POLITEKNIK UNGKU OMAR

THE EFFECTIVENESS OF BRICKFORM FORM IN ARCHITECTURE WORK

FATIN NUR ALIYAH BINTI SAZLIM

(01BCT21F3021)

JABATAN KEJURUTERAAN AWAM

SESSION II 2023/2024

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A project report/thesis submitted in partial fulfilment of the requirement for the award of the Bachelor of Civil Engineering Technology with Honours

JABATAN KEJURUTERAAN AWAM

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STATEMENT OF AUTHENTICITY AND PROPRIETARY RIGHTS

THE EFFECTIVENESS OF BRICKWORK FORM IN ARCHITECTURE WORK

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ABSTRACT

This study examines the impact of unskilled workers on project delays within the construction industry, focusing on the ongoing project Warehouse I9B at Persiaran Bukit Raja Kayangan. Through a systematic three-phase methodology involving on-site observations, form development, and calculating the effectiveness of the form, the research identifies the multifaceted factors contributing to delays when unskilled workers are involved. The study is the development and implementation of a user-friendly form for architectural trade drawings, with an emphasis on extracting door and window details. Comprehensive analysis of the data collected to evaluate the effectiveness of the proposed brickwork form in mitigating project delays. Qualitative analyses reveal significant reductions in rectifications for door and window areas, with door rectifications decreasing from 31.33% to 27.20% and window rectifications from 36.64% to 30.19%. Additionally, brick waste decreased by 44% for door areas and 46% for window areas. These findings highlight the potential economic and environmental benefits of minimizing material waste. The study provides robust evidence of the brickwork form's effectiveness, validated through statistical analyses and data visualization techniques. The practical implications suggest improved project timelines, cost savings, and sustainable practices. The research concludes by discussing limitations and proposing future directions to enhance construction efficiency through innovative solutions for unskilled labor challenges.

ABSTRAK

Kajian ini meneliti kesan pekerja tidak mahir terhadap kelewatan projek dalam industri pembinaan, dengan memberi tumpuan kepada projek Gudang I9B yang sedang berlangsung di Persiaran Bukit Raja Kayangan. Melalui metodologi tiga fasa yang sistematik yang melibatkan pemerhatian di tapak, pembangunan borang, dan pengiraan keberkesanan borang tersebut, kajian ini mengenal pasti faktor-faktor pelbagai yang menyumbang kepada kelewatan apabila pekerja tidak mahir terlibat. Kajian ini adalah pembangunan dan pelaksanaan borang mesra pengguna untuk lukisan perdagangan seni bina, dengan penekanan pada pengambilan butiran pintu dan tingkap. Analisis menyeluruh terhadap data yang dikumpul untuk menilai keberkesanan borang batu bata yang dicadangkan dalam mengurangkan kelewatan projek. Analisis kualitatif menunjukkan pengurangan yang ketara dalam pembetulan bagi kawasan pintu dan tingkap, dengan pembetulan pintu berkurang daripada 31.33% kepada 27.20% dan pembetulan tingkap daripada 36.64% kepada 30.19%. Selain itu, sisa batu bata berkurang sebanyak 44% untuk kawasan pintu dan 46% untuk kawasan tingkap. Penemuan ini menyoroti potensi manfaat ekonomi dan alam sekitar dengan meminimumkan pembaziran bahan. Kajian ini memberikan bukti kukuh tentang keberkesanan borang batu bata, yang disahkan melalui analisis statistik dan teknik visualisasi data. Implikasi praktikal mencadangkan penambahbaikan dalam garis masa projek, penjimatan kos, dan amalan mampan. Kajian ini diakhiri dengan membincangkan keterbatasan dan mencadangkan arah masa depan untuk meningkatkan kecekapan pembinaan melalui penyelesaian inovatif bagi cabaran tenaga kerja tidak mahir.

TABLE OF CONTENT

LIST OF TABLES

`

LIST OF FIGURES

`

CHAPTER 1

INTRODUCTION

1.1 Introduction

The construction industry is a quickly growing industry which contributes significantly to the financial growth of all countries (Farooq, 2018). Additionally, it contributes to the increase of the populace's standard of living through the provision of essential socioeconomic infrastructure, including roadways, hospitals, schools, and other fundamental facilities. Despite the worldwide financial crisis, the construction sector makes a substantial contribution to Malaysia's Gross Domestic Product (GDP) (Tagod, 2021). Numerous elements influence the effective implementation of construction projects, including design, planning, resource allocation, and execution. Nevertheless, a persistent obstacle that causes significant disruptions to project timelines within the construction sector is the matter of project delays.

A project delay is characterized by the failure of a project to advance or reach completion within the initially established timeframe or timeline. Within many industries and sectors, such as construction, manufacturing, and information technology, among others, the occurrence of project delays may have a substantial influence on the overall success of a project, its financial implications, and the satisfaction levels of the stakeholders engaged in the endeavor. Numerous cases exemplify these situations, for example Muhwezi et al. (2014) found that negotiator-related delays have the highest impact in Uganda. In Taiwan, there have been 35 instances of construction delays stemming from modifications in client specifications (Yang and Wei, 2010). Similarly, Seddeeq et al., (2019) also proved that the most significant factor contributing to delays in Saudi Arabia is clients making changes to the design and scope during the construction process. In Ghana, the most frequently recorded issue pertains to delayed payments to contractors or suppliers (Amoatey et al., 2015). Major causes of delays in Jordan encompass contractor financial challenges, problems with subcontractors, and apprehensions regarding the quality of the

contractor's performance (Sweis et al., 2008). A similar situation has been encountered in Malaysia, where the primary causes of construction project delays were identified as shortages of equipment, inadequacies in materials and tools, disruptions resulting from these deficiencies, limited construction expertise, and have many of unskilled workers in construction (Sweis, 2008).

Unskilled workers within the construction industry can be defined as individuals who possess limited or no formal training, certifications, or prior experience in tasks or trades directly associated with construction. Most of these workers generally lack specialized skills or qualifications in fields such as carpentry, masonry, plumbing, electrical work, or other construction-related disciplines. Unskilled laborers are frequently engaged in the execution of general and labor-intensive duties that do not necessitate the application of advanced technical expertise or specialized training (Wonil Lee, 2019). The role of unskilled workers in construction projects is crucial, as they fulfil various necessary tasks. However, their limited expertise in specialized skills can occasionally lead to setbacks, mistakes, or potential safety issues if not effectively controlled and overseen. The provision of suitable training, guidance, and oversight to unskilled laborers is of utmost importance within the construction industry. This is necessary to ensure the safe and efficient execution of their assigned tasks, thereby making a significant contribution to the overall success of the project.

1.2 Problem Statement

Malaysia has the highest number of migrant workers in Southeast Asia, making up approximately 20% of the country's workforce (Noraini,2007). The laborers on the construction site are mostly foreign workers. Laboure's belong to the category of workers who do not necessitate any specific training or prior experience to carry out certain tasks proficiently. They engage in physically strenuous work and support skilled workers in construction, maintenance, and repair projects (Hezekiah Oluwole Adeyemı1, 2020). In the construction site, a multitude of subcontractors have been assigned to carry out different tasks. Additionally, there is a significant number of workers within each subcontractor. However, the large workforce poses a challenge in distinguishing unskilled workers. This factor can be one of the reasons for construction delays. Delay of construction projects has adverse effect on the reputation of the

construction industry’s contribution to the global economy (Christian Nnaemeka Egwim, 2021)

The demand for labor has been constantly increasing in the construction industry because of the high rate of development (Serneels, 2007). In addition, it is observed that salary payments to foreign citizens are more cost-effective when compared to those made to local citizens. Therefore, foreign workers will be given priority over local workers by employers (Hamzah Abdul-Rahman, 2012). Other than that, foreign employees possess different characteristics, including different cultural practices, varied personal histories, and differences in language, which serve to differentiate them from the local population. These factors contribute to elevated risks of accidents among immigrant laborers (Serdar Korkmaz, 2017).

According to the study conducted by Ashiru, Ismail Oladunni, and Anifowose (2022) the utilization of unskilled labor in construction projects can be attributed to a lack of adequate machinery. In addition to alternating work schedules and overstaffing, deficiencies in tools and equipment also contribute to the utilization of unskilled labor in construction projects. These concerns have the potential to result in operational inefficiencies and decreased output at construction sites, thereby demanding a more thorough evaluation of the sector's resource allocation and management (Anifowose,2022)

Unskilled workers have also caused a problem at the warehouse located at Persiaran Bukit Raja Kayangan. The presence of incorrect level and casting errors, among other issues, has been identified. The present issue is attributed to a deficiency in the workers' ability to accurately interpret drawings. The occurrence of such an incident will lead to the generation of material waste, as it necessitates the execution of a hacking procedure on an erroneous location. The present study aims to examine the distinct factors and resulting implications associated with project delays attributed to the employment of unskilled labor in the warehouse project. Figure 1.1 shows a visual representation of the works that necessitate hacking due to misalignment of the fin subsequent to the completion of the casting process. The floor level is not equal to the guidelines mentioned in the drawings consequences of unskilled workers who are not good in reading drawing. Figure 1.2 shows the timeline of project delays caused by several reasons, and one of them is unskilled workers.

Figure 1.1: Hacking work.

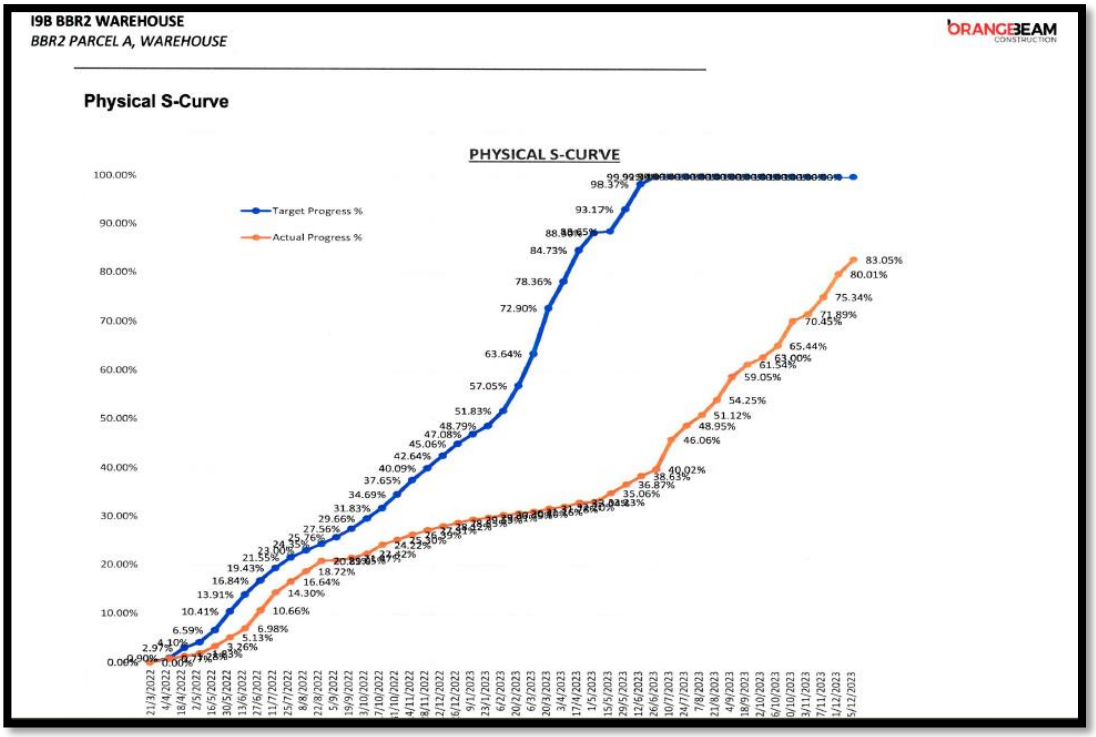

Figure 1.2: Project timeline

1.3 Objective

The purpose of this study is:

i. To identify factors that cause project delays contributed by unskilled workers in the study area.
ii. To develop a form, correspond to the important measurement specified in the architect's trade drawing for usage by unskilled workers.
iii. To calculate the effectiveness of the form

1.4 Scope of study

i. This study was conducted only for unskilled workers in architecture trade at warehouse I9B Bukit Raja as shown in figure 1.3.
ii. This research is focuses to extract drawing architecture trade to given at unskilled workers.

iii. The form is only provided to workers at the warehouse I9B and is given to those who can read both Bahasa Malay and English.

iv. This survey was conducted on 15 unskilled workers only.

v. The data taken for this research is for 2 months including data before and data after implement the form.

Figure 1.3: Location of the project

1.5 Significance of study

In this study, the focus is on addressing project delays caused by unskilled workers. The research highlights the implications of inadequate skills among workers, shedding light on how it affects project timelines. By understanding these challenges, project stakeholders, including decision-makers, can become more aware of the factors contributing to delays in achieving project objectives. Additionally, the research suggests improvements and identifies measures to mitigate the impact of unskilled labor on project schedules, providing valuable insights for enhancing overall project management efficiency on construction sites.

CHAPTER 2

LITERATURE REVIEW

2.1 Project Delay

The term "delay" describes an event that happens later than expected, as stipulated in the contract, or after the parties have agreed upon a deadline for project delivery (Keith, 2005). According to Hareru et al., (2016) a construction delay occurs when work is completed later than expected or as per the terms of the contract. Arantes and Ferreira (2020) state that a project is deemed successful if it is finished on schedule and satisfies the established standards for both cost and quality. The location, nature, scale, and scope of the project may all affect the reasons for construction delays. Construction delays in engineering projects are a typical occurrence in Egypt, as they are in many other developing nations.

Sambasivan and Soon's study, which looked at the relationship between the causes and consequences of delays, more than 10 years ago identified the top ten variables that Malaysian construction professionals believed to be significant delays. One of the first studies to scientifically demonstrate the relationship between each cause and effect was this one. In a different study conducted that same year, Alaghbari et al. (2016) investigation of the causal delay factors discovered that the owner's financial difficulties brought on by economic issues, financial issues affecting the contractor, the consultants' inefficiency in issuing instructions, their slowness in supervising work, and the lack of materials on the market were the main causes of the delay. Although these studies provide a deeper comprehension of the factors causing delays in Malaysia, they were conducted more than ten years ago, at a time when the maturity of the construction sector was lower. Additionally, they only consider the reasons on a single agreement or frequency scale, which can reduce the validity of their findings. It is also important to note that this research did not analyze the underlying reasons; instead, they focused primarily on identifying the relevant causes. To close these disparities, the current

research reassesses the reasons for delays via the evaluation of important indices that additionally include severity and frequency. Determining the primary dimensions of delays also helps to clarify the fundamental elements influencing schedule performance.

Subsequently, in Vietnam, staff and management issues are the main causes of delays (L. Le-Hoai, 2008). The most serious financial issue facing a contractor in Egypt is money. A different set of factors, including invasions, border checkpoint closures, and inadequate supplies of building materials, are found in the Gaza Strip in Palestine (A. Enshassi, 2010). These factors may be related to the political climate in the area. Doloi et al. examined building projects in India and found that a major contributing cause to project delays is a lack of commitment saw the prioritization of the delay factors specific to Beninese building projects by Aktobe et al., (2013) who considered the respondents' assessments of the causes' severity and frequency of occurrence. The main time-inhibitors were determined to be the owners' financial difficulties, the contractors' weak financial standing, and the subcontractors' subpar work. However, Muhwezi et al. (2014) in Uganda used the Relative Importance Index (RII) in their research and found that consultant-related variables significantly increased delays. Mydin et al. (2014) investigated of the housing developers' viewpoint in Malaysia and found that causes associated to contractors are more important than those related to consultants, clients, and external parties. An analogous finding was previously documented by Abdullah et al. (2016) about procurement initiatives managed by Majlis Amanah Rakyat (MARA), a government organization that supports, educates, and mentors Malays and other indigenous Malaysians. This is also in line with previous comparable studies conducted in Pakistan, where "difficulties in financing project by the contractor" was the primary reason, and in Egypt, where a contractor-related group of delay causes was most essential, with RII = 79.91%. (Aziz, 2013)

Larsen et al., (2018) highlight that over the last five years, consultant-related issues have been the main obstacles to project schedule performance in Denmark. They also show that delays resulted in increased expenses and poor project quality. Nguyen and Chileshe (2017) found in Vietnamese research that inadequate planning and staff incompetence are major factors in project failures. The following year, technical incompetence, inexperience, and financial fragility of contractors were shown to be the main causes of time performance delays in another empirical research conducted in the economically disadvantaged country of Burkina Faso. The top five factors contributing

to delays in road building projects in Egypt are contractor, materials, equipment, funding, and scheduling. Regarding the United Arab Emirates, the inherited adversarial customs of the principal players are linked to the reasons of delays. Bajjou and Chafi (2015) categorized the reasons in Morocco into nine categories. The top three were inadequate waste management plan, inadequate training and competence of project staff, and postponed progress payments. The most frequent reasons for delays in China include variances, unpaid progress payments, intense competitive bidding, subcontractors' poor performance, and communication failures. Zidane and Andersen (2009) identified 10 major delay issues in Norway the same year. The top three include inefficient planning and scheduling, numerous design modifications made during construction, and delaying interim payments to contractors.

On the other hand, a delay is one of the main challenges that affect the performance in any business sector, and it can be considered one of the most complex problems which affect the construction sector. According to Sanni-Anibire et al., (2021) the delay is the primary source of productivity loss. Also, according to Aziz & Abdel-Hakam (2016) several contractors have expressed their worries over the problem of delays and how hard it is to overcome this problem. The primary reasons for their concerns can be expressed as their poor ability to identify the factors which are accountable for the delays and affect the construction phase. Trauner et al. stated four types of project delays. The first one is the excusable or non-excusable delay. Excusable delays, such as natural disasters, are caused by unexpected situations and are uncontrollable by the owner or contractor. Non-excusable delays, such as submission of submittals, are defined because of delaying action taken by the contractor or the owner.

Most recently, Arantes and Ferreira (2020) research in Portugal found that six of the ten most important reasons are comparable to the top ten universal delays in building projects, based on Zidane and Andersen (2009) list of the ten universal causes of delays. Six fundamental factors emerged from their exploratory factor analysis: poor planning, poor consultant performance, disorganized site management, owner intervention, bureaucratic red tape, and subpar contracts. According to Toor and Ogunlana (2008) the bulk of delays are caused by a failure to anticipate challenges and the use of untrained staff. Furthermore, they observe the same pattern of problems

emerging in numerous nations throughout the globe. There are several more reasons that contribute to project delays.

2.1.1 Cost Overruns

A cost overrun occurs when actual project expenses end up being more than anticipated or budgeted. One of the biggest issues that may have a major impact on economies throughout the globe is cost overruns (A. Balali, 2020). According to Aziz (2013), the causes influencing cost difference in wastewater projects were established utilizing a statistically representative sample of construction practitioners and experts who participated in a structured questionnaire survey. The data was analyzed using Frequency Index (FI), and recommendations were made to deal with these problems in future projects. Tharl. et al., (2010) established a technique for identifying crucial characteristics that may signal possible cost overruns via data analysis using Multiple Linear Regression (MLR). Based on semi-structured interviews, Razek et al., (2008) identified the primary reasons of construction project delays in Egypt from the perspectives of owners, consultants, and contractors.

Flyvbjerg et al., (2002) have out more study to demonstrate the distribution of the cost overrun issue. 90 percent of the projects had budget overruns and exceeded their initial allocation; 50–100% of the contributing causes were common to all the projects under investigation. Furthermore, Charoenngam & Sriprasert (2001) noted that inability to manage construction costs or prevent cost rises may result in the failure of construction businesses. According to Annamalaisami & Kuppuswamy (2022), one of the most important factors in determining the success of a project is its cost. As a result, any departure from the estimated building cost might have an impact on the project's success rate.

2.1.2 Miscommunication

Throughout the course of a construction project, a great deal of information is shared with all parties involved. It is crucial to the project at every level, since each step affects the project's outcome (Mohammed M, 2016). Similarly, the success of the

project is said to be greatly dependent on how well construction workers communicate with one another (Ishaq IM, 2019). It has been verified that the project managers communicate with the stakeholders engaged in the project for over 90% of their working hours. To satisfy the client's expectations and needs, effective communication and process coordination are crucial to the project's ultimate outcomes. It has been reported by the Project Management Institute (PMI) that around 55% of project managers said that good communication is essential to the project's success (Taleb H, 2017). Over 40% of the workers on the building site said that there is a breakdown in communication between project participants (Ishaq IM, 2019). In order to track the caliber of work at each stage of the project, a few academics have also proposed a variety of performance measurement instruments.

The 10 most important criteria were identified from research on the variables that delayed the growth of Makkah's building sector. Ineffective communication came in at number eight (Al-Emad N, 2017). According to another research, there are eight reasons why construction projects take longer than expected to complete, with insufficient coordination and communication among project participants ranking sixth (NOM., 2018). Another significant problem that the Gulf area has encountered in over a thousand projects is legal challenges. Empirical research has found that misunderstanding among project members is the primary cause of disagreements.

A number of factors can lead to miscommunication, including delayed or sluggish information dissemination, a lack of communication during the contract's early phases, inefficient reporting systems, inappropriate channels, malfunctioning communication technology; and, inappropriate channels that result in faulty message transmission (Gamil Y, 2019). Cost overruns are more likely when project participants are not in contact or coordination, particularly if they come from diverse backgrounds (Gamil Y, 2019). The Saudi Arabian building sector is now in a state of growth. Numerous earlier studies on construction in Saudi Arabia have highlighted communication challenges, however these problems have also been linked to other concerns with the structures and projects. To the best of the authors' knowledge, no research that addresses misunderstanding and its consequences in the construction business has been done for Saudi Arabia.

2.1.3 Delay Payment

Three key parties were engaged in the payment of contractors: the owner, the contractor, and the consultant. The procedure of paying contractors was often broken down into three phases for each intermediate payment. The contractor's invoice was forwarded to the owner or the owner's agent as the initial step. Inspection and the issuance of the certificate of inspection constituted the second step. It was considered since the agreed-upon amount of work completed had been accepted and certified by the consultant and quantity surveyor/engineers. The owner used direct payment to carry out the third step of payment. At least two separate delays occurring at the same time are considered causes of payment delays. The delays may be attributed to factors both outside and within the contractor's control. All parties directly or indirectly engaged in the project have a cascading impact on their cash flow because of the payment delay. It has an impact on the project's timeline, budget, and performance quality. Over time, material suppliers, subcontractors, and contractors saw a decline in their overall and financial viability (Jiang, 2012). Payment delays are caused by several things. Most projects include owner, contractor, and consultant mistakes in their work. The owner's reasons for not paying contractors on time include not understanding the terms of the agreement, not acting with a proper attitude by unfairly deducting payment from the contractor, and not following the established process. The contractor's reasons for not paying contractors on time include not agreeing to the work's valuation, filing claims incorrectly, and not filing claims (Ayudhya, 2012). The inability of consultants to handle money, lack of coordination of project team operations, and delay in the quantity surveyor's appraisal of completed work are the reasons for consultant-borne failure to pay contractors on schedule (Hasmori, 2012). Furthermore, the reasons for designer-borne delays in contractor payments arise from the need for applications, design management strategies, and other software programs to be implemented at every stage of the design process (Mamoon, 2016) .

2.2 Unskilled workers

Four principles are taken into consideration when considering skill specialization, according to the International Standard Classification of Education (ISCED): The kind of expertise needed, the equipment and tools utilized, the materials

handled or dealt with, the products and services generated. According to a survey by the International Labor Organization, workers are divided into three groups according to their educational backgrounds and skill sets. There are craft jobs that need highly trained laborers, there are jobs that demand semi-skilled laborers with less training, and there are jobs that don't need highly trained laborers anyone can perform the task with minor direction). According to reference (Vereen, 2013), on the other hand, low skilled occupations are those that require little to no training or instruction, such as general helping and roofing, and highly skilled occupations are those that require years of specialized education or training, such as pipefitting, electrification, and carpentry.

A shortage of skilled laborers may have a significant impact on project productivity (Hossein et al., 2018). In 2009 research, for instance, Dai et al. grouped ten sets of characteristics that illustrate the basic structure of productivity. The authors discovered that labor problems were connected to training, craft worker, supervisor competence, qualification, and foreman competency. Furthermore, they discovered that the most important aspect with the greatest potential to increase project productivity is labor qualification. Higher project productivity is significantly impacted by the effectiveness of workers' improved training (Wang et al., 2008). According to Karimi et al. (2016), the loss in productivity of construction projects is directly related to the unavailability or lack of experienced trained workforce. The authors also discovered a strong correlation between the decline in project productivity and the difficulty in finding competent workers. Projects with a shortage of competent workers often experience increased labor and material expenses, delays in project completion, poor scheduling, and subpar work that falls short of schedule.

Furthermore, since they lack understanding about proper construction techniques and procedures, less trained or experienced laborers are less knowledgeable about safety accidents (Karimi et al., 2016). According to research done in 2005 by Glazner et al., the most frequent reasons for damage during project building were unsuitable behavior, inexperience, and a failure to follow safety protocols. Additionally, the survey found that 54.5% of losses resulted from a lack of safety precautions taken during construction. In the process of designing and planning a project, it is important to swiftly identify or anticipate any labor skills-related issues so that they may be addressed promptly and efficiently. Inability to identify these issues may result in erratic and uncontrollable actions that postpone the completion of building projects. Research

on the reasons for construction delays by Hussain et al., (2018b) and Gündüz et al. (2013) discovered that untrained or unskilled laborers were a contributing factor. Odeh and Battaineh (2002) looked into the reasons behind construction project delays and found that, from the perspective of the contractors, labor productivity is one of the main reasons for project delays. When there are not enough workers with the necessary skills, practices, experiences, capacities, or proficiencies to do a given job, there is a skill shortage (Ho, 2016).

The construction industry's labor deficit will result in a longer construction timeline (Essays, 2018). The lack of employment in the construction business will result in a delay in the construction timeline. According to Zannah (2017), there won't be any construction delays if all of the projects can go according to plan and adhere to the timetable. The contractor and unskilled laborer's misunderstandings are likely to cause the construction time to be delayed. The unskilled worker has never had the necessary training to encounter problems with communication amongst them (Zannah, 2017). Additionally, the more complex project hinders the inexperienced laborer's performance since he lacks experience and abilities and has never been prepared. According to Chetty (2017), unskilled workers are unable to complete the job in accordance with the customer's standard criteria. As a result, following evaluation and inspection, the construction work must be repeated, which has an adverse effect on the project's timeline. The contractor must begin restoration work and pay fines to the customers if the project is not finished within the prearranged time limit. This may have a direct impact on how quickly construction is completed.

According to Edum-Fotwe and McCaffer (2015), labor scarcity will make it challenging to manage and monitor the project's schedule, cost, and quality. The majority of a contractor's time spent on a project is spent trying to recruit a qualified worker, which slows down site building. Because of the difficulties associated with hiring untrained laborers, the construction time is out of control when using them. They must spend their time becoming acquainted so that the untrained laborer may understand how to start the task in the best possible way and ultimately extend the building timeline. The contractor will probably not be able to complete the job on time if they do not have enough experienced laborers.

2.3 Wastage at Construction Site

Al-Rifai and Amoudi (2016) examined the primary causes of material waste in construction project related to management and the workforce are the most significant contributors to construction waste. Specifically, the lack of skilled labor and subcontractors, along with errors made by workers that necessitate rework, were found to have the greatest impact on the generation of construction waste. Al-Rifai and Amoudi (2016) linked these issues to the casualization of labor and the contractors' and subcontractors' neglect of proper training. Similarly, a separate study in Jordan by Bekr (2014) found that material waste on construction sites ranges from 15% to 21%. The primary causes of this waste include design and client changes, worker errors leading to rework, poorly drafted contracts, inadequate material storage, lack of waste reduction strategies, shortage of experienced skilled workers, poor worksite conditions, transportation damage, theft and vandalism, and mistakes by quantity surveyors.

A survey conducted by Esin and Cosgun (2007) in Istanbul, Turkey, revealed that poor workmanship due to the employment of unskilled labor, inadequate tools, and substandard workplace conditions are primary causes of waste generation downstream in construction projects. In Australia, Teo and Loosemore (2001) utilized Ajzen’s 'theory of planned behavior' to explore the attitudinal factors influencing behavior at the operative level. Their study discovered that construction workers believe waste is inevitable, partly because management does not prioritize waste management and fails to provide the necessary resources and incentives to support waste reduction efforts. Consequently, Al-Sari et al. (2012) argue that addressing human factors is crucial for minimizing downstream waste. In the Palestinian construction industry, Al-Sari et al. (2012) found that construction projects generate approximately 17 to 81 kilograms of waste per square meter of building floor area. This waste generation is largely due to labor-intensive techniques influenced by contractors' attitudes and behaviors towards waste management. The study also noted that a higher number of unskilled workers negatively impacts contractors' attitudes toward waste reduction and their practices regarding waste sorting and disposal. Unskilled workers tend to be less aware of the environmental impact of construction, have misconceptions about the quality of recycled products, receive low wages, lack motivation, and are less effectively supervised.

Khaleel and Al-Zubaidy (2018) identified key factors contributing to waste generation in building projects in Iraq, including material damage on-site, poor material handling, and the incompetence of contractors' technical staff. Sakunde and Valunjkar (2017) applied Six Sigma principles and found that the unfriendly behavior and attitudes of labor and project team members significantly influence waste generation and management on construction sites. According to Asgari et al. (2017), the lack of skilled and experienced personnel to implement effective management programs affects both the quantity and quality of construction and demolition waste. Haruna et al. (2017) highlighted several factors contributing to waste on construction sites, such as poor workmanship, materials theft and pilferage, overestimation of materials, inadequate labor supervision, and incorrect interpretation of drawings. Popoola et al. (2018) reported that operational factors, particularly poor workmanship, are the leading contributors to on-site waste generation, especially in building construction projects.

2.4 Construction Drawing

Construction drawings constitute a broad term encompassing the drawings integral to the production information included in tender documentation and subsequently incorporated into the contract documents for construction projects. These drawings hold legal significance, forming a vital part of the agreement between the employer and the contractor. The primary objective of construction drawings is to offer a visual representation of the intended construction. It is imperative for these drawings to be clear, concise, and well-coordinated to minimize ambiguity and confusion, thereby reducing delays and misunderstandings.

While specifications delineate the materials, standards, techniques, and other details essential for executing the works, construction drawings serve as graphical representations indicating component arrangements, detailing, dimensions, and more. It is advisable to avoid duplicating information present in specifications whenever possible. In instances where there is overlap, careful coordination is crucial to prevent confusion. In cases of discrepancies, specifications typically take precedence over drawings. A comprehensive set of construction drawings typically includes floor plans, elevations, sections, and detailed drawings, collectively providing a comprehensive

depiction of the building. Major trades, such as electrical and plumbing, often have separate trade drawings. While construction drawings can be created manually, the more prevalent practice involves using computer-aided design (CAD) or computer-aided drafting software (Sonit Bafna, 2019).

CHAPTER 3

METHODOLOGY

3.1 Introduction

The following section outlines the methodology employed for the identification of unskilled labor as a contributing factor to construction delays. Similar protocols are followed in the field of research. The methodology employed in this study comprises three distinct phases: firstly, the identification of project delay issues; secondly, the estimation of the extent to which project delays are associated with architectural trade; and finally, the generation of concepts for the creation of an abstract drawing form. The methodology involved the utilization of drawing techniques to facilitate the development of a comprehensive form for the purpose of gathering and analyzing the pre-specified information.

3.2 Research Design

The present study aims to gather a comprehensive dataset by utilizing both primary and secondary sources of information. The collection of primary data was conducted through the distribution of form to workers at the site. The collection of secondary data involved on-site observations aimed at identifying the issues caused by unskilled workers.

There is a distinct connection between the implementation of workplace practices and the challenges associated with on-site activities involving unskilled workers. This connection is influenced by various factors, such as the nature and intensity of the tasks performed, the frequency of incidents, supervision by relevant authorities, financial considerations, and more. Consequently, research design for unskilled workers is to identify all pertinent parameters related to work-related challenges, aiming to enhance overall work efficiency and effectiveness. The research

process, illustrated in Figure 3.1, unfolds in three phases which is the first phase was the start up, the second phase is the assessment part, and third phase was the end.

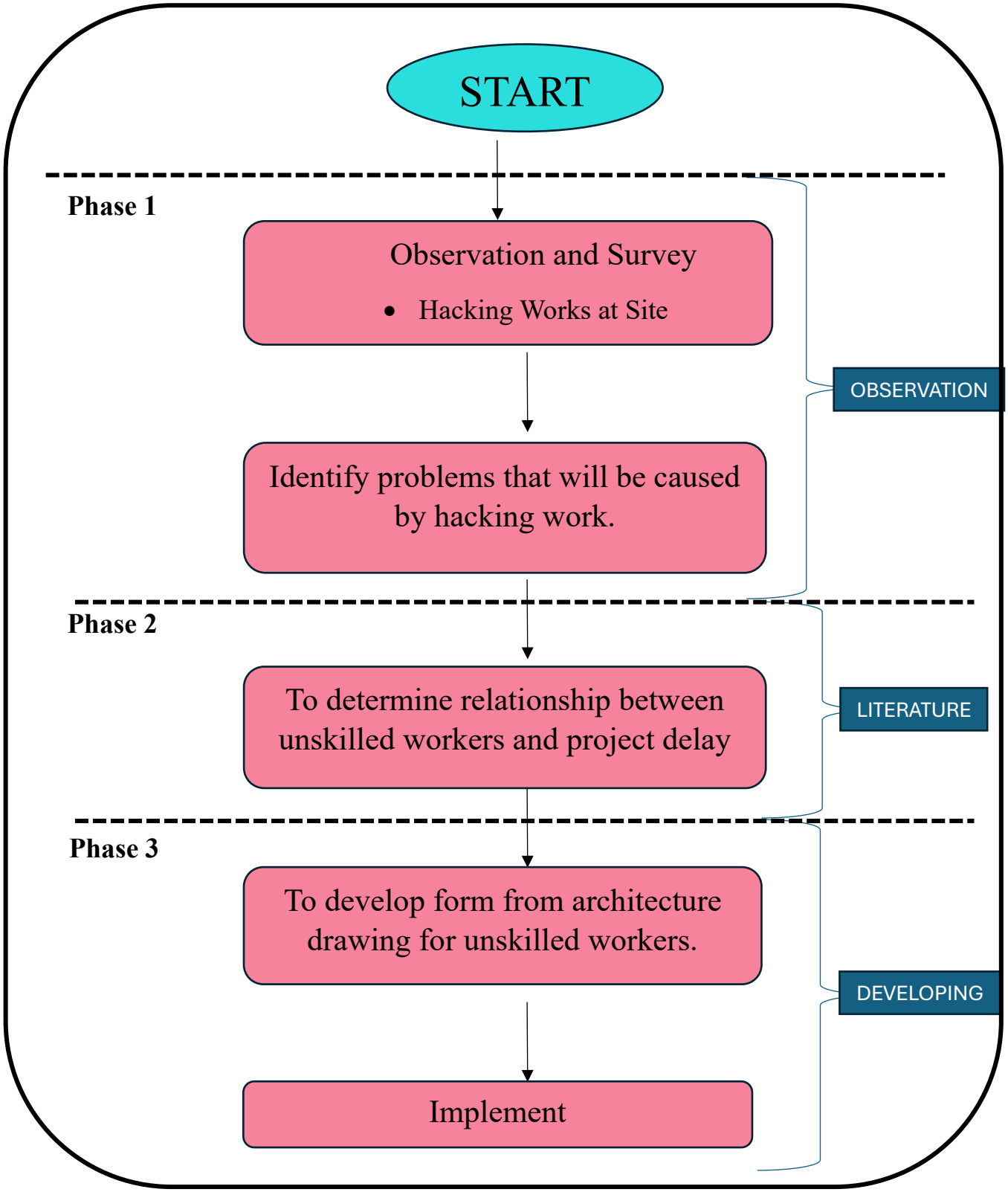

Figure 3.1. Research Framework

3.2.1 Phase 1- Observing

Phase 1 involves observing and surveying at Bukit Raja Klang warehouse. This has been noticed while observing the workers hack many areas. Researchers spent a few weeks investigating the site to identify the problem. The observation indicates that the issue lies with unskilled workers. This is due to unskilled workers' inability to read drawings and identify numerous areas of door and window hacking work.

3.2.2 Phase 2- Determine relationship between unskilled works and project delay

In phase 2, searching for journals and finding information in the literature review have been done to find the relationship between unskilled workers and project delay. Additionally, company data reveals several reasons for project delays, including a significant amount of hacking activity.

3.2.3 Phase 3- Develop form and Implement

Phase 1 and Phase 2 demonstrate that the delay in the warehouse project is primarily due to unskilled workers. These unskilled workers are not good at reading drawings, and the result is a form to make work easier for these unskilled workers. This form has been created using Excel, and the necessary data in this form is the door and window data that needs to be taken from the architectural drawing. Dimensions for door and window data must be entered into the form. This form has two parts: one that needs to be filled out by the supervisor and the other that needs to be given to unskilled workers.

3.3 Developing Form Using Microsoft Excel

Microsoft Excel, a part of the Microsoft Office suite, is a powerful spreadsheet application that has transformed data management, analysis, and visualization in various industries such as business, finance, science, and academia. Nevertheless, the versatility, accessibility, and powerful features of Excel have made it an essential tool for professionals and researchers, greatly influencing the way organizations handle and analyze data. Data analysis can be done utilizing a variety of tools and techniques in Microsoft Excel because of this. Additionally, because Google has a ton of tutorials available. This facilitates the discovery of numerous forms and data analysis techniques. To generate this format in Excel, the initial requirement is to have an architectural drawing.

Excel was selected for creating this form because it is available for free. Additionally, Excel offers numerous tools to facilitate form creation and has a wealth of tutorials accessible on Google. Consequently, data analysis can also be performed using Excel, aiding in the efficient preparation of this analysis data.

3.4 Data Collection

The analysis necessitates detailed data on the types of doors and windows involved in the brickwork activities, as well as the quantity of bricks utilized and wasted. To thoroughly understand the impact of the new brickwork form, the data collection process spans two months, capturing the number of rectifications performed both before and after the form's implementation. This comprehensive approach ensures that the study can accurately assess the form's effectiveness in reducing errors and material wastage.

To facilitate this data collection, 15 unskilled workers were involved in the study. These workers, who have been selected based on their proficiency in both Malay and English, were tasked with providing essential data on their brickwork activities. The data gathered includes not only the types and quantities of materials used but also the frequency and nature of rectifications required. This information, although not included in the written document for privacy reasons, serves as a crucial reference for the analysis, ensuring that the findings are robust and grounded in real-world observations.

3.4.1 Workers Data

Data on unskilled workers was collected to understand the demographics and professional backgrounds of those involved in the brickwork activities before and after the implementation of the new form. The key demographic information included the nationality of each worker, which is essential for understanding the diverse backgrounds and potential cultural influences on their work. Additionally, the data captured how long each worker had been in the construction field, providing insight into their levels of experience and expertise.

The unskilled workers selected for the study were required to have proficiency in both Malay and English. This criterion ensured that all workers could effectively understand and follow the instructions provided by the new brickwork form, minimizing errors due to language barriers. Proficiency in these languages was critical for clear communication, thus enhancing the implementation process and contributing to the observed improvements in brickwork activities.

For confidentiality reasons, the detailed data collected from administrative records is not included in this document. The private and sensitive nature of this information necessitates its exclusion from the thesis, ensuring the privacy of the workers. However, this data serves as a vital reference, supporting the analysis and conclusions drawn from the study. The collected information underpins the findings, ensuring they are based on accurate and comprehensive worker profiles, thereby validating the observed improvements in efficiency and reduction in brick wastage.

3.4.2 Data Before and Data After for Brickwork

The data for this study was meticulously collected over a period of two months to ensure a comprehensive analysis of the brickwork activities before and after the implementation of the new form. The study aims to evaluate the form's impact on improving efficiency and reducing material wastage. To achieve this, it is crucial to consider several key factors. First, the number of employees participating in the study must be accurately recorded. This includes noting both the total workforce involved and any changes in the workforce composition during the data collection period. Additionally, the start and finish dates of data collection are essential to establish the precise duration of the study, which is critical for comparing performance metrics before and after the form's introduction.

Furthermore, detailed records of the types of doors and windows involved in the brickwork activities are necessary. By focusing specifically on these elements, the study can ensure more detailed and targeted data collection, allowing for a nuanced analysis of the form's impact on different types of installations. The total amount of data collected must be calculated meticulously to provide a clear picture of the scope of the study. For each data total, it is important to account for the number of rectifications made, as well as any brick wastage that occurs. This comprehensive approach enables

a thorough analysis, highlighting areas of improvement and quantifying the benefits of the new brickwork form. By addressing these factors, the study aims to provide a robust evaluation of the form's effectiveness in enhancing the efficiency and accuracy of brickwork activities.

3.5 Architecture Drawing

Architectural drawings are indispensable in the construction process, acting as the primary medium for visual communication among architects, engineers, contractors, and on-site workers. These drawings encapsulate comprehensive information about the design, dimensions, materials, and construction methods for a building project, ensuring that all parties involved have a clear and unified understanding of the project's specifications. For this study, grasping the nature and significance of architectural drawings is vital, as they underpin the development of the abstract form designed to assist unskilled workers in executing their tasks with greater accuracy and efficiency.

Architectural drawings typically encompass several key types of representations, each serving a unique purpose. Floor plans are among the most essential drawings, offering a top-down view of the layout of spaces within a building. They illustrate the arrangement of rooms, walls, doors, and windows, providing a comprehensive map of the interior spaces. This plan is crucial for unskilled workers to understand the spatial organization and the precise locations where construction elements should be installed.

Elevations are another critical component, depicting the external facades of a building from various angles. These drawings show the height, architectural style, and external finishes of the structure, enabling workers to visualize the exterior appearance and align their construction activities accordingly. Elevations are particularly important for tasks involving external brickwork, cladding, and window installations.

Sections offer cross-sectional views of the building, slicing through the structure to reveal the internal configuration and construction methods. These drawings are vital for understanding the relationships between different levels of the building and the placement of structural elements like beams, columns, and floors. Sections help workers

see the building's internal framework, ensuring that all components are accurately aligned and constructed.

Figure 3.2 shows the original architect's drawing for the door and the key measurements needed for the form. The highlight area is the dimension that is needed for the form. These complex drawings are simplified to include only essential information like width left and width right, making them easier for unskilled workers to understand and follow.

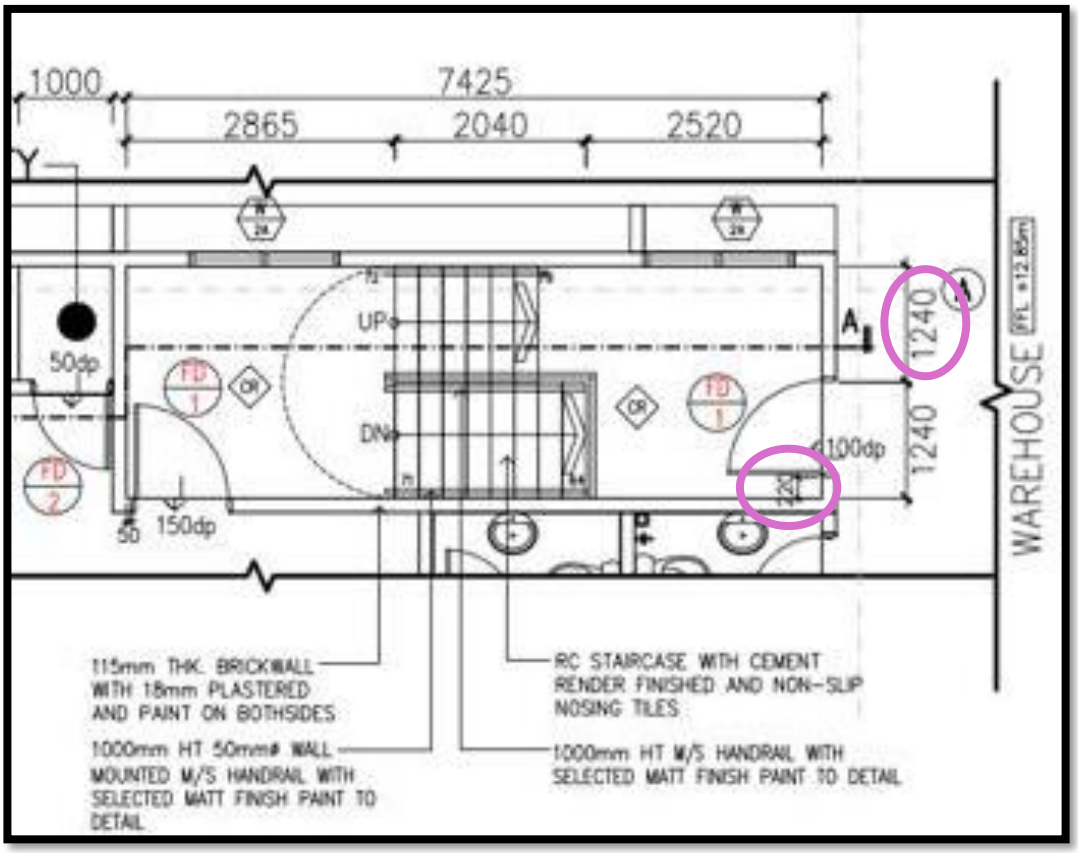

Figure 3.2 Architecture Drawing for door area

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CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents a comprehensive analysis and discussion of the data collected to evaluate both the factors contributing to project delays due to unskilled workers and the potential effectiveness of the proposed brickwork form in mitigating these delays. The analysis aims to provide detailed insights into the specific factors that lead to delays when unskilled labor is involved and to assess the viability of the proposed solution in addressing these challenges. By examining the root causes of delays and evaluating the practicality and impact of the brickwork form, this chapter seeks to offer valuable recommendations for improving efficiency and reducing delays in construction projects. The findings will help in understanding how unskilled workers interact with architectural drawings and how tailored tools and forms can enhance their performance, ultimately leading to more timely project completions.

4.2 Factor Project Delay Contribute by Unskilled Workers.

Project delays caused by unskilled workers often stem from their inability to understand drawings, poor quality work, and difficulty communicating in Malay and English. Misinterpretation of drawings can lead to incorrect measurements and placements, necessitating rework that wastes time and resources. Poor quality work due to a lack of skills and experience frequently fails inspections, requiring corrections that further delay the project. Additionally, language barriers can result in miscommunication of instructions and safety protocols, hindering coordination and increasing the risk of accidents.

4.2.1 Inability to understand drawing

One of the main challenges unskilled workers face at this study site is their difficulty in understanding and reading technical drawings. This issue has been consistently observed over the past several months. To gain deeper insights into this problem, interviews were conducted with engineers and managers who are actively working on site. These conversations aimed to gather their perspectives and confirm the extent of the problem. The interviews were done informally and spontaneously, without any recordings, to capture genuine and immediate feedback from the professionals. Their input has further strengthened the observation that the inability to read drawings is a significant barrier for the unskilled workers, affecting their efficiency and poor quality on the job.

4.2.2 Poor Quality Work

At the I9B project site, there are numerous instances of poor-quality work primarily due to unskilled workers who struggle with interpreting architectural drawings. This lack of understanding can significantly contribute to project delays, as errors stemming from misinterpretation require corrections that consume additional time and resources. Poor quality work by unskilled workers is a major reason for project delays. Rashid et al. (2020) explain that unskilled workers often do not have the necessary knowledge and skills to complete construction tasks correctly. This leads to mistakes, defects, and work that does not meet the required standards, resulting in the need for corrections or rework. Figure 4.1 show an example of poor workmanship with uneven plastering. This issue not only reflects the workers' inadequate skills but also necessitates rework to meet the project's quality standards. Such rework further delays the project's progress.

Figure 4.1: Uneven Plastering

Furthermore, an additional example of substandard quality observed in my project is the installation of wall cladding, which fails to meet the prescribed specifications. Figure 4.2 shows the uneven application of wall cladding, indicative of inadequate oversight during installation. This deficiency in supervision has resulted in the misalignment, irregularity, and improper fitting of the cladding materials.

Figure 4.2: Uneven Installation Wall Cladding

4.2.3 Difficulty Communicating in Malay and English

As observed at the I9B project site, communication barriers posed a significant challenge for the unskilled workers, contributing to project delays. The workforce comprised individuals from various nationalities such as Bangladesh, each with varying levels of proficiency in Malay and English – the primary languages used for communication on Malaysian construction sites. This communication gap manifested in several ways, leading to errors, misunderstandings, and ultimately, project delays. In some instances, workers misinterpreted the instructions provided by supervisors, resulting in tasks being executed incorrectly. Consequently, rework was required to rectify these mistakes, consuming additional time and resources.

4.3 Development of the Brickwork Form for Unskilled Workers

The development of the brickwork form was a direct response to the challenges faced by unskilled workers in interpreting architectural drawings accurately. As identified through on-site observations and data collection, the inability of unskilled workers to comprehend complex architectural plans was a significant contributor to project delays. The brickwork form was meticulously designed to address this issue by

presenting essential information in a simplified and user-friendly manner. The form's primary objective was to extract the critical dimensions and measurements for door and window areas from the architectural trade drawings and present them in a format that unskilled workers could easily understand and apply. The form itself was divided into two distinct sections. The first section was intended for supervisors and the second one for unskilled workers.

4.3.1 Excel Form Using by Supervisor

This form has been meticulously designed to facilitate easy data entry by contractors responsible for overseeing architectural work. It is divided into two distinct sections: the first section is intended to be filled out by the contractor, while the second section is designated for unskilled workers. The form is comprehensive, containing detailed information about the ongoing project, including precise measurements and specifications. Contractors are required to fill in specific sections of the form, after which the information seamlessly continues to subsequent sections. This design ensures that data is consistently and accurately transferred, minimizing the risk of errors and omissions. One of the key features of this form is its versatility and ease of use. It can be utilized in various locations and by different personnel, thanks to its straightforward and user-friendly layout. This ease of use is crucial in construction settings, where clarity and precision are paramount. The practicality and effectiveness of this form have been tested through an informal study at Project Warehouse I9B. In this trial, several engineers and subcontractors utilized the form in real-world conditions. Although this study was not formally documented, it served as an experimental validation of the form’s design and functionality. The feedback from these professionals indicated that the form significantly streamlined the data entry process, making it more efficient and less prone to errors.

Figure 4.3 and figure 4.4 are forms that need to be filled out by supervisor based on the architecture drawing for brickwork at area window and door. The supervisor needs to fill in the title where the project being carried out, type of window or type of window, width, and height. Once filled, the dimensions will automatically appear on the diagrams. These two figures are forms that help supervisor input necessary information extracted from architectural drawings. However, it's essential to note that

these forms are not visible to unskilled workers. Workers only interact with the data entered separate forms designed specifically for them.

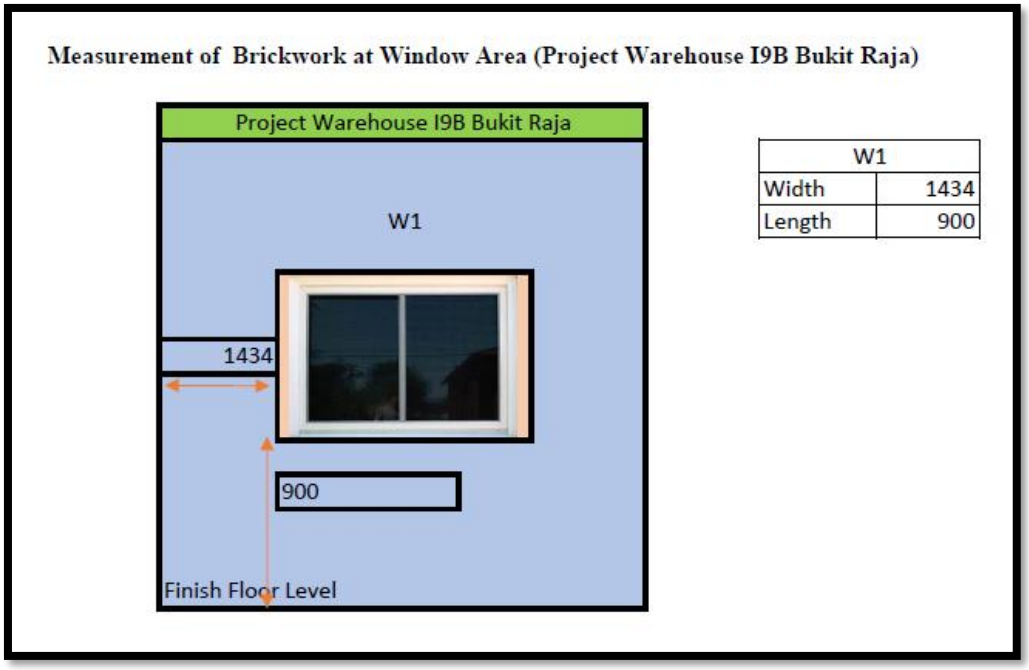


Figure 4.3: Form Window for fill by Supervisor

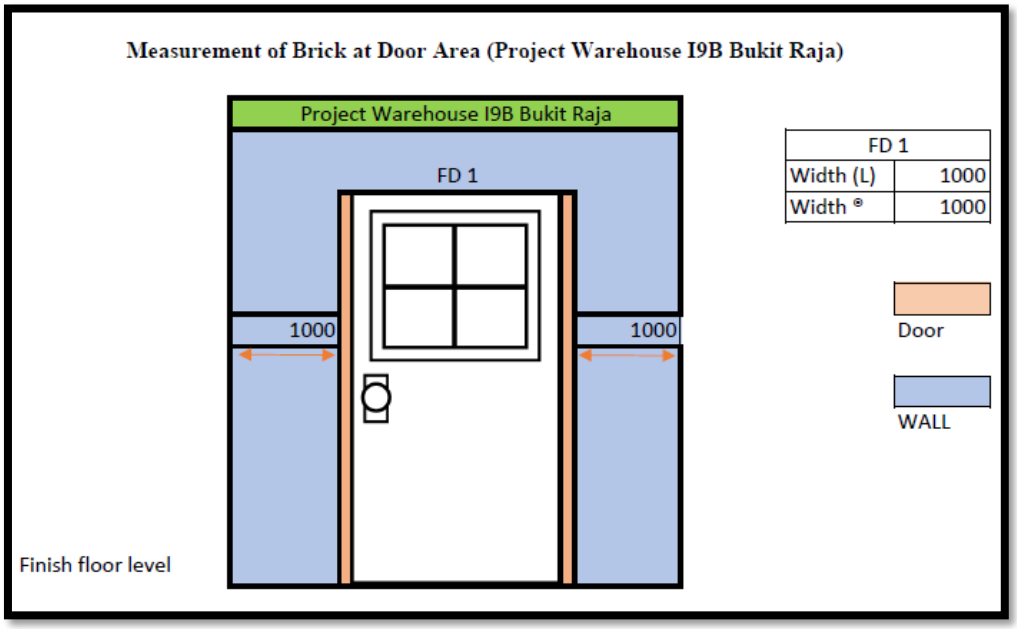


Figure 4.4: Form Door for fill by Supervisor

4.3.2 Form Using by Unskilled Workers

The development of the brickwork form was driven by the principles of simplicity and clarity, aiming to present critical information in a way that unskilled workers could easily understand. This approach was essential to ensure that these workers could accurately perform their tasks without needing to interpret complex architectural drawings, which often pose a significant challenge due to their lack of specialized training. The brickwork form was specifically designed to capture the essential measurements for brickwork around window and door areas, which are critical components in the construction process. The form clearly presents the width and length dimensions for window areas, as well as the width dimensions for door areas. By providing these specific measurements directly, the form minimizes the potential for errors and misinterpretations that unskilled workers might encounter when trying to extract this information from intricate architectural drawings. This design not only simplifies the construction process for unskilled workers but also enhances accuracy and efficiency, reducing the likelihood of project delays due to misinterpretation of the drawings. This form represents a practical solution to a common problem in the construction industry, aligning with the goal of improving overall project timelines and quality

Figures 4.5 and 4.6 illustrate forms specifically designed for unskilled workers, focusing solely on the dimensions of windows and doors, including their width and height. These forms simplify the essential information, making it more accessible and easier to understand compared to the complex architectural drawings typically used in construction projects. The dimension data on these forms is automatically generated from the detailed information entered by the contractor, as depicted in Figures 4.3 and 4.4. By streamlining the information to include only the critical measurements, these forms help unskilled workers execute their tasks with greater accuracy and efficiency, reducing the likelihood of errors that can arise from misinterpreting more intricate architectural plans. This approach enhances the workers' ability to comprehend and follow the specifications, thereby improving the overall quality and efficiency of the construction process.

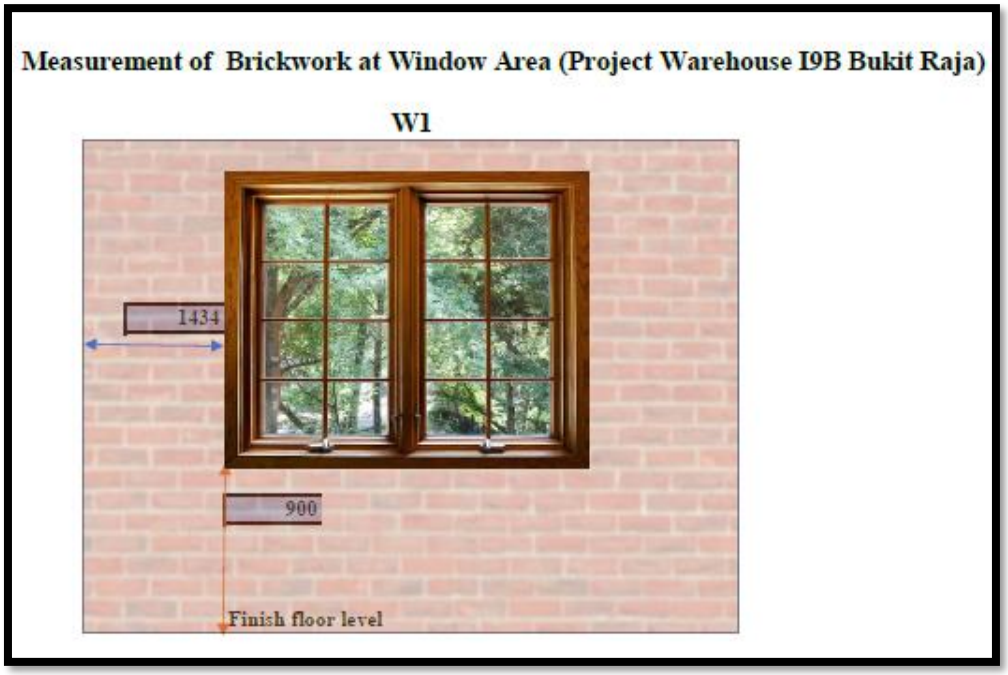


Figure 4.5. Form Window for Unskilled Workers

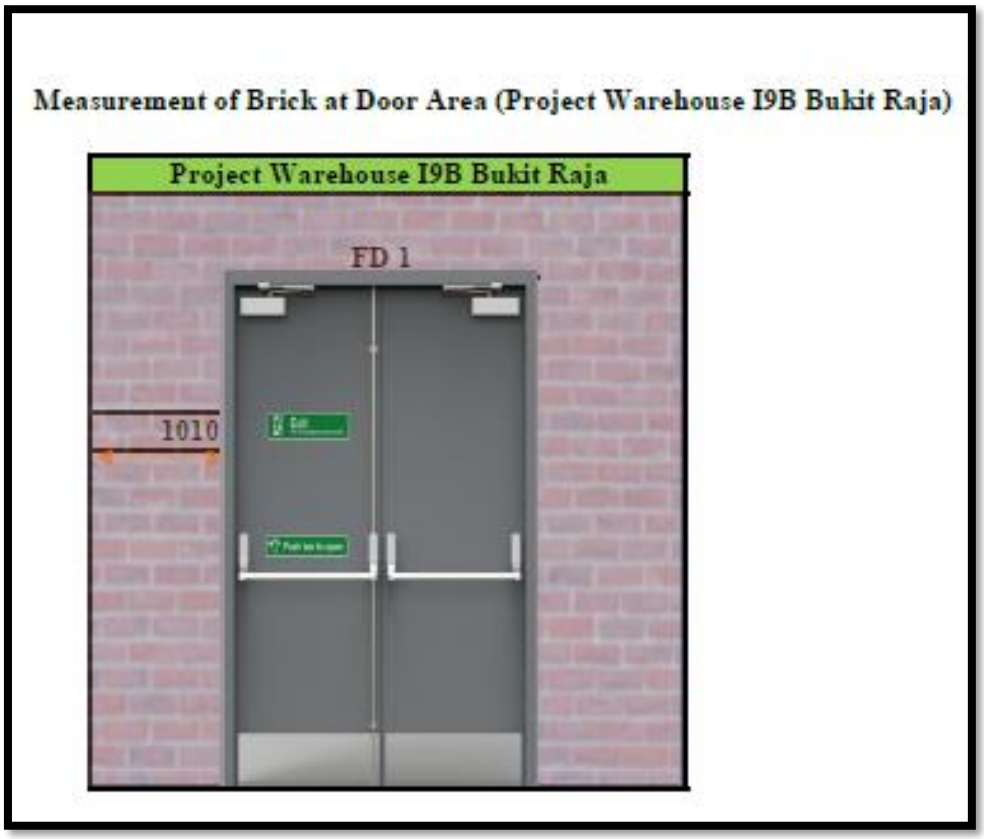
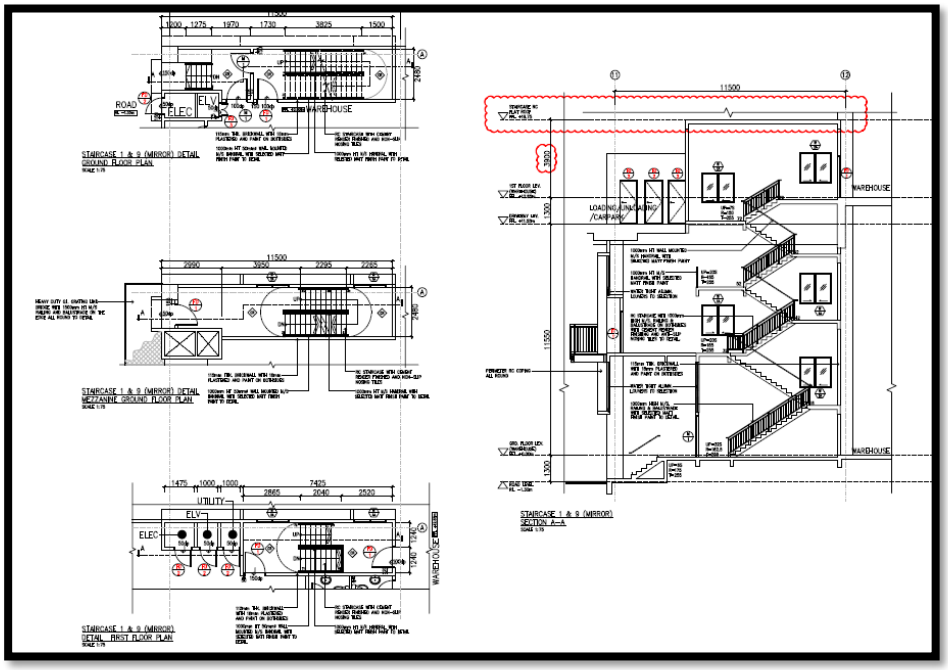


Figure 4.6. Form Door for Unskilled Workers

Figure 4.7 illustrates a drawing and a simplified form specifically designed for unskilled workers involved in brickwork activities. This form represents a significant departure from complex architectural drawings by focusing solely on essential information that is easy for unskilled workers to comprehend and implement effectively. By presenting clear and straightforward instructions regarding dimensions, placement, and construction methods, the form aims to minimize errors that typically arise from misinterpretation or misunderstanding of detailed architectural plans.

The simplicity of this form plays a crucial role in reducing the need for rectifications and adjustments during the construction process. When workers can easily grasp and follow the instructions provided, they are less likely to make errors in measurements or execution. As a result, there is a notable decrease in material wastage and the time spent correcting mistakes. This streamlined approach not only enhances the overall efficiency of brickwork activities but also contributes to keeping the project on schedule and within budgetary constraints.

Moreover, by reducing the occurrence of errors and subsequent rectifications, the project benefits from improved productivity and resource utilization. Workers can focus more on executing tasks accurately from the outset, rather than allocating time and resources to rectify mistakes. This efficiency gains momentum throughout the project timeline, leading to smoother operations and a more streamlined construction process overall.



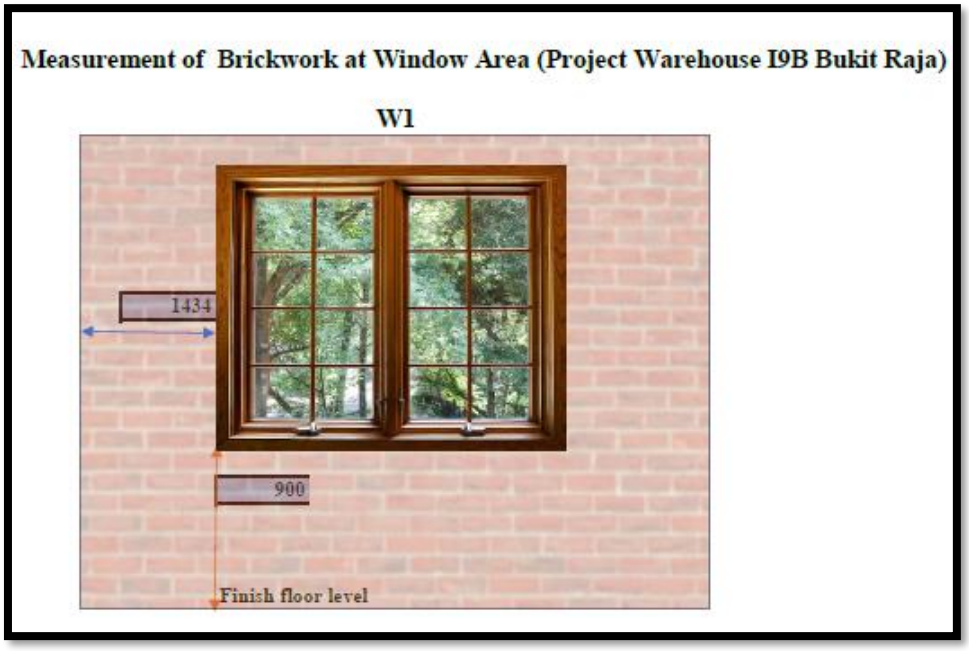


Figure 4.7: Actual drawing vs Form for Window

4.4 Effectiveness of the form

The data collection process focused on capturing various parameters related to brickwork activities for door and window areas. Initially, data was collected in February 2024 to establish a baseline scenario before the introduction of the brickwork form. This baseline data provided a reference point for evaluating the existing efficiency and accuracy of brickwork performed by unskilled workers without the aid of the form.

In March 2024, the brickwork form was distributed to 15 unskilled workers to assess its impact on the construction process. This phase involved closely monitoring the workers as they used the form and systematically recording data to compare with the baseline. Parameters such as the accuracy of measurements, the frequency of errors, the time taken to complete tasks, and overall productivity were tracked to determine the effectiveness of the form in improving brickwork activities.

By systematically comparing the data collected before and after the introduction of the form, the study aimed to quantitatively evaluate the effectiveness of the form in enhancing brickwork activities. This approach not only provided valuable insights into

the tangible benefits of using structured forms in guiding unskilled workers but also contributed to identifying areas for further refinement or improvement in construction practices. The comprehensive analysis of these parameters helped validate the form's role in improving efficiency, reducing errors, and optimizing resource utilization within the construction site environment.

4.4.1 Analysis of Door Area Data

A comparison of the data collected for brickwork activities in the door area before and after the introduction of the brickwork form reveals significant improvements in efficiency and reduction in wastage. Table 4.1 provides a detailed overview of the brickwork activities performed during two distinct periods: before the implementation of the new brickwork form and after its introduction to unskilled workers. Before the form was introduced, data was collected from February 1 to February 8, 2024. During this period, five doors were completed in brickwork. However, the process required two rectifications in the door area, resulting in a wastage of 50 bricks. This high level of rectification and wastage indicates inefficiencies in the initial brickwork activities.

After the form was introduced to unskilled workers, data was collected from March 9 to March 14, 2024. During this period, there was a noticeable improvement in the brickwork activities. Six door installations were completed, and only one rectification was needed. Additionally, the wastage of bricks significantly decreased to just 12 pieces. This comparison highlights the positive impact of introducing the brickwork form. The form appears to have provided unskilled workers with better guidelines or procedures, which likely contributed to fewer errors and reduced material wastage. The decrease in rectifications from two to one and the reduction in brick wastage from 50 to 12 pieces indicate that the form has led to more precise and efficient brickwork activities.

Table 4.1: Rectification data before using the form.

DATA COLLECTION DOOR (BEFORE)									
MONTH	**DATE START**	**DATE FINISH**	**DAYS**	**TYPE OF DOOR**	**AREA**	**TOTAL DOOR**	**RECTIFICATION**	**BRICK WASTAGE**	**WORKERS**
February	1-Feb-24	8-Apr-24	8	FD1	Staircase	5	2	50	4
	2-Feb-24	9-Feb-24	8	FD2	Staircase	6	4	38	6
	9-Feb-24	13-Feb-24	5	M1	Staircase	4	3	41	6
	14-Feb-24	21-Feb-24	8	FD1	Staircase	4	1	16	5
	14-Feb-24	21-Feb-24	8	FD2	Staircase	6	3	29	3
	22-Feb-24	24-Feb-24	3	FD3	Staircase	1	0	0	3
Total						26	8	122	

Table 4.2: Rectification data after using the form.

DATA COLLECTION DOOR (AFTER)									
MONTH	**DATE START**	**DATE FINISH**	**DAYS**	**TYPE OF DOOR**	**AREA**	**TOTAL DOOR**	**RECTIFICATION**	**BRICK WASTAGE**	**WORKERS**
March	4-Mar-24	9-Mar-24	6	FD1	Staircase	5	2	21	6
	9-Mar-24	14-Mar-24	6	FD2	Staircase	6	1	12	3
	14-Mar-24	18-Feb-24	5	M1	Staircase	5	2	34	4
	14-Mar-24	19-Mar-24	6	FD1	Staircase	6	1	9	8
	20-Feb-24	23-Feb-24	4	M1	Staircase	3	1	18	5
	23-Mar-24	25-Mar-24	3	FD3	Staircase	2	0	0	1
Total			24			27	6	76	

4.4.2 Analysis of Window Area Data

Table 4.1 presents data on brickwork activities before and after implementing a new form, highlighting a significant improvement in performance and reduction in brick wastage. The analysis covers two distinct periods: before the introduction of the new brickwork form and after its implementation.

Between February 2 and February 8, 2024, 13 windows were completed in brickwork. However, the process encountered several issues, requiring 8 rectifications in the window area. These rectifications led to a considerable wastage of 98 bricks. The high number of rectifications and brick wastage indicates inefficiencies and potential skill gaps among the workers, resulting in increased material costs and extended completion times.

After introducing the new form to unskilled workers, data was collected from March 12 to March 19, 2024. During this period, 10 windows were completed in brickwork. Remarkably, only 3 rectifications were needed, and the wastage of bricks was reduced to just 29 pieces. This significant improvement demonstrates the effectiveness of the form in guiding unskilled workers, leading to fewer mistakes and more efficient use of materials.

The comparison of these two periods highlights the substantial benefits of the new brickwork form. The form appears to have provided clearer instructions or better procedures, enabling unskilled workers to perform their tasks with greater accuracy and efficiency. The reduction in rectifications from 8 to 3 and the decrease in brick wastage from 98 to 29 pieces underscore the form's positive impact.

Table 4.3: Rectification data window before using the form.

DATA COLLECTION WINDOW (BEFORE)									
MONTH	**DATE START**	**DATE FINISH**	**DAYS**	**TYPE OF WINDOW**	**AREA**	**TOTAL WINDOW**	**RECTIFICATION**	**BRICK WASTAGE**	**WORKERS**
February	2-Feb-24	8-Feb-24	7	W1	Office 1A	13	8	98	7
	2-Feb-24	5-Feb-24	4	W4	Office 1A & 1B	6	2	22	6
	9-Feb-24	16-Feb-24	7	W1	Office 1B	15	7	144	9
	17-Feb-24	21-Feb-24	5	W1	Office 2B & 3	6	1	17	3
	19-Feb-24	21-Feb-24	3	W5	Office 2B & 3	4	0	0	7
	21-Feb-24	23-Feb-24	3	W1	Office 2A	4	1	12	5
	24-Feb-24	24-Feb-24	1	W5	Office 2A	2	0	0	2
Total						50	19	293	

Table 4.4: Rectification data window after using the form.

DATA COLLECTION WINDOW (AFTER)									
MONTH	**DATE START**	**DATE FINISH**	**DAYS**	**TYPE OF WINDOW**	**AREA**	**TOTAL WINDOW**	**RECTIFICATION**	**BRICK WASTAGE**	**WORKERS**
March	4-Mar-24	7-Mar-24	5	W1	Office 4A	8	2	57	6
	7-Mar-24	8-Mar-24	2	W4	Office 4A	2	1	13	1
	7-Mar-24	8-Mar-24	2	W5	Office 4A	2	0	0	1
	9-Mar-24	13-Mar-24	5	W1	Office 4B	8	3	22	5
	13-Mar-24	14-Mar-24	3	W4	Office 4B	2	0	0	5
	10-Mar-24	11-Mar-24	1	W5	Office 4B	2	0	0	4
	12-Mar-24	19-Mar-24	8	W1	Office 5A & 5B	10	3	29	9
	20-Mar-24	22-Mar-24	3	W4	Office 5A & 5B	5	2	20	4
	20-Mar-24	22-Mar-24	3	W5	Office 5A & 5B	2	1	0	3
	22-Mar-24	25-Mar-24	4	W1	Office 6A	5	1	12	6
	24-Mar-24	25-Mar-24	1	W5	Office 6A	2	1	10	3
	22-Mar-24	25-Mar-24	4	W1	Office 6B	5	2	33	6
	25-Mar-24	27-Mar-24	3	W5	Office 6B	2	1	11	6
Total						17	17	207	

4.4.3 Analysis of Data for Effectiveness of the Form

To further evaluate the effectiveness of the brickwork form, a detailed analysis of the percentage of rectifications was conducted for both door and window areas. This analysis aimed to quantify the reduction in errors and rework achieved by introducing the brickwork form to unskilled workers.

4.4.3.1 Percentage Rectification of Door

Table 4.5 presents a comparison of the percentage of rectifications for door areas before and after the introduction of the brickwork form. Before the introduction of the brickwork form, the average percentage of rectifications for door areas was 31.33%.

However, after implementing the brickwork form, the average percentage of rectifications for door areas decreased significantly to 27.20%. This reduction of 4.13% percentage points represents a substantial improvement in the accuracy and quality of work performed by unskilled workers when using the brickwork form. The data clearly demonstrates that the brickwork form played a role in minimizing errors and rectifications in door installation, leading to improved construction efficiency and reduced rework.

Table 4.5: Percentage of Rectifications for Door Area

BEFORE			**AFTER**		
RECTIFICATION		**PERCENTAGE (%)**	**RECTIFICATION**		**PERCENTAGE (%)**
Total Door	**Rectification**		**Total Door**	**Rectification**	
5	2	40.00	5	2	40.00
6	2	33.33	6	1	16.67
4	1	25.00	5	2	40.00
4	1	25.00	6	1	16.67
6	2	33.33	3	0	0.00
1	0	0.00	2	0	22.67
26	8	31.33			27.20

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4.4.3.2 Percentage Rectification of Window

Table 4.6 presents a comparison of the percentage of rectifications for window areas before and after the introduction of the brickwork form. Before the brickwork form was introduced, the average percentage of rectifications for window areas was 36.64%. After implementing the brickwork form, the average percentage of rectifications for window areas decreased to 30.19%, reflecting a reduction of 6.45%. While the improvement is less pronounced compared to the door area, it nonetheless demonstrates the positive impact of the brickwork form in reducing errors and rework in window installation tasks.

Table 4.6: Percentage of Rectifications for Window Areas

BEFORE			**AFTER**		
RECTIFICATION		**PERCENTAGE (%)**	**RECTIFICATION**		**PERCENTAGE (%)**
Total Window	**Rectification**		**Total Window**	**Rectification**	
13	8	61.54	8	2	25.00
6	2	33.33	2	1	50.00
15	7	46.67	2	0	0.00
6	1	16.67	8	3	37.50
4	0	0.00	2	0	0.00
4	1	25.00	2	0	0.00
2	0	0.00	10	3	30.00
		36.64	5	2	40.00
			2	1	50.00
			5	1	20.00
			2	1	50.00
			5	2	40.00
			2	1	50.00
50	19	36.64	55	17	30.19

The data analysis reveals that the brickwork form contributed to enhancing the accuracy and quality of work performed by unskilled workers, resulting in fewer rectifications and improved construction efficiency for both door and window areas. These findings align with the objective of mitigating project delays caused by unskilled workers' inability to interpret architectural drawings accurately. By providing clear and concise dimensions through the brickwork form, unskilled workers were able to execute their tasks with greater precision, minimizing errors and reducing the need for rework.

The reduction in rectifications not only impacts project timelines positively but also has economic implications by minimizing the additional costs associated with rework and material wastage. Furthermore, the improved construction quality and reduced waste generation contribute to sustainable construction practices, aligning with the industry's growing emphasis on environmental responsibility. Overall, the analysis of the percentage of rectifications for door and window areas provides quantitative evidence of the brickwork form's effectiveness in addressing the challenges faced by unskilled workers in interpreting architectural drawings. These findings support the potential of the brickwork form as a practical solution for enhancing construction efficiency, reducing project delays, and promoting sustainable practices in the construction industry.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

This research explores how unskilled workers impact project delays in the construction industry. By following a three-step approach that includes on-site observations, creating a new form, and measuring how effective the form is, the study identifies various factors that cause delays when unskilled workers are involved. The research found that unskilled workers have a hard time understanding architectural drawings, which leads to mistakes, rework, and project delays. The data showed that these workers struggle with the detailed measurements in the drawings, causing poor-quality work and the need rectification.

To address this issue, a user-friendly brickwork form was created for architectural drawings. This form simplifies and highlights the key measurements for doors and windows, making it easier for unskilled workers to understand and follow. As a result, they can now perform their tasks more accurately and efficiently. The data clearly shows that the brickwork form is effective in reducing project delays. The need for corrections in door areas dropped from 31.33% to 27.20%, and for window areas, it went down from 36.64% to 30.19%. These reductions help improve project timelines and save money by cutting down on rework and wasted materials.

Furthermore, the study has highlighted the potential environmental benefits of the brickwork form. By reducing the need for rectifications and rework, the form has contributed to a substantial decrease in brick waste, with a 38% reduction for door areas and a 29% reduction for window areas. These findings underscore the form's alignment with sustainable construction practices and the industry's growing emphasis on environmental responsibility. Overall, this research has provided a comprehensive understanding of the challenges posed by unskilled workers in the construction industry and has presented a practical solution in the brickwork form. The positive impact on

project timelines, cost savings, and sustainable practices reinforces the significance of this research endeavor and its potential for broader implementation within the construction sector.

5.2 RECOMMENDATION

To further validate and strengthen the findings of this research, it is advisable to expand the study to include a larger sample size of unskilled workers. By incorporating a more diverse and representative sample, the study can account for variations in factors such as experience levels, cultural backgrounds, and learning styles among unskilled workers. A larger sample size would enhance the statistical power and generalizability of the results, providing a more robust foundation for the implementation of the brickwork form across a broader range of construction projects.

It is recommended to explore the potential impact of workers' nationalities on their ability to comprehend and effectively utilize the brickwork form. Cultural backgrounds, educational systems, and language proficiencies may vary among workers of different nationalities, potentially influencing their interpretation and application of the form's instructions. By analyzing the performance and feedback of unskilled workers from diverse national origins, the study can identify specific challenges or opportunities for tailoring the form to better accommodate different cultural contexts.

In the era of digital transformation, leveraging advanced technologies such as artificial intelligence (AI) can further enhance the accessibility and usability of the brickwork form. It is recommended to develop a mobile application or web-based platform that incorporates AI capabilities to facilitate the distribution and utilization of the form among unskilled workers. This application could feature intelligent form-filling assistance, real-time translation into multiple languages, and interactive tutorials or demonstrations to aid unskilled workers in comprehending and applying the form's instructions effectively. Additionally, the application could incorporate data collection and analysis functionalities, enabling continuous monitoring and optimization of the form's effectiveness across diverse construction projects. By implementing these recommendations, the research can garner more comprehensive and robust insights into the brickwork form's efficacy, fostering its widespread adoption and adaptation to

diverse project contexts. Moreover, the integration of innovative technologies such as AI can further augment the form's accessibility, usability, and potential impact on mitigating project delays and promoting sustainable construction practices within the industry.

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APPENDIX 1

PICTURE OF RESEARCH AREA

 	Hacking work is caused by unskilled workers.
	Material wastage due to hacking work

 	Unskilled workers are using the form in the door area and window area. For door area brickwork at the staircase and for window area brickwork at the office.