain the business. The company also stated that during MCO, the majority of staff worked remotely, which allowed them to rethink and improve technology in order to ensure company continuity, accessibility, and security.

In detail, digital technology should aid collaboration in the construction industry. This pandemic encourages people to use the digital tools better and innovate them to “hyper-collaborate” virtually and exchange information more freely. According to the research by Hansen, et al. (2021) in Indonesia, the Covid-19 impacted quantity surveyors’ activities especially tendering and created an opportunity to implement the e-tendering system or online tendering. In brief, it is time to utilise and innovate e-tendering system in the construction industry entirely.

2.8 Summary

In a nutshell, the tendering system is the most important phase in the construction industry. Without it, on-site construction works cannot be commenced. However, the Covid-19 pandemic had impacted on construction industry worldwide, including Malaysia. Some projects were unable to proceed with the traditional tendering system. Hence, e-tendering is suitable to implement in this pandemic. Some of the companies such as Gamuda Bhd. and Sunway Sdn. Bhd. already implement e-tendering system before Covid-19 pandemic. The implementation of e-tendering system contains a lot of critical success factors such as cost reduction, time saving, improved communication and transparency and improved storage of tender documents. The security of the system, the high cost of the system, a lack of knowledge and expertise, and a staff attitude that resists utilising the e-tendering system are the obstacles to using an e-tendering system. Nevertheless, there is limited studies regarding the critical success factor and obstacles of application of e-tendering during the Covid-19 pandemic.

CHAPTER 3

METHODOLOGY AND WORK PLAN

3.1 Introduction

Research methodology is a systematic approach to conducting research. It refers to the processes or strategies used to discover, gather, evaluate, and analyse data in the context of research. Two major questions were addressed in the methodology section: What was the best way to collect data? What method was used to examine the data collected? This chapter described the research methods used for this research in the following. Sampling and analysis methods were also marked out in this chapter.

3.2 Research Methods

The study's research design is separated into two methods, which are qualitative research and quantitative research, in order to collect and interpret data. Qualitative research is conducted to collect the answers and data from respondent's perceptions, experiences, emotions, behaviour, and interactions by undergoing in-depth interviews, group discussions, or respondents' observations (Pathak, Jena and Kalra, 2013). The qualitative research only requires a small number of respondents due to its in-depth nature as the goal is to gain depth of information rather than statistical representativeness by digging deep into each respondent's experiences on the research issue (Hennink, Hutter and Balley, 2020). The data generated is non-numerical, which is in the form of texts and words.

Quantitative research is purposed to quantify and analyse a research problem from a study population (Hennink, Hutter and Balley, 2020). It adopts structured methods and technical tools such as surveys and questionnaires in order to gather the data accurately in a systematic way (Almeida, Queirós and Faria, 2017). Unlike qualitative research, quantitative research requires a large number of respondents. The data generated is numerical. Table 3.1 illustrated the comparison of qualitative research and quantitative research.

Table 3.1: Comparison of Qualitative Research and Quantitative Research

Characteristics	Qualitative Research	Quantitative Research
Objective	To get a more contextualised knowledge of people's actions, views, and motivations.	To quantify data and generalise outcomes to a larger group of people.
Purpose	To comprehend why? How? What exactly is the procedure? What factors or circumstances are at play?	To quantify, calculate, or measure a problem. To answer the question, how much is it? How often do you do it? What is the ratio? Which factors have a relationship?
Data	Non-numerical data or textual data	Numerical data or statistical data
Study population	Only a few people responded; they were purposefully chosen (non-probability sampling)	A large number of people responded.
Data Collection Methods	In-depth interviews, observation, focus group discussion	Population surveys, questionnaires, opinion polls, exit interviews
Analysis	Interpretative.	Statistical.
Outcome	To get a basic understanding, to recognise and explain behaviour, ideas, or actions	To find out how common something is, averages, and patterns in data. To apply to a larger group of people.

(Source: Hennink, Hutter and Balley 2020)

According to Hennink, Hutter and Balley (2020), qualitative research is useful for answering "why" questions and identifying problems, as well as "how" questions that describe actions and attitudes. Quantitative research is used when the researcher wants to find out how common the outcomes are by projecting them to the broader population.

3.2.1 Research Method Used

In this research, quantitative research was chosen to collect data from a large group of people and to generalise the outcomes to the population. This research approach collected data that may be numerically analysed and evaluated in the form of tables and statistics. The data was provided in tables, which made it simple to comprehend. Quantitative research approach was used to understand the commonly used tendering system prior to and during Covid-19 pandemic in the population of quantity surveyors. Besides, it was also utilised to identify the level of agreement towards critical success factors and obstacles of e-tendering system application expressed by the targeted respondents. A questionnaire was prepared based on the literature review to find out the research questions. The Likert scale was used in the questionnaire to collect numerical data from the respondents. The questionnaires were then distributed to the quantity surveyors in the Malaysian construction industry.

3.3 Data Collection

Data is districted into two forms which are primary data and secondary data. Primary data is the data acquired directly from the respondents by the researcher himself. It can also refer to the data that is updated in real-time (Surbhi, 2020). The primary data collection method is costly and time-consuming. Observations, interviews, surveys, and case studies can be used to collect primary data (Adams, Khan and Raeside, 2014). To put it another way, the data is gathered through qualitative and quantitative research methods.

Secondary data is the data collected and published by someone. In comparison to primary data, the collection of secondary data is more cost-effective and takes less time. The secondary data can be referred to the information which can be collected from books, journals, news, magazines, and websites. The data is used as the main source of information for the study or as a supplement to the data obtained (Adams, Khan and Raeside, 2014).

3.3.1 Primary Data

Questionnaire surveys were used to gather the primary data for this study. The questionnaire was used to collect raw data from the targeted respondents. With a list of structured questions, the questionnaire was developed in a uniform way. The questionnaires were distributed to the quantity surveyors via email, WhatsApp, Facebook, and other platforms. Each question must be answered according to the directions given to the respondents.

3.3.2 Secondary Data

Secondary data for this study came from online journal articles, online magazines, online newspapers, e-books, published reports, and published websites. The library of Universiti Tunku Abdul Rahman was primarily responsible for providing access to online journal articles and e-books. The secondary data collected was compiled and expanded in Chapter 2, Literature Review. The conclusions of primary data obtained through interviews and questionnaires were supplemented by secondary data.

3.4 Sampling

Naoum (2007) described that a sample is a part or piece of a population that used to reflect how the rest of the population looks. The features of the sample must be similar to those of the population, and it must be a representative sample of the total population. In short, sampling is the process of choosing a group of individuals from a population to be the study's responders. The following explained the sampling technique and the sampling size for this study.

3.4.1 Sampling Technique

Purposive sampling was used as the sampling technique in this research. It is one of the non-probability sampling techniques. Non-probability sampling was used because the population distribution was unknown. Purposive sampling refers to the practise of selecting samples depending on the researcher's knowledge of the population being sampled (Edgar and Manz, 2017). Therefore, the quantity surveyor-related professions in the Malaysian construction industry were selected to be the respondents by purposive sampling.

3.4.2 Sampling Frame

A sampling frame is an important consideration when designing the sampling. Sampling frame is aimed to choose the specific individuals of the target population who will be taken part in the questionnaire survey. There is possible to have more than one sampling frame in a research and each sampling frame provides various types of information and viewpoints on the research issue (Turner, 2003).

Quantity surveyors from consultancy firms, contractor firms, and developer companies in the construction industry made up three sets of sample frames in this study. To acquire thorough information and a diverse variety of opinions on the application of e-tendering systems in the Malaysian construction industry, these three sampling groups were utilised.

3.4.3 Target Respondents

The target respondents for the questionnaire survey were quantity surveyor-related professions in the Malaysian construction industry. All respondents were the quantity surveyors from consultant firms, contractor firms, and developer companies. The respondents should have a fundamental understanding of tendering process as well as prior experience.

3.4.4 Sampling Size

Cochran's formula was used to establish the sample size for the questionnaire surveys. When dealing with huge populations, Cochran's formula was used as below (Israel, 1992).

$$\begin{aligned}
 n &= \frac{Z^2 p(1-p)}{e^2} \\
 &= \frac{(1.96)^2 (0.5)(1-0.5)}{(0.10)^2} \\
 &= 96
 \end{aligned}
 \tag{3.1}$$

Where,

n = sample size

Z = confidence level

p = estimated sample proportion

e = desired level of precision

At 95 % of confidence level, the value of Z was 1.96. The level of precision was set as 10 %. 10 % was used because the lower the level of precision, the more precise of the sample size calculated. It was assumed there was a large population, but the variability in the proportion of people who was qualify to answer the survey is unknown therefore the p was set at 0.5. 0.5 was the maximum variability (Israel, 1992). As a result, the sample size for questionnaire surveys was 96.

This research also applied Central Limit Theorem (CLT) concept for the sampling size. The central limit theorem explains the sampling distribution approximates the standard normal distribution when the sample size equals or exceeds 30 (Kwak and Kim, 2017). Therefore, the sample size required for the independent categories such as natures of company and working experience should be equal of more than 30 in order to get a valid result. The results would be more realistic with larger sample size.

3.5 Research Instrument

The data gathering tools or techniques used in the research were referred to as research instruments. In this research, online questionnaires surveys were used to collect accurate data.

3.5.1 Questionnaire Design

This research questionnaire was categorised into four sections: Section A, B, C, and D. The questionnaire was made up of open and closed-ended questions. Section A was to collect the respondents' general background, including the natures of company, working experience, and current working mode.

Next, Section B compared the tendering system used before and during the Covid-19 pandemic. This section was divided into four sections, the first

three dealt with the types of tendering systems and tender interviews utilised during the specified periods. The fourth part was dealing with the respondents' preferences for tendering systems and tender interviews. The Likert Scale presented in Table 3.2 was used for the respondents to rate the level of preference for each system.

Table 3.2: Level of Preference (5-Point Likert Scale)

Ratings	Definitions
1	Not Prefer
2	Slightly Prefer
3	Moderately Prefer
4	Prefer
5	Extremely Prefer

Section C was to determine the critical success factor of e-tendering system application in Malaysia's construction Industry. The last section was Section D, which identified the obstacles of applying the e-tendering system in Malaysia's construction industry. The Likert Scale was used in Sections C and D to enable the respondents to express the level of agreement with a statement. The Likert Scale was a 5-point scale, as shown in Table 3.3. The questionnaire was created using "Google Forms" and distributed to the respondents via email, Facebook, WhatsApp, and other social media platforms.

Table 3.3: Level of Agreement (5-Point Likert Scale)

Ratings	Definitions
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

3.5.2 Pre-test

A pre-test was undertaken before distributing the final version of the questionnaire to the targeted respondents. It was a test run of the questionnaire to ensure that all questions were clear and free of errors. Ten sets of questionnaires were sent to the freshly graduated quantity surveying students,

classmates and the industry professionals for this study's pre-test. This pre-test lasted seven days, from 4 February 2022 to 10 February 2022. The feedback from the pre-test such as grammatical mistakes and misleading statements were amended to enhance the questionnaire design. The questionnaire was distributed to the targeted respondents once the inaccuracies were corrected.

3.6 Data Analysis

This study used reliability test, inferential statistics, and descriptive statistics to analyse the data obtained from the questionnaire survey. The Statistical Package for the Social Sciences (SPSS) was utilised to conduct these tests to interpret the data.

3.6.1 Reliability Test

According to Gilem and Gilem (2003), Cronbach's alpha is a method to test the reliability of the data collected from the questionnaires. It is used to test the reliability of the multiple-question Likert scale. In this study, this test was to identify the reliability of critical success factors and obstacles of applying an e-tendering system in the Malaysia's construction industry. Table 3.4 showed how the Cronbach's Alpha value is calculated using the rules of thumb. Gilem and Gilem (2003) said that usually, the reliability coefficient falls between 0 and 1. The value of Cronbach's Alpha indicates how consistent the components in the scale are internal. The higher the value, the better the data gathered.

Table 3.4: Rule of Thumb for Cronbach's Alpha

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

(Source: Gilem and Gilem 2003)

3.6.2 Descriptive Statistics

Descriptive statistics includes the frequency distribution and measure of central tendency, which aims to provide a basic summary of the results. Depending on the size of the sample, this approach can analyse data in percentages or actual numbers (Naoum, 2007). The frequency distribution method categorizes the data and establishes the number of respondents who fall into each category. This method was used to evaluate the respondents' demographic data, and the results were displayed in the table. Besides, the measure of central tendency used mean and median to rank the variables of this research. The critical success factors and obstacles of e-tendering system application agreed by the respondents were ranked based on the mean value and median value. The mean value was used for ranking while the median was used to categories the results whether they were strongly agreed or strongly disagreed.

3.6.3 Inferential Statistics

Non-parametric statistical method was utilised in this study due to the small sample size and use of ordinal scale in the questionnaire. Inferential statistics is a non-parametric method for determining the mean rank difference between two or more sample groups (Israel, 2008). The use of the Likert scale in the questionnaire necessitated using a non-parametric statistical method in this study. Mann-Whitney U test and Spearman rank correlation were the inferential statistics used in this study.

3.6.3.1 Mann-Whitney U Test

The Mann-Whitney U test is a non-parametric test to compare the outcomes of two independent groups on the ordinal dependent variables. P-value is generated to test if there is any significance difference between two separate groups (Marshall and Jonker, 2011). There are two hypotheses generated based on the p-values. The null hypothesis (H_0) indicates no significant differences between two independent groups when the p-value is more than 0.05. In contrast, the alternative hypothesis (H_1) indicates significant differences between two independent groups when the p-value is equal or less than 0.05.

The Mann-Whitney U test was conducted to see if there was a significant difference in the critical success factors and obstacles of e-tendering

system application between the categories of respondents including natures of company and working experiences.

3.6.3.2 Spearman Rank Correlation

The Spearman rank correlation is a non-parametric test for investigating the strength of the relationship between two variables (Naoum, 2007). The value of Spearman rank correlation coefficient, r_s is analysed based on the strength of the correlation as presented in Table 3.5. There are two hypothesis generated based on the Spearman rank correlation. When the p-value is greater than 0.05, the null hypothesis (H_0) states that there is no connection between two variables. In contrast, the alternative hypothesis (H_1) confirms a connection between two variables when the p-value is equal or less than 0.05.

Table 3.5: Interpretation of Spearman Rank Correlation Coefficient

Spearman Rank Correlation Coefficient, r_s (positive or negative)	Interpretation
0.00 – 0.09	Negligible connection
0.10 – 0.39	Weak connection
0.40 – 0.69	Moderate connection
0.70 – 0.89	Strong connection
0.90 – 1.00	Very strong connection

(Source: Schober and Schwarte, 2018)

The Spearman rank correlation was conducted in this research to analyse if there was a positive or negative relationship between the respondents' perceptions which were e-tendering system users and non-e-tendering system users regarding the obstacles of e-tendering system application.

3.7 Summary

Quantitative research method was used for this study by gathering the data through questionnaire surveys. The sample size determined in this research was 196. The targeted respondents were the quantity surveying related professionals who working in the consultancy firms, contractor firms and developer companies in the Malaysian construction industry. The pre-test was developed on the prepared questionnaire to examine the validity and appropriateness

before the commencement of the questionnaire survey. The reliability test, descriptive statistics, and inferential statistics were applied to interpret and analyse the data collected from the questionnaire survey.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This research contained three objectives. The first objective was to compare the tendering system used before and during the Covid-19 pandemic. The following two objectives were to determine the critical success factors and obstacles of e-tendering system application. The targeted respondents for this research were the quantity surveyors working in the construction industry. The questionnaires were sent out via WhatsApp, LinkedIn, Messenger and email for 3 weeks. There were only 100 sets of questionnaires received. One set of responses was removed as the respondent was not working as a quantity surveyor in the construction industry. Thus, there were 99 qualified responses included in this research. The collected data were analysed using SPSS software and presented in the tables. The descriptive statistics analysed the demographic data of the respondents. The variables of critical success factors and obstacles underwent Cronbach's Alpha reliability analysis to test the reliability. Besides, inferential statistics were carried out to determine any significant differences between the respondent groups regarding the variables.

4.2 Respondent's Demographic

Table 4.1 summarised the background information of the respondents. Out of 99 responses, 47.5% of respondents were from consultancy firms, while 41.4% were from contractor firms. The respondents' years of working experience varied from 0 to 20 years, with less than 2 years and 2 to 5 years categories having nearly identical percentages of 40.4% and 41.4%, respectively. The majority of the respondents worked from the office with the highest percentage (75.7%).

Table 4.1: Respondents' Demographic (N=99)

Parameter	Category	Frequency (n)	Percentage (%)
Natures of company	Consultant	47	47.5
	Contractor	41	41.4
	Developer	11	11.1
Years of working experience	Less than 2 years	40	40.4
	2 – 5 years	41	41.4
	More than 5 years	18	18.2
Current working mode	Work from office	75	75.7
	Work from home	8	8.1
	Partially work from office and partially work from home	16	16.2

4.3 Tendering System Used Prior To and During Covid-19 Pandemic

The data collected was the tendering systems used by the respondents in three phases, including

- (i) Prior to Covid-19 pandemic (before March 2020).
- (ii) Early stage of Covid-19 pandemic (from March 2020 till October 2021).
- (iii) Later stage of Covid-19 pandemic (November 2021 until now).

The Malaysian government declared MCO, CMCO, RMCO, and FMCO according to the severity of the Covid-19 pandemic from March 2020 to October 2021 to slow the transmission of the virus in the country (New Straits Times, 2020; Ashman, 2021; Malaysiakini, 2021). Since November 2021, the government had met its goal of having 90% of the adult population fully vaccinated. Malaysians can travel abroad without applying for permission. If the number of Covid-19 positive cases increases significantly, a wide lockdown would not be imposed again (Chu, 2021).

If involved in the tendering process during these three phases, the respondents had to indicate the methods used to send or receive the tender documents and for tender submission. Besides, the types of the tender interview also had to be indicated. There was a Likert scale set for the questions, which

were 3 was “all of my project”, 2 was “some of my projects”, and 1 was “none of my projects”. The respondents had to choose only one option when answering the methods used for tendering systems and types of tender interviews.

4.3.1 Prior to Covid-19 Pandemic

As shown in Table 4.2, 69 respondents (69.7%) were involved in the tendering process prior to March 2020, which was before the Covid-19 outbreak.

Table 4.2: Respondents’ Participation in Tendering before Covid-19 Pandemic (N=99)

	Category	Frequency (n)	Percentage (%)
Involving in tendering process	Yes	69	69.7
	No	30	30.3

Table 4.3 illustrated the median and mean of tendering systems used and types of tender interviews used among quantity surveyors in the construction industry before the Covid-19 pandemic. The majority of the respondents were collecting tender from the office for all of the projects with a median value of 3.00. The email (median = 2.00) was used for some of the projects to send or receive tender documents. Most of the respondents answered that none of the projects were using the e-tendering system to send or receive tender documents. Besides, tender submission to a specific location had the highest median, 3.00, followed by email and e-tendering systems with median values of 2.00 and 1.00, respectively. Furthermore, the physical tender interview was found to have median of 3.00. The respondents used physical tender interview for all of the projects. In short, before the Covid-19 pandemic, most of the respondents collected the tender documents from the office and submitted the tender to a specific location during the tender submission for all of the projects. There were fewer respondents using email or e-tendering systems for tendering. Next, compared to a virtual tender interview, the respondents frequently used the physical tender interview.

Table 4.3: Descriptive Statistics on Tendering Systems Used before Covid-19 Pandemic (N=69)

	Category	Median	Mean
Send or receive tender document	Collect from office	3.00	2.48
	By email	2.00	1.62
	By e-tendering system	1.00	1.25
Tender submission	Submit to specific location	3.00	2.57
	By email	2.00	1.58
	By e-tendering system	1.00	1.22
Tender interview	Physical (face-to-face)	3.00	2.46
	Virtual (video conferencing)	2.00	1.59

15 respondents (15.2%) used e-tendering systems out of 69 respondents in the tendering process before the Covid-19 pandemic. Table 4.4 presented the six e-tendering systems used by the respondents, including SAP Ariba, L10 Pro, Cubicost E-Tendering, BIM 360, Zycus, and BuildSpace. SAP Ariba had the largest proportion of these systems (33.3 %).

Table 4.4: E-Tendering System Used (N=15)

E-Tendering System	Frequency (n)	Percentage (%)
SAP Ariba	5	33.3
L10 Pro	4	26.7
Cubicost E-Tendering	3	20.0
BIM 360	1	6.7
Zycus	1	6.7
BuildSpace	1	6.7

4.3.2 During Covid-19 Pandemic

The Covid-19 pandemic was distributed into two phases, one was the early stage of Covid-19 pandemic which was from March 2020 to October 2021, and the other one was later stage of Covid-19 pandemic that lasted from November 2021 to the present day.

4.3.2.1 Early Stage of Covid-19 Pandemic

From March 2020 to October 2021, 67 respondents (67.7%) were involved in the tendering process, as presented in Table 4.5.

Table 4.5: Respondents' Participation in Tendering from March 2020 until October 2021 (N=99)

	Category	Frequency (n)	Percentage (%)
Involving in tendering process	Yes	67	67.7
	No	32	32.3

Table 4.6 illustrated the median and mean of the tendering systems used at the early stage of Covid-19 pandemic. Among 67 responses, sending or receiving tender documents by the e-tendering system and email had the same median, 2.00, which means these two systems were being used moderately by the respondents. However, e-tendering system (mean = 1.90) had slightly higher usage than email (mean = 1.78). Next, the tender submitted by the e-tendering system and email had a same median value of 2.00 too. Both methods also used moderately during tender submission. The e-tendering system had a mean of 1.90 which was higher than email with a mean value of 1.66. Besides, a virtual tender interview, which used video conferencing to conduct the tender interview had the same median of 2.00 as the physical tender interview. Nevertheless, the virtual tender interview (mean = 2.40) had slightly higher usage than the physical tender interview (mean = 1.60).

It was concluded that most respondents frequently used an e-tendering system and email to send and submit the tender documents throughout this time frame at which the MCO, CMCO, RMCO and FMCO were undertaken according to the Covid-19 situation at that time. During this period, most of the tender interviews were conducted virtually through video conferencing software.

Table 4.6: Descriptive Statistics on Tendering Systems Used from March 2020 to October 2021 (N=67)

	Category	Median	Mean
Send or receive tender document	By e-tendering system	2.00	1.90
	By email	2.00	1.78
	Collect from office	1.00	1.48
Tender submission	By e-tendering system	2.00	1.90
	By email	2.00	1.66
	Submit to specific location	1.50	1.58
Tender interview	Virtual (video conferencing)	2.00	2.40
	Physical (face-to-face)	2.00	1.60

Among 67 respondents involved in the tendering process during the early stage of the Covid-19 pandemic which was from March 2020 to October 2021, only 38 respondents (38.4%) used e-tendering systems. During the period from March 2020 to October 2021, the usage percentage of e-tendering systems increased from 15.2% before the Covid-19 pandemic to 38.4%. Table 4.7 showed the e-tendering systems used by the respondents: SAP Ariba, Cubicost E-Tendering, BuildSpace, NiuAce, L10 Pro, BIM 360, and Zycus. SAP Ariba had the highest percentage (31.6%).

Table 4.7: E-Tendering System Used (N=38)

E-Tendering System	Frequency (n)	Percentage (%)
SAP Ariba	12	31.6
Cubicost E-Tendering	10	26.3
BuildSpace	8	21.1
NiuAce	3	7.9
L10 Pro	2	5.3
BIM 360	2	5.3
Zycus	1	2.6

4.3.2.2 Later Stage of Covid-19 Pandemic

Table 4.8 indicated that 55 respondents (55.6%) were involved in the tendering process during the later stage of the Covid-19 pandemic which was from November 2021 until now.

Table 4.8: Respondents' Participation in Tendering from November 2021 until Recent (N=99)

	Category	Frequency (n)	Percentage (%)
Involving in tendering process	Yes	55	55.6
	No	44	44.4

Table 4.9 presented the median and mean of the tendering systems used in the later stage of the Covid-19 pandemic. From November 2021 until recently, sending or receiving the tender documents by collect from office and email obtained the same median, 2.00, which means most of the respondents chosen "some of my projects" for both systems. However, collecting tender from office (mean = 1.85) had higher mean value than email (mean = 1.78). Furthermore, the tender submitted to specific location and those submitted by email had the same median, 2.00 but different mean values which were 2.02 and 1.65 respectively. Moreover, the majority of respondents conducted virtual and physical tender interviews moderately as both had the same median value of 2.00. Virtual tender interviews had a mean of 2.15, higher than the physical tender interview with a mean value of 1.89.

Table 4.9: Descriptive Statistics on Tendering Systems Used from November 2021 until Recent (N=55)

	Category	Median	Mean
Send or receive tender document	Collect from office	2.00	1.85
	By email	2.00	1.78
	By e-tendering system	1.00	1.51
Tender submission	Submit to specific location	2.00	2.02
	By email	2.00	1.65
	By e-tendering system	1.00	1.47
Tender interview	Virtual (video conferencing)	2.00	2.15
	Physical (face-to-face)	2.00	1.89

Only 21 (21.2%) of the 55 respondents used the e-tendering system. The percentage of usage of the e-tendering systems was dropped from 38.4% to 21.2%. The frequency and percentage of the tendering systems were indicated in Table 4.10. SAP Ariba and Cubicost E-Tendering had the same percentage (23.8 %).

Table 4.10: E-Tendering System Used (N=21)

E-Tendering System	Frequency (n)	Percentage (%)
SAP Ariba	5	23.8
Cubicost E-Tendering	5	23.8
BuildSpace	4	19.0
L10 Pro	2	9.5
BIM 360	2	9.5
NiuAce	2	9.5
Zycus	1	4.8

4.3.3 Summary of Three Phases

Table 4.11 presented the summary of the tendering systems used and types of tender interview conducted in the three phases which were prior to Covid-19 pandemic, early stage of Covid-19 pandemic and later stage of Covid-19 pandemic.

In brief, before the Covid-19 outbreak in Malaysia, most of the respondents carried out the physical transmission of tender documents. However, in the early stage of Covid-19 pandemic, the e-tendering system and email were used moderately throughout the tendering process. The trend of using the e-tendering system increased dramatically as there were various lockdown policies established in Malaysia and everyone was encouraged to work from home. Then, in the later stage of Covid-19 pandemic, the trend was shifted back to the physical transmission of tender documents. Beside from the physical transmission, some of the projects continued to use email for transferring the tender documents. The later stage of Covid-19 pandemic could also be known as the recovery stage as there were 90 % of the adult population had been fully vaccinated in Malaysia and everyone was allowed to back to the office. According to the findings, the e-tendering system was still underutilised in the Malaysian construction industry, as when lockdown measures were lifted and respondents were permitted to return to the workplace, they reverted to physical tender document transmission.

Following that, the majority of the tender interviews were conducted physically before the Covid-19 pandemic. In the early phase of the Covid-19 pandemic, the virtual and physical tender interviews were conducted moderately. This was owing to the fact that during MCO, everyone was permitted to work

from home and the virtual tender interviews were conducted. When the Covid-19 cases were reduced and some of the employees were permitted to return to work, some of the respondents were able to perform physical tender interviews. Next, in the later phase of the Covid-19 pandemic, the virtual and physical tender interviews were conducted moderately. Some of the respondents continued to conduct the tender interviews virtually even though they were working in the office.

Table 4.11: Summary of Three Phases

Phases	Systems Used
Before Covid-19 pandemic (Before March 2020)	Send or receive tender documents <ul style="list-style-type: none"> ▪ Most of the projects collected tender documents from office. Tender submission <ul style="list-style-type: none"> ▪ Most of the projects submitted tender documents to specific location. Tender interview <ul style="list-style-type: none"> ▪ Most of the projects conducted physical tender interview.
Early stage of Covid-19 pandemic (March 2020 – October 2021)	Send or receive tender documents <ul style="list-style-type: none"> ▪ Some of the projects used e-tendering system. ▪ Some of the projects used email. Tender submission <ul style="list-style-type: none"> ▪ Some of the projects used e-tendering system. ▪ Some of the projects used email. Tender interview <ul style="list-style-type: none"> ▪ Some of the projects conducted virtual tender interview. ▪ Some of the projects conducted physical tender interview.
Later stage of Covid-19 pandemic (November 2021 – Now)	Send or receive tender documents <ul style="list-style-type: none"> ▪ Some of the projects collected tender documents from office. ▪ Some of the projects used email. Tender submission <ul style="list-style-type: none"> ▪ Some of the projects submitted tender documents to specific location. ▪ Some of the projects used email. Tender interview <ul style="list-style-type: none"> ▪ Some of the projects conducted virtual tender interview. ▪ Some of the projects conducted physical tender interview.

4.3.4 Preferences for Tendering Methods

In this session, the respondents were needed to indicate the enjoyment and preferences of the tendering methods and tender interviews. There was a 5-point Likert scale set for the questions discussed previously in Chapter 3, which were 1 was “not enjoy/not prefer”, and 5 was “extremely enjoy/ extremely prefer”. However, in the session asking for the respondents' enjoyment of the tendering methods, if the respondents had never used the system before, 0, “not relevant” can be chosen. 0 was excluded when calculating the mean and median.

The median and mean of the enjoyment with tendering methods based on the respondents' user experiences were tabulated in Table 4.12. These three tendering methods had the same median value of 4.00, "enjoy". The respondents enjoyed slightly more on e-tendering systems based on the user experience, with the highest value of 3.74. The email came in second with a mean score of 3.69, followed by traditional tendering with a mean value of 3.56.

Table 4.12: Enjoyment with Tendering Methods based on User Experience

	Median	Mean
By E-Tendering System (N=66)	4.00	3.74
By Email (N=89)	4.00	3.69
Traditional Tendering (N=98)	4.00	3.56

Table 4.13 illustrated the median and mean of the preference for tendering methods by the respondents. The median value for all these three tendering approaches was 4.00, which was “prefer”. These approaches had varied mean values despite having the same median value. E-tendering system (mean = 3.70) was slightly higher than the email email (mean = 3.60), and traditional tendering (mean = 3.53).

Table 4.13: Preference for Tendering Methods (N=99)

	Median	Mean
By E-Tendering System	4.00	3.70
By Email	4.00	3.60
Traditional Tendering	4.00	3.53

Table 4.14 summarised the median and mean of the two types of tender interviews. These two types of tender interviews had the same median value of 4.00, “prefer”. However, the virtual tender interview with a mean value of 3.88 was slightly higher than the physical tender interview with a mean value of 3.72.

Table 4.14: Preference for Tender Interviews (N=99)

	Median	Mean
Virtual Tender Interview	4.00	3.88
Physical Tender Interview	4.00	3.72

In summary, from the findings, the respondents were satisfied with the three tendering methods. The respondents enjoyed and preferred all these three tendering methods. This was because the respondents felt comfort when using these three methods. The comfort level they had, perhaps caused the slow adoption of e-tendering systems in the Malaysian construction industry.

4.4 Reliability Analysis

The collected data were subjected to a Cronbach's Alpha reliability analysis to determine the reliability as presented in Table 4.15. The critical success factors of using the e-tendering system were 0.874. There were two sets of statements concerning the obstacles of e-tendering system application. One was about the obstacles of implementing an e-tendering system faced by the respondents whose companies applied an e-tendering system. The other was about the obstacles envisioned by the respondents whose companies did not use the e-tendering system. The reliability values for both sets are 0.782 and 0.864, respectively. The values were more than 0.70, meaning that the data was acceptable, highly reliable, and consistent internally.

Table 4.15: Cronbach's Alpha Analysis

	Cronbach's Alpha Value	N of Items
Critical success factors of using e-tendering system	0.874	14
Obstacles of Applying E-Tendering System from Perception of E-Tendering System Users	0.782	15
Obstacles of Applying E-Tendering System from Perception of Non-E-Tendering System Users	0.864	16

4.5 Critical Success Factors of E-Tendering System Application

A total of 14 critical success factors of e-tendering system application were proposed. The 5-point Likert scale was set for each factor. The scale was ranged from 1, corresponding to “strongly disagree”, to 5, corresponding to “strongly agree”. The respondents were required to indicate the level of agreement of the critical success factors.

4.5.1 Descriptive Test on Critical Success Factors of E-Tendering System Application

The median and mean of critical success factors of e-tendering system application were tabulated in table 4.16. Five (5) critical success factors had median values of 5.00, which were (1) reduce printing cost; (2) avoid crowd gathering; (3) avoid physical contact; (4) reduce physical storage; and (5) reduce time on duplicating tender documents. These five critical success factors were strongly agreed by the respondents and the others nine were agreed only.

Table 4.16: Central Tendency of Critical Success Factors of E-Tendering System Application (N=99)

Critical Success Factors	Median	Mean
Reduce printing cost	5.00	4.57
Avoid crowd gathering	5.00	4.40
Avoid physical contact	5.00	4.35
Reduce physical storage	5.00	4.26
Reduce time on duplicating tender documents	5.00	4.24
Enable work remotely	4.00	4.17
Improve transparency of tendering process	4.00	4.06
Receive tender addendum immediately	4.00	4.02
Improve transparency of communication process	4.00	3.94
Reduce tendering period	4.00	3.92
Reduce management cost	4.00	3.88
Prevent data loss	4.00	3.85
Quicker communication process	4.00	3.78
Enable late adjustment	4.00	3.71

Reduce printing cost and reduce time on duplicating tender documents were both ranked as strongly agree critical success factors in applying e-tendering system. This was because the e-tendering system removes paper-

based tender documents favouring soft versions that can be accessed through the system (Sunmola and Shehu, 2020). After purchasing the tender documents, the tenderers can access and download the tender documents in the system. The use of printed tender documents dropped due to the electronic exchange of tender documents, lowering the cost of printing tender documents. Besides, since the tender documents were uploaded to the system, the time to duplicate and bind the documents shrank (Izzati, Suhaida and Kam, 2018).

Avoid crowd gathering was the strongly agreed critical success factor by the respondents. The usage of an e-tendering system can avoid crowd gathering during the tender opening. Next, avoid physical contact was also strongly agreed by the respondents for the critical success factors of application of e-tendering system. During tender submission, there was no physical contact between the tenderers and the consultant quantity surveyors during tender submission by uploading the tender documents to the e-tendering system (Oyediran and Akintola, 2011). Briefly, the respondents strongly agreed to avoid crowd gathering and physical contact because they did not wish to have gatherings now amid the Covid-19 pandemic.

Moreover, reduce physical storage was also ranked as strongly agree critical success factors in implementing e-tendering system. This was correspondent with the findings of Sayed et al. (2020) which the adoption of an e-tendering system to manage the tender documents alleviated the difficulties of dealing with heavy paperwork that was prone to misplacement. The e-tendering system improved the efficiency of the document storage and retrieval process. The consultants did not need to prepare sufficient physical storage for the collected tender documents from all the tenderers for tender evaluation. The tender documents can be accessed and evaluated from the e-tendering system.

Lastly, the respondents ranked the rest of the nine critical success factors of applying an e-tendering system as “agree”.

4.5.2 Inferential Test on Critical Success Factors

Mann-Whitney U test was carried out to analyse the critical success factors of applying an e-tendering system based on the user experiences and natures of the company. It was to investigate if there was any significant difference between the respondent groups.

For this study, the significant threshold was set at 0.05. The following were the hypothesis statements formed in this study:

H₀ : Both categories of respondents had the same perception of the critical success factors of e-tendering system application, $p > 0.05$.

H₁ : Both categories of respondents had different perceptions of the critical success factors of e-tendering system application, $p \leq 0.05$.

4.5.2.1 Critical Success Factors Based on User Experiences

Mann-Whitney U test was conducted to examine a significant difference between the two respondent groups regarding the critical success factors of an e-tendering system application. The two categories of respondents were those who had used the e-tendering system previously and those who had never used one. There were 14 critical success factors tested and only two factors were found significant differences between the two respondent groups. Table 4.17 exhibited the two critical success factors of the e-tendering system application perceived by two categories of respondents.

Table 4.17: Inferential Statistics on User Experiences for Critical Success Factors of E-Tendering System Application (N=99)

Critical Success Factors	Mean Rank		Asymp. Sig p-value
	Yes (N=48)	No (N=51)	
Reduce tendering period	56.83	43.57	0.016*
Improve transparency of communication process	56.60	43.78	0.020*

Note: *. A significant difference was found since the p-value was less than 0.05.

As shown in table 4.17, reduce tendering period ($p = 0.016$) and improve transparency of communication process ($p = 0.020$) had p-values of less than 0.05. The results rejected the null hypothesis (H_0) and accepted the alternative hypothesis (H_1) that both categories of respondents having different perceptions regarding reduce tendering period and improve transparency of communication process as the critical success factors in the e-tendering system application.

The respondents who never used the e-tendering system (mean rank = 43.57) ranked lower on reduce tendering period than the respondents who used the e-tendering system (mean rank = 56.83). This was correspondent with the findings of Tindsley and Stephenson (2008) which the respondents with a lack of experience were taking more time to explore the usage and train to use the e-tendering system. Thus, from their standpoint, using an e-tendering system was time-consuming and did not reduce the tendering period.

In addition, improve transparency of communication process had p-value of 0.020 which was less than 0.05. The respondents who used the e-tendering system (mean rank = 56.60) ranked higher than those who never used the e-tendering system (mean rank = 43.78). Sayed, et al. (2020) explained that the transparency of communication process between various stakeholders was improved by adopting the e-tendering system. The respondents who did not use e-tendering system expressed low agreement on improve transparency of communication process because they did not adopt e-tendering system.

4.5.2.2 Critical Success Factors Based on Natures of Company

Mann-Whitney U test was performed to determine any significant differences in opinion about the critical success factors of e-tendering system application across the respondents' categories, including the respondents from consultant firms and contractor firms. The respondents from developer companies were excluded from this test because the number of respondents was less than 30. Following the central limit theorem, the sampling distribution approximates the standard normal distribution when the sample size equals or exceeds 30 (Kwak and Kim, 2017). The results would be more realistic with larger sample size.

14 critical success factors were examined, with two of them showing a significant difference. Table 4.18 presented that reduce physical storage and reduce printing cost had p-values of 0.010 and 0.022, respectively, which was less than 0.05 ($p \leq 0.05$). The findings accepted the alternative hypothesis (H_1) that the respondents from consultancy firms and contractor companies had distinct perspectives.

Table 4.18: Inferential Statistics on Natures of Company for Critical Success Factors of E-Tendering System Application (N=88)

Critical Success Factor	Mean Rank		Asymp. Sig p-value
	Consultant (N=47)	Contractor (N=41)	
Reduce physical storage	50.49	37.63	0.010*
Reduce printing cost	49.17	39.15	0.022*

Note: *. A significant difference was found since the p-value was less than 0.05.

The respondents from contractor firms ranked lower (mean rank = 37.63) on reduce physical storage while the respondents from consultant firms ranked higher (mean rank = 50.49). Next, the respondents worked in consultant firms (mean rank = 49.17) which ranked higher than those who worked in contractor firms (mean rank = 39.15) on reduce printing cost. Tindsley and Stephenson (2008) indicated that most contractors lacked the software capabilities, and hence the hard copy of tender documents was issued by the contractors. Besides, the contractors also printed out the documents for inquiries during the tendering process. Therefore, the printing cost was not decreased from the contractors' standpoint. As hard copies of documents were still being used, the contractors reported a lower agreement towards reducing physical storage than the consultants.

4.5.2.3 Critical Success Factors Based on Working Experience

Mann-Whitney U test was carried out to explore if respondents' work experience influenced the perceptions of the critical success factors of an e-tendering system application. Respondents were divided into two groups: those who had worked for less than two years and those who had worked for two to five years. The number of respondents with more than five years of working experience was fewer than 30, and the central limit theorem was used to eliminate them from this test.

Only one critical success factor revealed a significant difference when 14 critical success factors underwent this test. Table 4.19 presented that quicker communication process ($p = 0.044$) had a p-value of less than 0.05 ($p \leq 0.05$). According to the results, the alternative hypothesis (H_1) was against the null hypothesis (H_0). The respondents with fewer than two years of work experience had different viewpoints from the respondents with two to five years of work experience on quicker communication process.

Table 4.19: Inferential Statistics on Working Experience for Critical Success Factors of E-Tendering System Application (N=81)

Critical Success Factor	Mean Rank		Asymp. Sig p-value
	< 2 years (N=40)	2 – 5 years (N=41)	
Quicker communication process	46.11	36.01	0.044*

Note: *. A significant difference was found since the p-value was less than 0.05.

The respondents with two to five years of working experience (mean rank = 36.01) ranked higher than those with less than two years of working experience (mean rank = 46.11). As discussed in Chapter 2 previously, email was used to replace mail to speed up the communication process. An email is a critical tool for construction professionals' work-related communications. The professionals encountered email overload from time to time and were unable to read and respond to emails promptly since there were several projects ongoing at the same time (Lanctot and Duxbury, 2021). Fresh graduates made up the majority of the respondents with less than two years of work experience, and

they were more technically savvy than those with two to five years of work experience. They could utilise email efficiently with the technical skills.

4.6 Obstacles of E-Tendering System Application

There were two categories of obstacles of e-tendering system application. One was the obstacles from the perceptions of the respondents whose companies used e-tendering systems. This was to find out the obstacles faced by the e-tendering system users. There were 15 obstacles were prepared in this category, including:

- (i) Security of sensitive data.
- (ii) Inconsistency of government policy.
- (iii) Company does not provide internet.
- (iv) High initial cost to purchase computer.
- (v) High initial cost to purchase software.
- (vi) Company has no budget to recruit skilled employee.
- (vii) Company has no budget to organise training course.
- (viii) High maintenance cost.
- (ix) Elder generation fail to keep up.
- (x) Limited training.
- (xi) Lack of knowledge.
- (xii) Lack of awareness of employer.
- (xiii) Lack of awareness of employee.
- (xiv) Comfortable with traditional tendering.
- (xv) Company faces financial issues during Covid-19 pandemic.

The other category was the obstacles from the perceptions of the respondents whose companies did not use e-tendering systems. This was for the non-e-tendering system users to consider which obstacles they might face when implementing the e-tendering system. This category had 16 obstacles, 15 identical to those in the prior category. The new obstacle was:

- (i) Company takes time to convert from traditional tendering.

The difference between these two sets of obstacles was only one statement: "company takes time to convert from traditional tendering". This was because the respondents whose companies did apply e-tendering system already use an e-tendering system, and this obstacle could not have been encountered during the implementation process.

The 5-point Likert scale was prepared for these two sets of obstacles. The scale ranged from 1, "strongly disagree" to 5, "strongly agree". The respondents were required to indicate the level of agreement with each obstacle.

4.6.1 Descriptive Test on Obstacles of Applying E-Tendering System from Perception of E-Tendering System Users

There were 41 respondents whose companies did apply the e-tendering system. Table 4.20 illustrated the median and mean of obstacles of e-tendering system application encountered by the 41 e-tendering system users. There were 13 obstacles ranked as "agree", one obstacle was ranked as "neutral", and one obstacle was ranked as "disagree".

Table 4.20: Central Tendency of Obstacles of Applying E-Tendering System from Users' Perception (N=41)

Obstacles	Median	Mean
Lack of knowledge	4.00	4.32
High maintenance cost	4.00	4.12
Elder generation fail to keep up	4.00	3.95
High initial cost to purchase software	4.00	3.93
Security of sensitive data	4.00	3.88
Limited training	4.00	3.78
Comfortable with traditional tendering	4.00	3.71
Inconsistency of government policy	4.00	3.63
Company has no budget to organise training course	4.00	3.56
High initial cost to purchase computer	4.00	3.49
Lack of awareness of employee	4.00	3.46
Company faces financial issues during Covid-19 pandemic	4.00	3.44
Lack of awareness of employer	4.00	3.29
Company has no budget to recruit skilled employee	3.00	3.37
Company does not provide internet	2.00	2.73

Lack of knowledge was ranked slightly higher if compared to the other 12 obstacles by referring to mean value. Amuda-Yusuf, et al. (2019) explained that a company's adoption of an e-tendering system might be influenced by lacking IT knowledge.

In addition, company has no budget to recruit skilled employee was ranked as “neutral” by the respondents. This was in line with the findings of Sydorenko (2017) who found that the majority of small and medium enterprises in the construction industry were unable to pay their own costs when hiring skilled employees with high salaries.

Moreover, company does not provide internet was the obstacle disagreed by the respondents. As the technologies advanced day by day, the internet became necessary for every construction company. Employees utilised the internet to send emails and carry out their everyday tasks (Lanctot and Duxbury, 2021). Therefore, this obstacle was disagreed by the respondents whose companies did apply e-tendering systems.

4.6.2 Descriptive Test on Obstacles of Applying E-Tendering System from Perception of Non-E-Tendering System Users

There were 58 respondents whose companies did not apply the e-tendering system. Table 4.21 showed the median and mean of the obstacles of applying the e-tendering system from the perceptions of 58 non-e-tendering system users.

Table 4.21: Central Tendency of Obstacles of Applying E-Tendering System from Non-Users' Perception (N=58)

Obstacles	Median	Mean
High initial cost to purchase software	5.00	4.34
Company takes time to convert from traditional tendering	4.50	4.28
Elder generation fail to keep up	4.00	4.12
Comfortable with traditional tendering	4.00	4.10
Lack of awareness of employee	4.00	4.09
High maintenance cost	4.00	4.07
Lack of knowledge	4.00	4.05
Limited training	4.00	4.03
Lack of awareness of employer	4.00	4.02
Security of sensitive data	4.00	4.00
Company has no budget to organise training course	4.00	3.84
Company has no budget to recruit skilled employee	4.00	3.69
Inconsistency of government policy	4.00	3.67

Table 4.21 (continued)

Company faces financial issues during Covid-19 pandemic	4.00	3.64
High initial cost to purchase computer	4.00	3.59
Company does not provide internet	2.00	2.57

High initial cost to purchase software was ranked as “strongly agree” by the respondents whose companies did not apply e-tendering system. Khalil and Waly (2015) revealed that the company had to spend a large amount of money obtaining a specific software to perform the e-tendering system effectively.

Besides, company takes time to convert from traditional tendering had a median value of 4.50. The company's boss took the time to understand the advantages of installing an e-tendering system for the company and all of the potential barriers that may obstruct the implementation process (Sitar, 2011). Also, it was time-consuming to decide which system was better to implement.

Next, there were 13 obstacles were agreed upon by the respondents. Elder generation fail to keep up was slightly higher than the other obstacles when comparing the mean value. Eadie, et al. (2009) revealed that the technology is developing at a dizzying speed. The older generation could not keep up with technological advancements and was ignorant of using e-tendering systems.

Furthermore, company does not provide internet was also ranked as “disagree” with a median value of 2.00. This result was consistent with the respondents whose companies did apply an e-tendering system.

4.6.3 Inferential Test on Obstacles of E-Tendering System Application

Spearman rank correlation was conducted to examine the relationship between the perceptions of the respondents and the obstacles of e-tendering system application. The data of both sets of the obstacles were combined and the data of company takes time to convert from traditional tendering was excluded to conduct this test. Hence, there were a total of 15 obstacles underwent this test.

The significance level for this research was 0.05. The hypothesis statements were formed as following:

- H₀ : There was no relationship between the respondents' perceptions and the obstacles of e-tendering system application, $p > 0.05$.
- H₁ : There was a relationship between the respondents' perceptions and the obstacles of e-tendering system application, $p \leq 0.05$.

4.6.3.1 Obstacles Based on Perceptions of E-Tendering System Users and Non-Users

The Spearman rank correlation was utilised to analyse the relationship between the respondents whose companies did apply e-tendering system and those whose companies did not apply e-tendering system towards the obstacles of e-tendering system application.

Table 4.22: Inferential Statistics between Respondents' Perceptions and Obstacles of E-Tendering System Application (N=99)

Obstacles	Respondents' Perceptions	
	r _s	p
Worry security of data	-0.018	0.863
Inconsistency of government policy	0.064	0.527
Company does not provide internet	-0.081	0.428
High initial cost to purchase computer	0.068	0.503
High initial cost to purchase software	0.227	0.024*
Company has no budget to recruit skilled employee	0.137	0.177
Company has no budget to organise training course	0.150	0.140
High maintenance cost	-0.020	0.843
Elder generation fail to keep up	0.083	0.412
Limited training	0.101	0.321
Lack of knowledge	-0.116	0.253
Lack of awareness of employer	0.357	0.000*
Lack of awareness of employee	0.332	0.001*
Comfortable with traditional tendering	0.177	0.079
Company faces financial issues during Covid-19 pandemic	0.102	0.317

Note: *. A relationship was found since the p-value was less than 0.05.

There were 15 obstacles assessed. Table 4.22 presented that three obstacles had a relationship with the respondents' perceptions: lack of

awareness of employer, lack of awareness of employee, and high initial cost to purchase software. The p-value for all these three obstacles was less than 0.05. The findings demonstrated the alternative hypothesis (H_1) was accepted and the null hypothesis (H_0) was rejected. There was a connection between the respondents' perceptions and the obstacles of e-tendering system application.

A weak positive connection was discovered between the respondents' perceptions and lack of awareness of employer ($r_s = 0.357$, $p = 0.000$). This finding suggested that the non-e-tendering system users had a greater perception of lack of awareness of employer. Besides, the evidence of $r_s = 0.332$ and $p = 0.001$ revealed that the connection between the respondents' perceptions and lack of awareness of employee exhibited a weak positive relationship. These were in line with the findings of Egbu, Vines and Tookey (2003) and Wimalasena and Gunatilake (2018), who found that employers and employees lacked awareness of using e-tendering systems and were unsure how these worked in the construction industry. As a result, employers and employees could not move away from traditional tendering and adopt an e-tendering system.

There was a weak positive relationship between the respondents' perceptions and the high initial cost to purchase software ($r_s = 0.227$, $p = 0.024$). According to the findings, the non-e-tendering system users perceived higher on the high initial cost to purchase software. This was because a substantial sum of money was required to set up the e-tendering system, which included the purchase of unique software and software licences (Cherif, Khalil and Waly, 2014).

4.7 Summary

In a nutshell, this chapter analysed and discussed the data collected from the questionnaire survey. The data underwent descriptive statistics, Cronbach's alpha reliability test, Mann-Whitney U test and Spearman rank correlation. The Cronbach's alpha values obtained for this research were higher than 0.70, indicating that the data were acceptable and highly reliable.

Before the Covid-19 pandemic, most of the respondents collected and submitted the tender documents at the office during the tendering process. The physical tender interviews were conducted for most of the projects. In the early

stage of the Covid-19 pandemic, the e-tendering system and email were used moderately by the respondents. Most of the tender interviews were conducted virtually through video conferencing software in this time frame. Next, in the later stage of the Covid-19 pandemic, some respondents continued to transmit and submit tender documents through email. In contrast, others collected and submitted tender documents in the office during the tendering process. The physical and virtual tender interviews were both conducted moderately at this stage.

Besides, five critical success factors were ranked as “strongly agree”, including reducing printing cost, avoiding crowd gathering, avoiding physical contact, reducing physical storage, and reducing time on duplicating tender documents. The respondents ranked the other nine critical success factors as “agree”. Next, the Mann-Whitney U test analysis manifested significant differences in perceptions between the respondent groups on the critical success factors of e-tendering system application.

In addition, the respondents whose companies did apply e-tendering system ranked 13 obstacles as “agree”, and lack of knowledge was slightly higher than others when comparing the mean. Company does not provide internet was disagreed by the respondents. Moreover, the respondents whose companies did not apply the e-tendering system strongly agreed high initial cost to purchase software was the obstacle faced if applying e-tendering system. Company does not provide internet was also disagreed by the respondents. Spearman rank correlation discovered a weak positive correlation between the non-e-tendering system users and the obstacles of e-tendering system application, which were lack of awareness of employer, lack of awareness of employee, and high initial cost to purchase software.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This research provided an overview of e-tendering system application in the construction industry during the Covid-19 pandemic. The objectives of this research were:

- (i) To compare the tendering system used prior to and during the Covid-19 pandemic.
- (ii) To identify the critical success factors of e-tendering system application.
- (iii) To evaluate the obstacles of e-tendering system application.

The research objectives were achieved based on the findings in Chapter 4. A total of 99 qualified responses were obtained in this research. The questionnaires were distributed to the targeted respondents in Malaysia. The targeted respondents for this research were quantity surveying related professionals in the construction industry. The data collected were analysed and interpreted using descriptive statistics, Mann-Whitney U Test and Spearman rank correlation.

5.1.1 To Compare Tendering System Used Prior to and During Covid-19 Pandemic

This research identified the tendering systems used by the respondents in three phases: before the Covid-19 pandemic, early stage of the Covid-19 pandemic, and later stage of the Covid-19 pandemic. The tendering systems used for the tendering activities, which were sending or receiving the tender documents and tender submission in these three phases, were discussed below:

- (i) Send or Receive tender documents.
 - Before Covid-19 pandemic
Most of the projects collected tender documents at the office.

- Early stage of Covid-19 pandemic
E-Tendering system and email were used moderately.
 - Later stage of Covid-19 pandemic
Some of the projects collected tender documents at the office while others continued using email.
- (ii) Tender submission
- Before Covid-19 pandemic
Most of the projects submitted tender to a specific location.
 - Early stage of Covid-19 pandemic
E-Tendering system and email were used moderately.
 - Later stage of Covid-19 pandemic
Some of the projects returned to submit tender to a specific location, while others continued using email.

The finding indicated that most of the respondents transferred the tender documents physically before the Covid-19 pandemic. This was attributed to the fact that there was no lockdown policy to force everyone to work from home. The employees were working at the office. However, the e-tendering system and email were used moderately in the early phase of the Covid-19 pandemic. The trend of using the e-tendering system was increased at that time. This was because various lockdown policies were declared in Malaysia in response to the Covid-19 epidemic. The employees were encouraged to work from home, and the lockdown restrictions limited their movements. The e-tendering system was used to continue the tendering process when working from home. Besides that, in the later phase of the Covid-19 pandemic, the trend shifted back to the physical transmission of tender documents. The usage of the e-tendering system was decreased. This was because the fully vaccinated adult population had reached 90 %, the lockdown policies were lifted and everyone was allowed to return to the office. Employees were free to collect and submit tender documents at the office because movement was not strictly controlled.

This research also revealed the types of tender interviews conducted before and during the Covid-19 pandemic. The types of tender interviews conducted in these three phases were discussed below:

- (i) Before Covid-19 pandemic.
Most of the projects conducted physical tender interviews.
- (ii) Early stage of Covid-19 pandemic.
Virtual and physical tender interviews were conducted moderately.
- (iii) Later stage of Covid-19 pandemic.
Virtual and physical tender interviews were conducted moderately.

Prior to the Covid-19 outbreak in Malaysia, most of the tender interviews were conducted physically in the office. The face-to-face interviews with tenderers were crucial. At the time, no social distance rules had to be obeyed. In the early stage of Covid-19 pandemic, the virtual and physical tender interviews were carried out moderately. This was because when MCO and FMCO were announced, everyone was permitted to work from home and strictly monitored mobility. The tender interviews were conducted virtually. CMCO and RMCO were declared after the Covid-19 cases in Malaysia were decreased, and some employees were allowed to return to the office. The face-to-face tender interviews could be conducted in the office. Next, in the later stage of the Covid-19 pandemic, the virtual and physical tender interviews were conducted moderately. Employees were allowed to return to the office at this time, and physical tender interviews took place. However, some projects continued to conduct the virtual tender interviews even after the employees returned to the office because they felt comfortable with the virtual tender interviews.

In addition, the respondents were also asked to express their enjoyment and preferences towards the three tendering methods: traditional tendering, e-tendering system, and email. The respondents enjoyed and preferred all these three tendering methods. This was because the respondents felt comfortable when using these three methods. The Malaysian construction industry had been sluggish to implement the e-tendering system due to the degree of comfort. This was because the employees felt comfortable using traditional tendering and e-

tendering systems. They might believe that traditional tendering was sufficient for conducting the tendering process and thus the adoption rate of e-tendering system was low in the Malaysian construction industry.

Lastly, the respondents preferred both virtual and physical tender interviews. This was because they felt comfortable when conducting both types of tender interviews. When conducting face-to-face tender interviews in the office, the consultants were able to read the tenderers' facial expressions and made the tender interviews completed successfully. Employees might also undertake virtual tender interviews from the comfort of their own offices, eliminating the need to go to other locations. Simultaneously, travel time was reduced.

5.1.2 To Identify Critical Success Factors of E-Tendering System Application

This research revealed that the most significant underlying critical success factors of e-tendering system application in the construction industry were:

- (i) Reduce printing cost (median = 5.00).
- (ii) Avoid crowd gathering (median = 5.00).
- (iii) Avoid physical contact (median = 5.00)
- (iv) Reduce physical storage (median = 5.00)
- (v) Reduce time on duplicating tender documents (median = 5.00).

Besides, the Mann-Whitney U tests were conducted between the two respondent groups towards the critical success factors of e-tendering system application. The respondents who used the e-tendering system before ranked slightly higher than those who did not use the e-tendering system before.

- (i) Reduce tendering period ($p = 0.016$).
- (ii) Improve transparency of communication process ($p = 0.020$).

Following that, the respondents from consultancy perceived higher than the respondents from contractor firms on the following critical success factors:

- (i) Reduce physical storage ($p = 0.010$).

- (ii) Reduce printing cost ($p = 0.022$).

The respondents with less than two years of work experience perceived higher on the following critical success factor than the respondents who had two to five years of work experience:

- (i) Quicker communication process ($p = 0.044$).

5.1.3 To Evaluate Obstacles of E-Tendering System Application

In this research, there were two categories of obstacles of e-tendering system application. One was the obstacles faced by the respondents whose companies used e-tendering systems. The other category was the obstacles envisioned by the respondents whose companies do not use e-tendering systems.

There were significant obstacles ranked by the respondents whose companies applied e-tendering system in this research:

- (i) Lack of knowledge (median = 4.00)
- (ii) Company has no budget to recruit skilled employee (median = 3.00).
- (iii) Company does not provide internet (median = 2.00).

Moreover, there were also several significant obstacles ranked by the respondents whose companies did not apply the e-tendering system:

- (i) High initial cost to purchase software (median = 5.00)
- (ii) Company takes time to convert from traditional tendering (median = 4.50)
- (iii) Elder generation fail to keep up (median = 4.00)
- (iv) Company does not provide internet (median = 2.00)

Furthermore, Spearman rank correlation was utilised to find out the correlation between the e-tendering system users and non-e-tendering system users' perceptions of the obstacles of e-tendering system application. The correlation between the respondents' perceptions and the obstacles of e-tendering system application were:

- (i) A weak positive correlation with lack of awareness of employer ($r_s = 0.357$, $p = 0.000$).
- (ii) A weak positive correlation with lack of awareness of employee ($r_s = 0.332$, $p = 0.001$).
- (iii) A weak positive correlation with high initial cost to purchase software ($r_s = 0.227$, $p = 0.024$).

5.2 Significances of Research

The emphasis of this research was on the tendering methods used in the Malaysian construction industry. This research was significant for the construction professionals to understand the various tendering systems used before and during the Covid-19 pandemic. The readers could understand the trend of the different tendering systems in the Malaysian construction industry before and during the Covid-19 pandemic. This research also revealed how the Covid-19 pandemic affected the tendering systems used in this time frame. This study also includes information on the types of tender interviews done before and during the Covid-19 pandemic. The lockdown policies during the Covid-19 pandemic forced the usage of the virtual tender interviews to increase. The virtual tender interviews became famous in the Malaysian construction industry because the employees no longer needed to travel to other places to attend the tender interviews; instead, they could sit in the office and attend the tender interview via the video conferencing software.

Furthermore, this research also provided the critical success factors and obstacles of implementing the e-tendering system in the construction industry. This study demonstrated that the users of e-tendering system and non-e-tendering system users had conflicting views on the obstacles of applying the e-tendering system. The non-users indicated that the high initial cost of purchasing software was the main obstacle of applying the e-tendering system. In contrast, the users disagreed and claimed that lack of knowledge was the main obstacle when implementing the e-tendering system. Besides that, the construction companies could use the critical success factors revealed in this research to understand better the importance and benefits of implementing the e-tendering system. Therefore, the adoption rate of the e-tendering system could

be increased in the Malaysian construction industry. The construction companies also needed to be aware of the obstacles when implementing the e-tendering system to prevent the tendering process's failure. As prevention is better than cure, the construction companies should be prepared to avoid the obstacles mentioned in this study arising while implementing the e-tendering system.

5.3 Limitations of Research

Several limitations were encountered in the research. The first limitation was that this study's sampling was restricted to Malaysia. The study outcomes were based on the opinions of the quantity surveyors from the Malaysian construction industry. The perceptions might differ for other countries due to different working environments and cultures. Tendering systems used before and during the Covid-19 epidemic might vary in other countries.

Moreover, the tiny amount of respondents who participated in the questionnaire survey was also one of the study's limitations. This was due to the limited timeframe for distributing the questionnaire. As there were only 99 samples collected in this study, according to the Cochran's formula, it had a 10 % margin of error. Hence, the results had a 10 % of margin of error.

Furthermore, this study concentrated solely on the perceptions of the quantity surveyors from consultant and contractor firms, leaving out the perceptions of the quantity surveyors from developer firms. This was because the number of respondents from the developer companies was less than 30, and the inferential statistics were unable to be carried out if followed the central limit theorem. Hence, most of the data gathered from the respondents came from consulting and contracting firms. Different groups of respondents had multiple viewpoints on the critical success factors and obstacles of e-tendering system application, such as working experiences and the natures of company. The participation of quantity surveyors from developer firms in the research may provide important information to the study and investigate the tendering system adopted in the developer companies before and during the Covid-19 outbreak.

5.4 Recommendations for Future Research

The recommendation for future research is to understand the tendering methods used in the construction industry in other countries such as Singapore, Indonesia and Thailand. The study can investigate the insights of the quantity surveyors in various countries regarding the critical success factors and obstacles of e-tendering system application.

In future research, the sampling size shall be increased to acquire more generalizable information. A larger sample size guarantees that the sample truly reflects quantity surveyors in the Malaysian construction industry, and the study's findings may be applied across the board. On the other hand, small sample size will make finding a meaningful association in the data more challenging. It is also essential to ensure that the questionnaire is answered equitably by all the respondent groups to acquire a thorough impression of the e-tendering system implementation in the Malaysian construction industry. The number of respondents from developer companies should increase to allow a broad perspective on implementing the e-tendering system in the construction industry.

Lastly, future studies shall conduct mixed-method research to further enrich the findings on the e-tendering system application by conducting in-depth interviews and distributing the questionnaires. The in-depth interviews may be utilised to look at the tendering methods used before and during the Covid-19 pandemic. In-depth interviews can also question the reasons and reviews for applying the methods. The combination of in-depth interviews and questionnaires can improve the validity and reliability of the study.

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APPENDICES

Appendix A: Questionnaire Survey

Dear Sir/Madam,

I am Tan Yee Ying, a final year undergraduate student from Universiti Tunku Abdul Rahman studying Bachelor of Science (Honours) Quantity Surveying. I am conducting my final year project titled "Exploring Application of E-Tendering in Malaysia Construction Industry during Covid-19 Pandemic". The research aim is to study the application of e-tendering in Malaysia construction industry during the Covid-19 pandemic. The target respondents for this research are professional quantity surveyors that familiar with the tendering process in Peninsular Malaysia.

This survey consists of four (4) sections covered the following objectives:

- i. To compare the tendering systems used prior to and during Covid-19 pandemic.
- ii. To identify the critical success factors of e-tendering system application.
- iii. To evaluate the obstacles of e-tendering system application

It would be appreciated if you could spare 10 minutes to answer the following survey. You are being assured that all the information collected will be treated as private and confidential and will be strictly used for this research only.

If you have any enquiries, please do not hesitate to email me at ying0810tan@utar.my.

Thank you.

Sincerely,

Tan Yee Ying

Bachelor of Science (Honours) Quantity Surveying

University Turku Abdul Rahman

Are you working as a quantity surveyor related profession in the construction company?

- a. Yes (If yes, proceed to answer this questionnaire.)
- b. No (Thank you, you may leave the questionnaire)

Section A: General background

1. What is the nature of the company that you currently working with?
 - a. Consultant company
 - b. Contractor company
 - c. Developer company
 - d. _____

2. How many years have you been working in the construction industry?
Answer: _____

3. What is your working mode now?
 - a. Work from office
 - b. Work from home
 - c. Partially work from office and partially work from home

Section B1: Tendering system used before Covid-19 pandemic.

1. How do you send or receive the tender documents before Covid-19 pandemic? Please rate the frequency of the following statements.

	None of my project	Some of my projects	All of my projects
Collect from office			
By using Email			
By using E-Tendering System			

2. If you were using e-tendering system, what system were you using before Covid-19 pandemic? Please name the system.

3. What kind of tender interview do you join before Covid-19 pandemic? Please rate the frequency of the following statements.

	None of my project	Some of my projects	All of my projects
Physical (Face-to-face)			
Virtual (Via Zoom or any other video conferencing software)			

4. How was the tender submission conducted before the Covid-19 pandemic? Please rate the frequency of the following statements.

	None of my project	Some of my projects	All of my projects
Hard copies of tender documents submitted to specific location			
Submit through email			
Upload to the E-Tendering system			

Section B2: Tendering system used from March 2020 to October 2021 (lockdown period)

1. Are you involving in tendering process from March 2020 to October 2021?
 - b. Yes (Proceed to question no. 2)
 - c. No (Proceed to Section B3)

2. How do you send or receive the tender documents from March 2020 to October 2021? Please rate the frequency of the following statements.

	None of my project	Some of my projects	All of my projects
Collect from office			
By using email			
By using E-Tendering system			

3. If you were using e-tendering system, what system were you using from March 2020 to October 2021? Please name the system.

4. What kind of tender interview do you join from March 2020 to October 2021? Please rate the frequency of the following statements.

	None of my project	Some of my projects	All of my projects
Physical (Face-to-face)			
Virtual (Via Zoom or any other video conferencing software)			

5. How was the tender submission conducted from March 2020 to October 2021? Please rate the frequency of the following statements.

	None of my project	Some of my projects	All of my projects
Hard copies of tender documents submitted to specific location			
Submit through email			
Upload to the E-Tendering system			

Section B3: Tendering system used from November 2021 until now

1. Are you involving in tendering process from November 2021 until now?
- Yes (Proceed to question no.2)
 - No (Proceed to Section B4)
2. How do you send or receive the tender documents from November 2021 until now? Please rate the frequency of the following statements.

	Never	Some of my projects	All of my projects
Collect from office			
By using email			
By using E-Tendering system			

3. If you are using e-tendering system, what system are you using now? Please name the system.

4. What kind of tender interview do you join from November 2021 until now? Please rate the frequency of the following statements.

	Never	Some of my projects	All of my projects
Physical (Face-to-face)			
Virtual (Via Zoom or any other video conferencing software)			

5. How was the tender submission conducted from November 2021 until now? Please rate the frequency of the following statements.

	Never	Some of my projects	All of my projects
Hard copies of tender documents submitted to specific location			
Submit through email			
Upload to the E-Tendering system			

Section B4: Preference on Tendering Method

1. Which of the following methods do you enjoy?

	Not relevant	Not enjoy	Slightly Enjoy	Moderately Enjoy	Enjoy	Extremely Enjoy
Traditional Tendering						
Email						
E-Tendering						

2. Which of the following methods you prefer to use in the future?

	Not Prefer	Slightly Prefer	Moderately prefer	Prefer	Extremely Prefer
Traditional Tendering					
By using email					
By using E-Tendering system					

3. Which method of tender interview do you prefer?

	Not Prefer	Slightly Prefer	Moderately Prefer	Prefer	Extremely Prefer
Physical (Face-to-face)					
Virtual (Via Zoom or any other video conferencing software)					

4. What are your understanding about e-tendering?

- E-Tendering is the digital transmission of tender documents via internet.
- E-Tendering is the fax transmission of tender documents.
- E-Tendering is the transfer of hard copy tender documents by courier.

Section C: Critical success factors of e-tendering system application in Malaysia's construction industry

E-tendering system is described as the electronic conduct of tendering process, which includes advertising, communicating, accessing, collecting, and submitting tender documents via an internet-based system. For example, SAP Ariba and Cubicost E-Tendering are the e-tendering systems.

1. Do you use e-tendering system before?
 - a. Yes
 - b. No

In your opinion, what are the critical success factors of applying e-tendering system? Please rate agreements on the following questions.

Critical Success Factors	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Do you agree that using an e-tendering system can help reduce cost of printing tender documents?					
Do you agree using an e-tendering system can reduce management cost of tendering process?					
Do you agree that using an e-tendering system can reduce time on duplicating tender documents when preparing the tender documents for tenderers?					
Do you agree that using an e-tendering system can enable late adjustments of tender documents?					
A fully automated e-tendering system accelerate the tender evaluation process. Do you agree that application of e-tendering system can reduce the tendering period?					
Do you agree that using an e-tendering system					

can quicker the communication process among client, consultant and tenderers?					
Do you agree that the tenderers can receive tender addendum immediately through e-tendering system?					
Do you agree that application of e-tendering system can improve transparency of tendering process?					
Do you agree that application of e-tendering system can improve transparency of communication process?					
Do you agree that application of e-tendering system can reduce physical storage for hard copy of tender documents?					
Do you agree that application of e-tendering system can prevent data loss during transaction of tender documents?					
Do you agree that using an e-tendering system can enable employees to work remotely?					
Do you agree that application of e-tendering system can avoid physical contact during tender submission?					
Do you agree that application of e-tendering system can avoid crowd gathering during tender opening?					

Section D: Obstacles of e-tendering system application in Malaysia's construction industry.

Are your company currently using e-tendering system in the tendering process?

- a. Yes (Proceed to Section D1).
- b. No (Proceed to Section D2).

Section D1:

What are the obstacles you have encountered when using e-tendering system?
Please rate agreements on the following statements.

Obstacles	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The tenderers worry about security of sensitive data of the tender documents when using e-tendering system.					
Inconsistency of government policy affect the application of e-tendering system in construction industry.					
The company does not provide internet in the office for the employees and computers.					
E-tendering system requires high initial cost which is to purchase new computers.					
E-tendering system requires high initial cost which is to purchase and update e-tendering software and licenses such as SAP Ariba and Cubicost E-Tendering.					
The company has no budget to recruit skilled employees that familiar with e-tendering system.					
The company has no budget to organize training courses of e-tendering system frequently.					
E-tendering system requires high					

maintenance cost to ensure the software is always up to date.					
Elder generation in my project or in my company fail to keep up with technological changes and unable to use e-tendering.					
There is limited training provided by my company and cause the employees to have limited skills on using e-tendering system.					
Some tenderers are lack of knowledge about e-tendering and confuse about how to utilize it.					
The employer in my company is lack of awareness regarding the effectiveness of e-tendering system.					
The employees in my company are lack of awareness initiatives regarding the effectiveness of e-tendering system.					
People in my project or in my company are more comfortable with traditional tendering and refuse to use e-tendering system that they are unfamiliar.					
The company faces financial issue due to Covid-19 pandemic affect the application of e-tendering system.					

Section D2:

Which of the following statements do you believe could be preventing your company from using an e-tendering system?

Please rate agreements on the following statements.

Obstacles	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The tenderers worry about security of sensitive data of the tender documents when using e-tendering system.					
Inconsistency of government policy affect the application of e-tendering in construction industry.					
The company does not provide internet in the office for the employees and computers.					
E-tendering system requires high initial cost which is to purchase new computers.					
E-tendering system requires high initial cost which is to purchase and update e-tendering software and licenses such as SAP Ariba and Cubicost E-Tendering.					
The company has no budget to recruit skilled employees that familiar with e-tendering system.					
The company has no budget to organize training courses of e-tendering system frequently.					
E-tendering system requires high maintenance cost to ensure the software is always up to date.					

Elder generation in my project or in my company fail to keep up with technological changes and unable to use e-tendering system.					
The company does not provide training and cause the employees to have limited skills on using e-tendering system.					
Some tenderers are lack of knowledge about e-tendering and confuse about how to utilize it.					
The employer in my company is lack of awareness regarding the effectiveness of e-tendering system.					
The employees in my company are lack of awareness initiatives regarding the effectiveness of e-tendering system.					
People in my project or in my company are more comfortable with traditional tendering and refuse to use e-tendering system that they are unfamiliar.					
The company faces financial issue due to Covid-19 pandemic and is unable to use the e-tendering system.					
The company take time to convert from traditional tendering to e-tendering.					

