POLITEKNIK UNGKU OMAR

POST CONCRETING INSPECTION MOBILE APPLICATION (e-PCI)

NURUL AMNI NAZILA BINTI SUHAIMI

(01BCT20F3011)

CIVIL ENGINEERING DEPARTMENT

SESSION 2 2022/2023

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A project report/thesis submitted in partial fulfilment of the requirement for the award of the Bachelor's Degree of Civil Engineering Technology

CIVIL ENGINEERING DEPARTMENT

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STATEMENT OF AUTHENTICITY AND PROPRIETARY RIGHTS

POST CONCRETING INSPECTION MOBILE APPLICATION (e-PCI)

1. I, **NURUL AMNI NAZILA BINTI SUHAIMI (NO KP: 990715-06-6368)**, am a student of Bachelor of Civil Engineering Technology, in Politeknik Ungku Omar, at the address Jalan Raja Musa Mahadi, 31400 Ipoh, Perak.

2. I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

3. I hereby agree to let go the intellectual property ownership of this project to Ungku Omar Polytechnic in partial of the requirement for the award of the Bachelor of Civil Engineering Technology with Honours.

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ABSTRACT

In the construction industry, reinforced concrete is a common structural material used in many types of construction, such as structures, water tanks, foundations, towers, production structures, dams, and bridges. Sometimes cracks develop when loads, restrained shrinkage, or temperature changes give rise to tensile stresses more than the tensile strength of the concrete. Building defects which are cracking, blistering, bulging, isolation, honeycomb, and palpitations are the main components of building problems. Structural defects are any defects in a building that are attributable to defective design, workmanship, or material. It can occur due to overloading, and poor maintenance. Regular inspection is key to protecting the health of a building's structure. Engineers need to prepare Requests for Inspections (RFIs) to rectify the defects to prevent failure, and a lot of waste can be determined through the process. Therefore, this study focuses on the development of a mobile application for post-concreting inspection. Firstly, the Root Cause Analysis was used to identify the waste from the RFI's processes. Then, to reduce waste from the RFI work, an application called Post-Concreting Inspection Mobile Application (e-PCI) was developed using Flutter and the effectiveness of the e-PCI was evaluated. As a result, the wastage identified along the RFI processes is time, cost, and overproduction. By using current technology, such as e-PCI, all the waste that was produced can be reduced. From the questionnaire and survey, most respondents expressed high levels of satisfaction regarding the performance and effectiveness of the e-PCI, emphasizing its significant utility, particularly in the construction sector So, this Post-Concreting Inspection Mobile Application (e-PCI) is effective for use in the construction industry.

KEYWORDS: *Construction industry, structural defects, post-concreting, wastage, Root Cause Analysis.*

ABSTRAK

Dalam industri pembinaan, konkrit bertulang adalah bahan struktur biasa yang digunakan dalam pelbagai jenis pembinaan, seperti struktur, tangki air, tapak asas, menara, struktur pengeluaran, empangan, dan jambatan. Kadang-kadang keretakan terjadi apabila beban, susutan terkawal, atau perubahan suhu menimbulkan tegangan regangan lebih besar daripada kekuatan regangan konkrit. Kecacatan bangunan termasuk retakan, gelembung, pembengkakan, pemisahan, sarang lebah, dan denyutan adalah komponen utama masalah bangunan. Kekurangan struktur merujuk kepada sebarang kecacatan dalam bangunan yang disebabkan oleh rekabentuk yang cacat, kerja tangan yang tidak baik, atau bahan yang cacat. Ia boleh berlaku disebabkan oleh pemuatan berlebihan dan kekurangan penyelenggaraan yang baik. Pemeriksaan berkala adalah kunci untuk melindungi kesihatan struktur bangunan. Jurutera perlu menyediakan Permintaan Pemeriksaan (RFI) untuk memperbetulkan kekurangan tersebut bagi mencegah kegagalan, dan banyak pembaziran boleh ditentukan melalui proses tersebut. Oleh itu, kajian ini memberi tumpuan kepada pembangunan aplikasi mudah alih untuk pemeriksaan selepas pengecoran. Pertama, Analisis Punca Akar digunakan untuk mengenal pasti pembaziran dari proses RFI. Kemudian, untuk mengurangkan pembaziran dari kerja RFI, sebuah aplikasi yang dipanggil Aplikasi Mudah Alih Pemeriksaan Selepas Pengecoran (e-PCI) dibangunkan menggunakan Flutter dan keberkesanan e-PCI dinilai. Hasilnya, pembaziran yang dikenal pasti sepanjang proses RFI adalah masa, kos, dan pengeluaran berlebihan. Dengan menggunakan teknologi terkini seperti e-PCI, pembaziran yang dihasilkan dapat dikurangkan. Daripada soal kaji selidik, kebanyakan responden menyatakan tahap kepuasan yang tinggi terhadap prestasi dan keberkesanan e-PCI. Oleh itu, Aplikasi Mudah Alih Pemeriksaan Selepas Pengecoran (e-PCI) ini adalah berkesan untuk digunakan dalam industri pembinaan.

KATA KUNCI: *Industri pembinaan, kecacatan struktur, selepas pengekoran, pembaziran, analisis punca akar.*

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LIST OF ABBREVIATIONS

RFI/RIN	Requests for Inspection
e-PCI	Post Concreting Inspection Mobile Application
QAQC	Quality Assurance Quality Control
HVAC	Heating, ventilation, and Air Conditioning
LM	Lean Management
TQM	Total Quality Management
JIT	Just-in-time Production
ABM	Activity-based Management
HPWS	High Performance Work System
TPM	Total Productive Maintenance
IDE	Integrated Development Environment
TAM	Technology Acceptance Model
IS/IT	information systems/information technology
IOW	Inspector of Work
PU	Perceived of Usefulness
PEOU	Perceived Ease of Use
RE	Resident Engineer

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Every country uses concrete and reinforced concrete for building construction. In construction, reinforced concrete is a common structural material. The accessibility of reinforcing bars and the components of concrete (gravel or crushed rock, sand, water, and cement), as well as the relative simplicity of the skills needed to build with concrete, all contribute to reinforced concrete's ability to be more universally used than other types of construction. Buildings including structures, water tanks, wind turbine foundations, towers, offshore oil exploration and production structures, dams, and bridges employ both plain concrete and reinforced concrete. Concrete is strong in compression, but weak in tension. As a result, cracks develop whenever loads, restrained shrinkage, or temperature changes give rise to tensile stresses more than the tensile strength of the concrete (JK Wight, 2016).

Building defect is one of the major components of building problems that significantly needed attention. When a building fails to function as it should, we must immediately seek for the determination. Is the problem taking place as the result of the worker’s failure to assemble it properly? Is it involving the nature of it? Is the proper maintenance of the building not been performed as it should have been? The answers often depend upon several factors: the age of the affected building components, the exact nature of the problem, the presence or absence of human error, or some combination of all those three. Various forms of defects that might be seen on the surface of hardened concrete such as cracking, blistering, bulging, segregation, honeycomb, scaling, and spalling.

1.2 PROBLEM STATEMENT

Structural defects mean any defects in a structural element of a building that is attributable to defective design, defective or faulty workmanship or defective material and sometimes any combination of these. Building structure includes earth retaining walls, columns, beams, and flat slabs. Structural defects can be categorized as cracks in foundations, cracks in floor or slabs and cracks in walls. Most of the structural problem can be avoided by implying the exact and detail of the design and planning. Structural defects in a building can occur over time due to deterioration, wear and tear, overloading, and poor maintenance. They must be repaired to maintain the building's structure and to prevent any further failure. Regular inspection is the key to protecting the 'health' of a building's structure. Structural defect that always occurs are steel corrosion, cracks, and deflection.

Construction waste refers to waste resulting from defective materials, leftover materials, and wastage. There are seven categories of construction waste under the lean mechanism, which are the correction, over-processing, delay, inventory, conveyance, overproduction, and motion. Waste can be generated during the designing goods and services processes, and mistake by human too. Construction waste gives an enormous impact on project costs and time of any of construction projects.

When the building got defects, they need to rectify the defects to prevent any failure. The rectification works can produce wastage such as cost, time, materials, and productivity. To rectify all the defects, the engineer needs to prepare a report which is Requests for Inspections (RFI). RFI are frequently needed to conduct some inspections for the construction on projects like low- and high-rise structures, as well as horizontal projects like building highways, bridges, skyways, ports, and embankments.

1.3 OBJECTIVE

The objectives of this research are: -

a) To identify the wastage from the RFI’s processes by using Root Cause Analysis.

b) To develop an application for reducing wastage from the RFI works by using Flutter.

c) To evaluate the effectiveness of the application, e-PCI.

1.4 SCOPE OF STUDY

Figure 1. 1 Sunway Belfield

The scope of the study is at the construction site of Sunway Belfield project as shown in Figure 1.1. This study focuses on the inspection works at construction sites which is post concreting. This project is not limited to Quality Assurance Quality Control (QAQC), it can be access by various positions such as project manager, project engineer, documents controller, consultant and others can use this e-PCI Application.

This study focuses on making the engineer's work easier on handling the post concreting inspection on the site. Post-concreting inspection is used to identify and assess defects and issues during the concrete pouring and curing process, ensuring the structural integrity and safety of the building or structure.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Literature review is an essential part of a study to clarify underlining processes or component analysis of a research topic. For this study, the following literature review will establish a clear tie between the works that are going to be done in this research with previous findings and analysis.

Over the past two decades, the general practise in the building business has seen a significant shift from manual to computer aided techniques for knowledge processing. This chapter will focus on the ideas and theories of ongoing learning. In addition, this chapter will include background information on project monitoring technologies. The collection of pertinent information is crucial for producing high-quality writing. Both print and electronic mediums are available for getting the information. Print media sources include books, journals, articles, reports, and news on current events; electronic media sources include websites on the internet.

2.2 BUILDING DEFECTS

Building defects refer to flaws, faults, or deficiencies in the construction of a building that may affect its structural integrity, functionality, or aesthetics. These defects can arise due to design errors, poor workmanship, inadequate materials, or other factors. There are some common types of building defects, such as structural defects, waterproofing and moisture-related defects, defective electrical systems, Heating, ventilation, and Air Conditioning (HVAC) defects, and finish and cosmetic defects.

For structural defects, these involve issues with the load-bearing elements of a building, such as walls, columns, beams, or foundations. They can lead to instability, cracking, or collapse (Pascale et al, 2019). Waterproofing and Moisture-related Defects are the result of water infiltration, dampness, mould growth, or deterioration of building materials. They can occur due to improper installation of waterproofing systems, inadequate drainage, or faulty plumbing (Guggemos, A., & Yanev, B., 2016). Defective Electrical Systems encompass issues with electrical installations, such as faulty wiring, inadequate grounding, or improper placement of outlets and switches. They can pose safety hazards, including electrical shocks or fire risks (Sullivan, J., & Buchan, R., 2018). HVAC Defects are related to problems with the design, installation, or maintenance of HVAC systems, leading to inadequate heating, cooling, or ventilation, poor indoor air quality, or excessive energy consumption (Wargocki, P., & Frontczak, M., 2018). Lastly, Finish and Cosmetic Defects are defects that involve imperfections in the visual appearance of a building, such as paint or plaster defects, uneven surfaces, or damaged finishes. While they may not impact structural integrity, they can affect aesthetic appeal (Cooper, D., & Causley, J., 2015).

2.2.1 Type Of Reinforce Concrete Defects

Reinforced concrete structures can experience various defects that compromise their integrity and performance. One common issue is the occurrence of cracks, which can arise due to factors such as shrinkage, thermal expansion and contraction, excessive loading, improper reinforcement detailing, or inadequate concrete curing. Concrete defects are common issues that can arise in the construction industry.

There are some types of concrete defects such as cracks can occur in concrete due to various reasons such as shrinkage, settlement, thermal effects, or structural overloading. These cracks can compromise the integrity and durability of the concrete structure. Honeycomb are referring to voids or air pockets present in the hardened concrete, resulting from inadequate consolidation during the pouring and compaction process. It weakens the concrete and affects its appearance. Spalling is the chipping or breaking off small pieces or layers of concrete from the surface. It can occur due to corrosion of reinforcing steel, exposure to high temperatures, or chemical reactions. Lastly, scaling is the loss of the concrete surface layer, resulting in the formation of patches or flakes. It is typically caused by freeze-thaw cycles, poor-quality concrete, or improper finishing and curing techniques.

These defects can compromise the durability, structural strength, and overall performance of reinforced concrete elements. It is crucial to address these defects promptly through appropriate repair and reinforcement measures to ensure the long-term safety and functionality of the structure. Seeking guidance from experts, such as structural engineers or construction professionals, is advisable to assess and rectify these defects effectively.

2.3 BUILDING INSPECTION IN CONSTRUCTION

Building inspections are an essential part of the construction and real estate industry. They involve a thorough assessment and evaluation of a building's condition, including its structural integrity, safety, compliance with building codes and regulations, and overall functionality. Building inspections are typically conducted by qualified professionals, such as building inspectors or structural engineers, who have expertise in identifying defects, potential hazards, and areas of concern.

After conducting the inspection, the inspector typically provides a detailed report highlighting any deficiencies, defects, or areas that require attention. This report serves as a valuable tool for property owners, buyers, sellers, and stakeholders in making informed decisions regarding maintenance, repairs, or negotiations.

Building inspections play a crucial role in ensuring the safety, functionality, and compliance of structures, as well as providing peace of mind to owners and occupants. It is recommended to schedule regular inspections, especially during property transactions, renovations, or when concerns arise about the condition of a building.

2.3.1 Documentation For Inspection

Documentation for building inspections typically includes various records, reports, and forms to document the inspection process and its findings. Here are some common types of documentation used in building inspections such as inspection report, checklist, field notes, photograph, and visual documentation, building plans and drawing, building permits and documentation and code references and standards. It's important to note that the specific documentation used may vary depending on local regulations, organizational procedures, and the scope of the inspection. For accurate and comprehensive documentation, it is recommended to follow the guidelines and requirements set by the relevant regulatory authorities or professional associations in your region.

Documentation is essential for building inspections as it serves several important purposes especially for record keeping, evidence for dispute resolution, reference for maintenance and repairs. The importance of documentation in building inspections is widely recognized within the industry. Professional associations, regulatory bodies, and inspection guidelines often emphasize the significance of proper documentation to ensure the accuracy, reliability, and integrity of the inspection process.

2.3.2 Request For Inspection (RFI/RIN)

Request for Inspection (RFI) is a formal document used to request an inspection of a specific area, element, or aspect of a construction project. It is typically submitted by a contractor, subcontractor, or project manager to the appropriate inspection authority or agency. The RFI outlines the details of the requested inspection and provides necessary information for scheduling and conducting the inspection. The request for inspection in construction is an essential process that serves several important purposes.

Inspections help ensure that construction work meets industry standards and quality expectations. By verifying the workmanship, materials used, and installation techniques, inspections help maintain a certain level of quality throughout the project. This RFI serve to monitor and verify the progress of the construction project. By inspecting specific stages or elements, stakeholders can ensure that construction milestones are being met according to the project schedule. Requesting inspections demonstrates a commitment to quality, safety, and compliance with regulations. It helps to convince in clients, investors, and other stakeholders by providing assurance that the construction project is being carried out professionally and according to established standards.

Inspection works in construction can contribute to certain types of wastage, although the extent and impact may vary depending on various factors. There are a few potential areas of wastage associated with inspection in the construction industry such as time, rework, materials, administrative effort, duplication of inspection and disruption to workflow. To mitigate these types of wastage, it is crucial to establish efficient inspection processes, ensure clear communication and coordination among project stakeholders, and promote a proactive approach to quality control during the construction phase. By implementing effective quality management systems and fostering collaboration between contractors, inspectors, and regulatory authorities, construction projects can minimize wastage and optimize the inspection process.

2.4 WASTAGE

What is a waste? Waste is the useless by product of human activities which physically contains the same substance that are available in the useful product (White et al, 1995). Wastes have also been defined as any product or material which is useless to the producer (Basu, 2009). Dijkema et al, (2000) pointed out that, wastes are materials that people would want to dispose of even when payments are required for their disposal. Although, waste is an essential product of human activities, it is also the result of inefficient production processes whose continuous generation is a loss of vital resources (Cheremisinoff, 2003).

Most human activities generate waste (Brunner and Rechberger, 2014). Despite that, the production of wastes remains a major source of concern as it has always been since prehistoric period (Chandler et al, 1997). In recent times, the rate and quantity of waste generation have been on the increase. As the volume of wastes increases, so also does the variety of the waste increases (Vergara and Tchobanoglous, 2012). Unlike the prehistoric period where wastes were merely a source of nuisance that needed to be disposed of. Proper management was not a major issue as the population was small and a vast amount of land was available to the population at that time. In those days, the environment easily absorbed the volume of waste produced without any form of degradation (Tchobanoglous et al, 1993).

2.4.1 Type Of Wastage

Waste may take on many different forms, and there are various ways to characterise waste. Some common characteristics used in the classification of waste includes the physical states, physical properties, reusable potentials, biodegradable potentials, source of production and the degree of environmental impact (Demirbas, 2011; Dixon & Jones, 2005; White et al., 1995). White et al. (1995) stated that waste can be classified broadly into three main types according to their physical states; these are liquid, solid and gaseous waste. Although several classifications exist in different countries.

In the construction industry, several types of wastage can occur throughout the project lifecycle. These wastages, often referred to as the "7 Wastes" in lean construction, include overproduction, waiting, transportation, motion, inventory, overprocessing and defects. It's important to note that these wastages can occur at various stages of a construction project, including design, procurement, planning, construction, and handover. By identifying and addressing these types of wastage, construction projects can improve efficiency, reduce costs, and enhance overall project performance. The 7 Wastes concept is derived from the principles of lean management and has been applied to various industries, including construction.

2.4.2 Lean Management

The primary goal of lean management (LM), an integrated socio-technical system, is to eradicate waste while concurrently minimising supplier, customer, and internal variability (Shah and Ward 2007). LM may be summed up as a collection of distinct management techniques. Five techniques have been recognised as being most closely related to its implementation by a large majority of experts: total quality management (TQM), just-in-time production (JIT), activity-based management (ABM), high performance work system (HPWS), and total productive maintenance (TPM) (Shah and Ward 2003, Narasimhan et al. 2006). These procedures are used in both the manufacturing and non-manufacturing sectors, and they give companies the chance to maintain or improve performance by including all levels of the organisation. LM improves product design, productivity, and quality in a drive for global competitiveness (Mefford 2009).

Lean management is an approach focused on reducing waste and maximizing value in various industries, including construction. When applying lean principles to construction, several types of wastage can be identified. These wastages, also known as "The 8 Wastes“ in lean management, are as follows overproduction, waiting, transportation, motion, inventory, overprocessing, defects and unused talent.

By identifying and addressing these types of wastage, lean management principles can help construction projects become more efficient, productive, and cost-effective. Lean techniques such as value stream mapping, standardized work, continuous improvement, and visual management can be employed to reduce wastage, streamline processes, and optimize resource utilization in construction projects.

2.4.3 Ishikawa Diagram/Fishbone Diagram

Most businesses utilise quality tools for various quality assurance and control tasks. Although there are several high-quality tools accessible for certain disciplines, domains, and practises, some of these high-quality tools may be used to multiple domains at once. These high-quality instruments are extremely versatile and may be used to treat any disease. In enterprises, the seven fundamental quality tools are utilised. These technologies may offer a wealth of information regarding issues inside the company, helping to identify solutions.

Kaoru Ishikawa, who established quality management practises in the Kawasaki shipyards and went on to become one of the forefathers of contemporary management, popularised Ishikawa diagrams in the 1960s. Because of the way it looks, which resembles the side view of a fish skeleton, it is known as a fishbone diagram.

The design of the diagram looks much like a skeleton of a fish. Fishbone diagrams are typically worked right to left, with each large "bone" of the fish branching out to include smaller bones containing more detail. The technique uses a diagram-based approach for thinking through all the possible causes of a problem. This helps you to carry out a thorough analysis of the situation. There are four steps to using the tool:

a) Identify the problem.
b) Work out the major factors involved.
c) Identify possible causes.
d) Analyze your diagram.

Causes are usually grouped into major categories to identify these sources of variation. The categories typically include:

a) People: Anyone involved with the process
b) Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations, and laws
c) Machines: Any equipment, computers, tools, etc. required to accomplish the job
d) Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
e) Measurements: Data generated from the process that are used to evaluate its quality
f) Environment: The conditions, such as location, time, temperature, and culture in which the process operates.

2.5 APPLICATION/TECHNOLOGY IN CONSTRUCTION

It is impossible to overstate the value of technology, as demonstrated by the Woksepp, Stefan Woksepp, and Thomas Olofsson. In various activity areas, including construction phases (planning, design, procurement, and site operations), digital sites include adopting technology and automation in site operations, it was noted in 2006 that IT-based projected gains and impacts may be anticipated. Additionally, in corporate procedures, project management, and legal and contractual issues. Similar technology applications may be found in monitoring, performance measures, and life cycle performance of building and construction. Building product customization and differentiation, supply chain management, and costing and accounting procedures all contribute to quick, efficient, and economical building.

Technology is one of the sustainable strategies that may be employed to help the construction sector (Zhou., 2010). The long-term success of the building business depends on technological innovation. Only steady technical advancement can ensure a company's ongoing development. To meet the construction demands of important fields, a company should conduct straightforward, encouraging, and forward-looking technological research, develop its overall arrangement and overall integration capability, and apply technical innovation to both the construction process and the strategic growth cycle.

2.5.1 Flutter

Flutter is an open-source SDK developed by Google for building UI applications across multiple platforms using a single codebase. It utilizes the Dart programming language and offers features like cross-platform development, hot reload for real-time code updates, and a reactive UI framework with customizable widgets and smooth animations. Flutter apps are compiled to native code, ensuring high performance, and provide access to native features through plugins and packages. The strong developer community and ample documentation contribute to its popularity as a preferred cross-platform framework. Additionally, Flutter provides access to native features and APIs through its extensive library of plugins and packages, enabling developers to leverage device-specific capabilities.

2.5.2 Android Studio

Android Studio is the official Integrated Development Environment (IDE) provided by Google for developing Android applications. It offers a comprehensive set of tools and features to streamline the entire app development process. With its user-friendly interface, developers can easily navigate through project files, manage dependencies, and configure project settings. The powerful code editor supports essential features like code completion, syntax highlighting, and refactoring, enabling developers to write clean and efficient code. Android Studio utilizes the Gradle build system, which automates tasks such as compiling, packaging, and deploying the application. The built-in emulator allows developers to test their apps on virtual devices or connect physical devices for debugging purposes.

The visual layout editor provides a drag-and-drop interface for designing the app's user interface, making it easy to create visually appealing layouts. The IDE also offers robust debugging and profiling tools to identify and fix issues in the code. Android Studio seamlessly integrates with the Android SDK, giving developers access to a wide range of APIs and libraries for building feature-rich applications. Additionally, the IDE supports a plugin ecosystem, allowing developers to extend its functionality with third-party plugins. Regular updates from Google ensure that Android Studio stays up to date with the latest advancements in Android app development, making it the go-to tool for Android developers.

2.5.3 MySQL

MySQL is an open-source and widely used relational database management system known for its scalability, reliability, and user-friendliness. It offers robust data management capabilities, efficient performance, and strong security features. MySQL supports various data types, indexing, and querying, making it ideal for handling large-scale applications and high traffic volumes. It prioritizes data security through authentication, encryption, and access controls. MySQL is compatible with multiple operating systems, integrates well with different programming languages, and has a vibrant community providing extensive support. With commercial backing from Oracle, MySQL remains a trusted choice for diverse applications and industries.

2.6 EVALUATE THE EFFECTIVENESS

Using questionnaires or surveys to evaluate the effectiveness of a product can be an effective method for gathering feedback and insights from customers or users (Smith, 2018). The design of the questionnaire or survey is crucial, requiring clear, concise, and unbiased questions that cover essential aspects of the product (Jones et al., 2019). Careful sample selection, including random or stratified sampling, helps ensure a representative sample (Brown & Johnson, 2020). Higher response rates and larger sample sizes increase reliability and accuracy (Wilson & Williams, 2021).

Proper analysis and interpretation of collected data are essential, involving statistical techniques for quantitative data and qualitative analysis for open-ended responses (Robinson et al., 2022). However, potential limitations and biases should be considered, such as response bias and self-selection bias (Chen et al., 2017). It is advisable to combine questionnaires or surveys with other evaluation methods for comprehensive insights (Thompson & Smith, 2019).

2.6.1 Technology Acceptance Model (TAM)

The technology acceptance model (TAM) is one of the most influential research models in studies of the determinants of information systems/information technology (IS/IT) acceptance. In TAM, perceived usefulness and perceived ease of use are hypothesized and empirically supported as fundamental determinants of user acceptance of a given IS/IT (Patrick Y.K. Chau., 1996).

Of all the theories, the Technology Acceptance Model (TAM) is considered the most influential and commonly employed theory for describing an individual's acceptance of information systems. TAM, adapted from the Theory of Reasoned Action [Ajzen and Fishbein, 1980] and originally proposed by Davis [1986], assumes that an individual's information systems acceptance is determined by two major variables:

i. Perceived Usefulness (PU)
ii. Perceived Ease of Use (PEOU).

CHAPTER 3
METHODOLGY

3.1 INTRODUCTION

The methodology used for this study will be explained in this chapter. This chapter will cover every step of the study process, including the population, population frame, and interview sample methods. The chapter concludes with a detailed discussion of the form of analysis that was chosen, and the procedure employed to acquire the data.

This chapter will cover every step of the study process, including the population, population frame, and interview sample methods. The chapter concludes with a detailed discussion of the form of analysis that was chosen, and the procedure employed to acquire the data. Implementing the observation would be done while working on a job to assess the viability of the application. In this chapter, concept simulation is also demonstrated. The project will benefit from the use of primary and secondary sources. Surveys and observations have been undertaken for the primary source. While it comes from the data collecting and analysis for the secondary source.

The approaches to be taken will also be fully explained considering the difficulties at hand as well as the selection of appropriate systems when utilised and when selected appropriately inside the platform to use. Current work is the main emphasis of this, which is based on all relevant work, references such records, interviews, interactions, and other variables.

3.2 RESEARCH METHODOLOGY

The research methodology typically follows a systematic flowchart to guide the process of conducting research. It begins with identifying the research problem or question at hand and conducting a comprehensive review of existing literature related to the topic. From there, the researcher defines the research objectives and formulates specific research questions or hypotheses to address the problem. The appropriate research design is then chosen, taking into consideration factors such as the nature of the research problem and the available resources. Sample size determination and selection of a suitable sampling technique follow, ensuring the collection of data from a representative sample.

Data collection methods, such as surveys, interviews, observations, experiments, or document analysis, are employed to gather relevant information. Once the data is collected, it undergoes analysis using appropriate statistical or qualitative techniques. The findings are then interpreted in relation to the research questions or hypotheses. Based on the evidence, conclusions are drawn, summarizing the main outcomes of the research. Finally, the results are communicated through a research report, academic paper, or presentation. It's worth noting that the specific flowchart may vary based on the research discipline, methodology, and project requirements, with some steps overlapping or requiring iterations throughout the process. The example of Flow Chart in Research Methodology is shown in Figure 3.1.

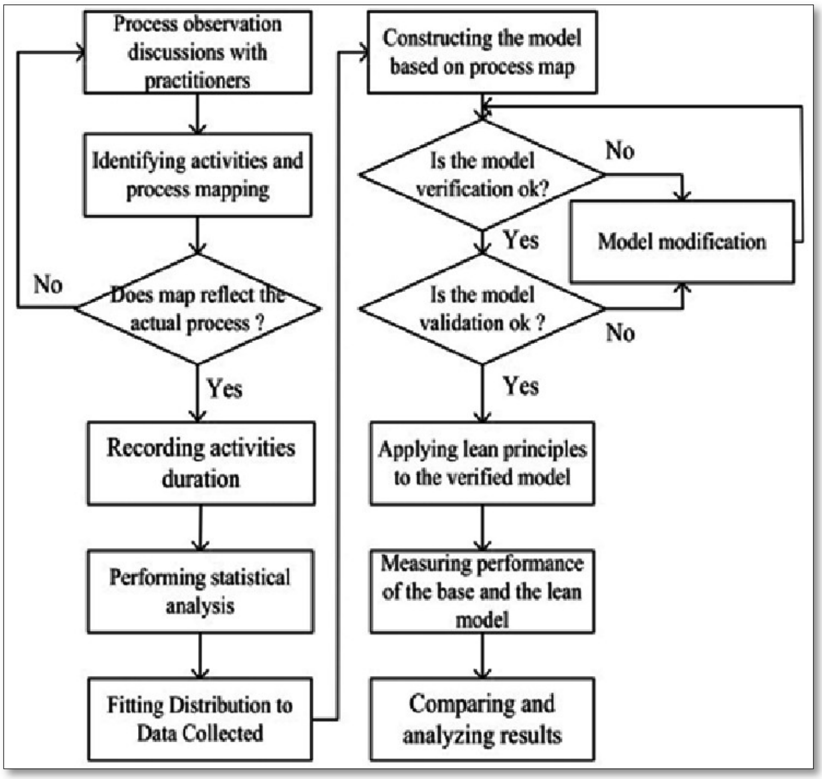


Figure 3. 1 Flow Chart in Research Methodology

Figure 3.2 shows the Flow Chart Methodology of e-PCI. This method aims to accomplish the project's objectives and deliver optimal outcomes. It will outline the specific research approach employed in this study. This chapter will encompass all the elements involved in conducting the research, including the population, population frame, and the sampling techniques implemented for the interviews. Additionally, it will provide a comprehensive explanation of the chosen mode of analysis and the data collection method utilized, offering detailed insights into the research process.

During the mission implementation, observations will be made to assess the feasibility of the application. This chapter will also include concept simulation to further illustrate the ideas. To enhance the value of the project, a combination of primary and secondary sources will be utilized. Primary sources will involve the use of questionnaires and observations. On the other hand, secondary sources will involve collecting and analyzing existing data. The incorporation of both primary and secondary sources aims to provide a comprehensive and well-rounded perspective for the project.

Moreover, this research will thoroughly outline the strategies to be employed, which will be determined based on the identified problems. The selection of suitable systems to be implemented within the platform will also be explained. The focus of this research is to build upon existing work and references, such as records, interviews, interactions, and other relevant variables. These sources will contribute to the development of a comprehensive understanding of the subject matter and aid in making informed decisions regarding the chosen strategies and systems for implementation.

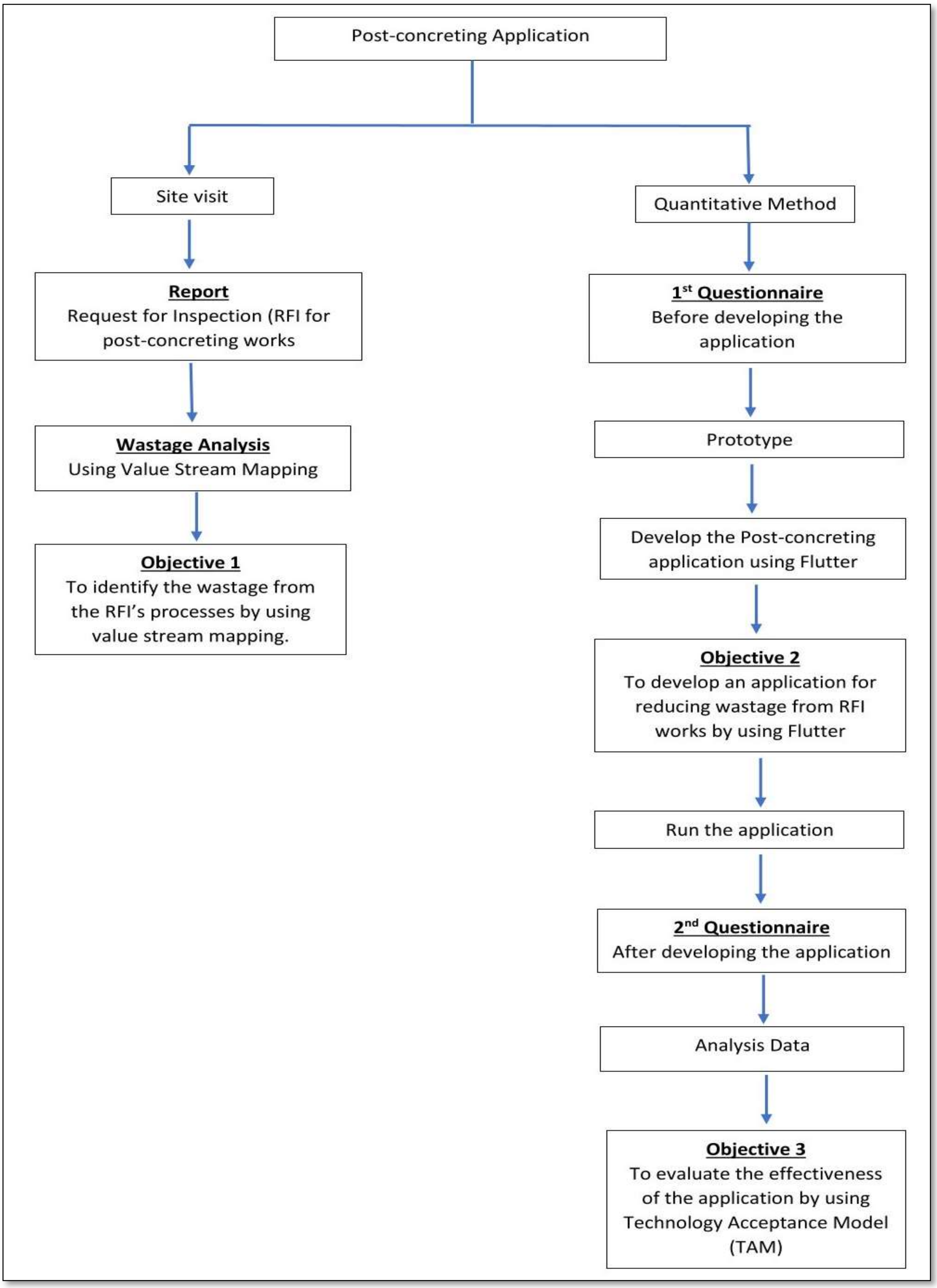


Figure 3. 2 Flow Chart Methodology of e-PCI

3.3 STUDY AREA

Study area for this project is at Ava Residence Project, Kepong. This project is to proposed development of 2 Blocks of 55-Storey Service Apartments (Block A & B) Phase 1 which consists of 2 storey (B1-B2) Basement Carpark, 1 storey (P1) Main Lobby, M&E Space, Carpark & Childcare Centre, 6 storey (P2-P7) Podium Carpark, 2 storey (P8 & P8A) Service Apartment Facilities, 44 storey (L9-L33 & L35-L53) Service Apartments (880 units) & 2 storey (L33A & L53A) Facilities Space & M&E

The development of 1 Block of 56-Storey Service Apartments (Block C) Phase 2 was also suggested. This block comprises of a 2 storey (B1-B2) Basement Carpark, a 1 story (P1) Main Lobby, M&E Space, Carpark & Childcare Centre, a 6 storey (P2-P7) Podium Carpark, and a 2 storey (P8 & P8A) Podium Carpark. Service apartment facilities are in Lot 20010 (formerly known as Lot 1152), Seksyen 69, Jalan Belfield, Wilayah Persekutuan, Kuala Lumpur. These facilities include 450 service apartments spread across 45 storeys (L9-L33 & L35-L53A) and two storeys (L33A & L55). According to Figure 3.3, this is the finalised project's view of Sunway Belfield. The Current View of Sunway Belfield for Towers A, B, and C is also shown in Figures 3.4.

Figure 3. 3 View of Sunway Belfield After Project Completed

Figure 3. 4 Sunway Belfield

3.4 PROCESS TO IDENTIFY THE ISSUES

The three primary components of the e-PCI paradigm are computers, networks, and mobile apps (Rebolj and Menzel, 2004). Design templates are pre-made visual and written elements that can be modified. Templates are often created to maintain consistency across users and media by adhering to predetermined standards or criteria. The template design prototype was developed through five design phases. The application will be built using Flutter, Android Studio and MySQL for data programming system. Previous reports, interviews, and questionnaires were utilized to identify the specific individual, problem, and details related to the issue. Various methods are employed to identify all the problems associated with this project.

3.4.1 Site Investigation

Monitoring the activity of a construction site can enhance the understanding of real construction techniques. Site investigations provide an engaging learning environment and practical experience in a construction project. By conducting site investigations, the ongoing work, gaining valuable insights into the building process and materials from both a technical and practical perspective can be observed.

3.4.2 Previous Report

The analysis of previous reports involves providing a comprehensive description of a specific area of study conducted earlier. These findings are derived from the documentation and reporting conducted in the previous report of this project. The issue lies in the time-consuming nature of compiling documentation and reports due to the abundance of data points, making it unsustainable and resulting in a low production rate that is difficult to measure. Conventional or traditional procedures often involve extensive paper usage for inspection work.

3.4.3 Wastage Analysis

For wastage analysis, the method that use to analyse the wastage is by using Root Cause Analysis. Ishikawa diagram is one of the tools in root cause analysis. The Ishikawa diagram, also known as a fishbone diagram or cause-and-effect diagram, is a visual tool commonly used for analyzing and identifying the causes of a problem or effect. When applied to wastage analysis in various industries, the Ishikawa diagram facilitates a structured approach to categorizing and understanding the factors that contribute to wastage. It involves creating a diagram with main categories, such as manpower, methods, machines, materials, measurement, and environment, and further branching out into sub-categories and potential causes. By systematically identifying and analyzing these causes, organizations can gain insights into the root causes of wastage and develop targeted improvement strategies. The Ishikawa diagram serves as a valuable tool for waste reduction and continuous improvement efforts. Figure 3.5 shows the Ishikawa or Fishbone Diagram that will be used for wastage analysis.

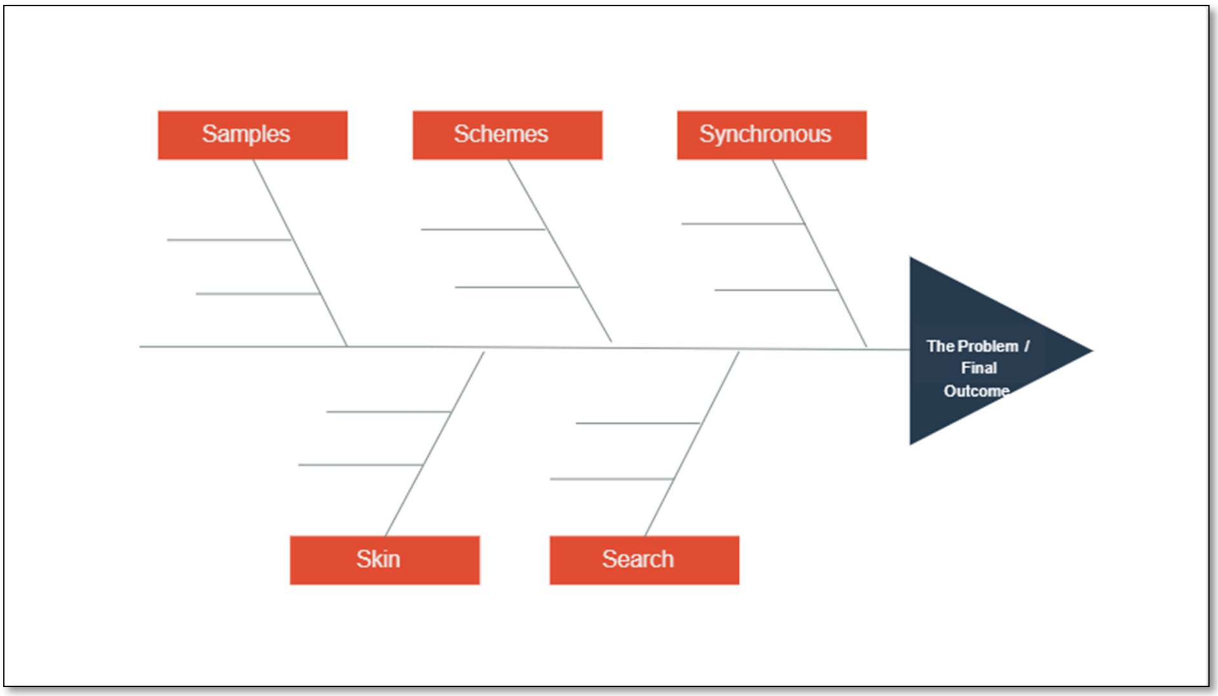


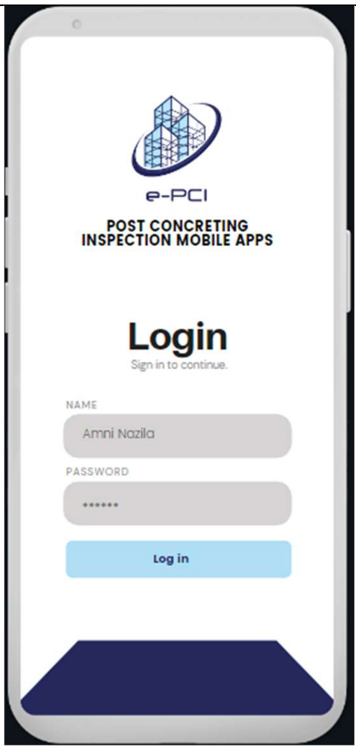
Figure 3. 5 Ishikawa Diagram for e-PCI

3.4.4 Quantitative Method

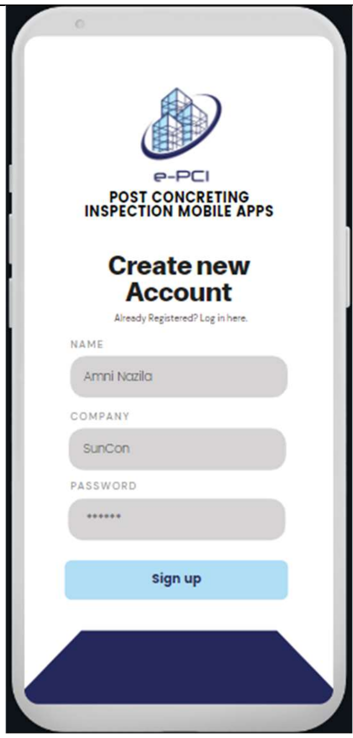
A systematic analysis of phenomena using quantifiable data and statistical, mathematical, or computational methods is referred to as a quantitative method. The scientific technique of quantitative application produces clear goals and objectives with testable hypotheses after an initial examination of theory and literature. Structured surveys (interviews and questionnaires), trials, and desk-based research using secondary data are examples of quantitative methods.

3.4.5 Prototype

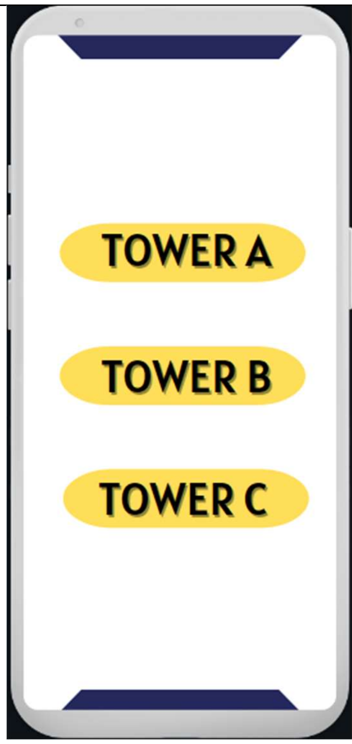
Create a prototype to test the problem-solving ideas developed in the earlier stage. The design team, other departments, or a small group of people who are not on the design team may exchange and test prototypes. Finding the optimal solution for each of the problems outlined in the first three phases is the objective of this experimental phase. One at a time, the solutions are included into the prototypes, and based on the feedback from the users, they are either accepted, improved upon, and re-examined, or rejected. The design team will have a greater grasp of the limitations and concerns with the product by the time this phase is over, as well as a better understanding of how actual users will act, think, and feel when using the finished product. Figure 3.6 illustrate prototype of e-PCI from step 1 to step 12.



Step 1

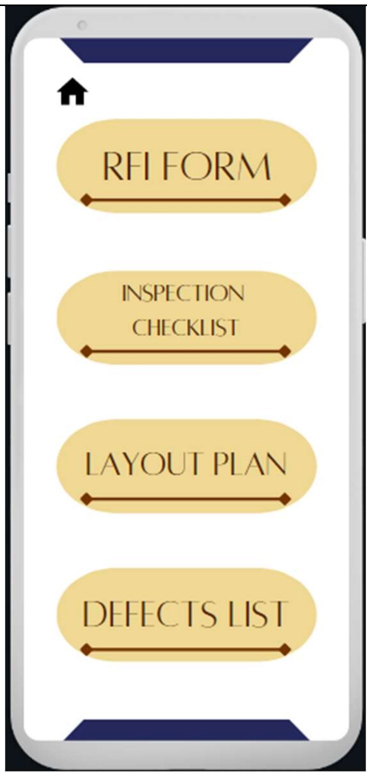


Step 2



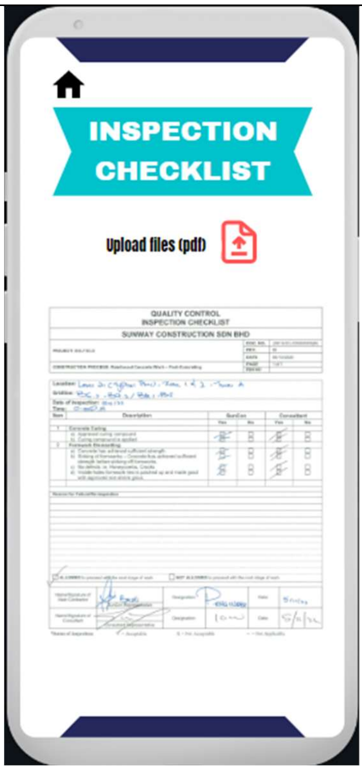
Step 3

Step 4

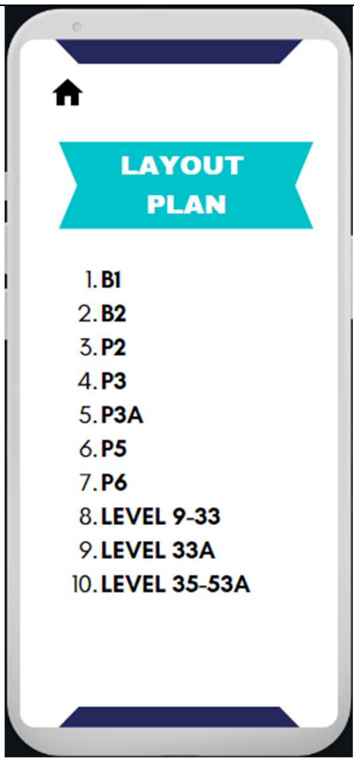


Step 5

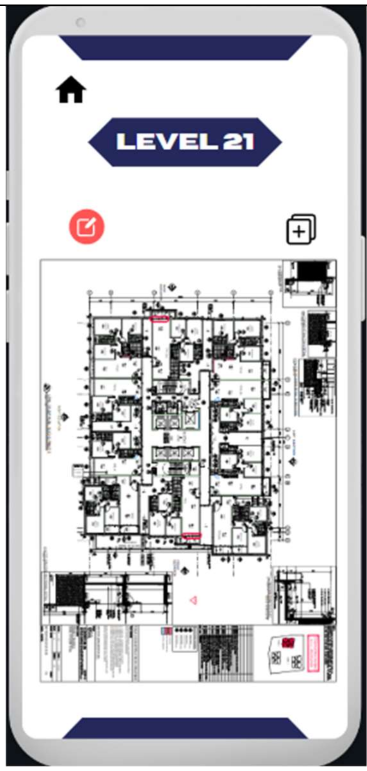
Step 6



Step 7



Step 8



Step 9

Figure 3. 6 Prototype of e-PCI

3.4.6 Flutter

Flutter is an open-source UI development kit by Google that allows developers to build cross-platform applications using a single codebase. With Flutter, developers can create visually appealing and high-performing applications for mobile, web, and desktop. Its hot reload feature speeds up development iterations, while the reactive UI framework enables smooth animations. Flutter also provides access to platform-specific features through plugins and has a strong developer community for support. Overall, Flutter simplifies the development process and offers a robust solution for building cross-platform applications.

3.4.7 Questionnaire (After Develop the Application)

The objective of the widely disseminated questionnaire is to learn more about awareness and understanding that could be connected to our project. Get perspectives that can be utilised to improve the implementation, aside from that. The questionnaire consisted of two sections, each serving a specific purpose. The primary objective of the first section was to collect background information that would determine the validity and effectiveness of the company's developed apps for implementation among site users. The next section is based on the usefulness and ease of use of the product.

The distributed questionnaire serves multiple purposes within our project. Firstly, it aims to gather information about awareness and understanding related to our project. Additionally, it seeks to obtain views and opinions that can be utilized to enhance the implementation process. Moreover, the questionnaire is designed to gather targeted user feedback on their agreement or disagreement with the concept of the application.

3.4.8 Analysis Data

All studies or experiments that use data and statistics as a research approach require data analysis, which is crucial. Data analysis is used in the great majority of social sciences as well as essential natural science and engineering studies. It is also a very helpful technique for bringing out the real shape of the approximations to a problem that is extremely complex or unknown. Data analysis is at the core of social science research. Unfortunately, data analysis may be utilised, whether knowingly or unknowingly, to draw incorrect conclusions. Data analysis is only a tool, not a replacement for thorough thought and analysis.

3.5 CONCLUSION

This chapter presented the research methodology employed in the study, covering various aspects such as research design, data collection methods, analysis techniques, and the chosen technology for application development. The methodology followed a systematic flowchart, starting from problem identification to data analysis and conclusion drawing. The Ishikawa diagram was used for wastage analysis, while Flutter was chosen as the development framework. A questionnaire was distributed to gather user feedback, and data analysis played a crucial role in interpreting the findings. Overall, the research methodology allowed for a comprehensive understanding of the research problem and will contribute to the success of the project.

CHAPTER 4
RESULT: DATA ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

The findings of this study encompass two main components. The first component involves an assessment of the issues associated with the current method being used, which was conducted prior to the implementation of the Post Concreting Inspection Mobile Application (e-PCI). The second component involves evaluating the satisfaction of users after the adoption of e-PCI.

Before the development of e-PCI, interviews were conducted with seven specific users, including project managers, assistant project managers, project engineers, resident engineers, QAQC personnel, consultants, and site supervisors. These interviews focused on gathering insights regarding work experience and documentation reports. The viewpoints expressed by the respondents concerning the existing problems were collected and used as the foundation for the problem statement in this study.

The data and conclusions derived from the questionnaire and site-based interviews are presented and discussed in this chapter. Additionally, the results of the project's objectives are mentioned. The project's objectives will be justified based on the results, and an assessment will be made as to whether the goals have been achieved.

4.2 WASTAGE

From Result Analysis on Figure 4.1, there are four wastage that can be identified which is cost, time and over production and extra processing. Regarding expenses, a significant portion of the budget is allocated to materials such as paper, printer ink, internet, and printer maintenance in the context of empty costs. As for time allocation, a considerable amount is spent on generating reports before and after inspections, waiting for defect lists to be printed out, and creating defect lists for follow-up rectification works. For overproduction and excess processing, the use of paper is prevalent throughout the RFI process. It starts from the opening of the RFI, generating defect lists, follow-up rectification works, and continues until the defect's inspection works are closed.

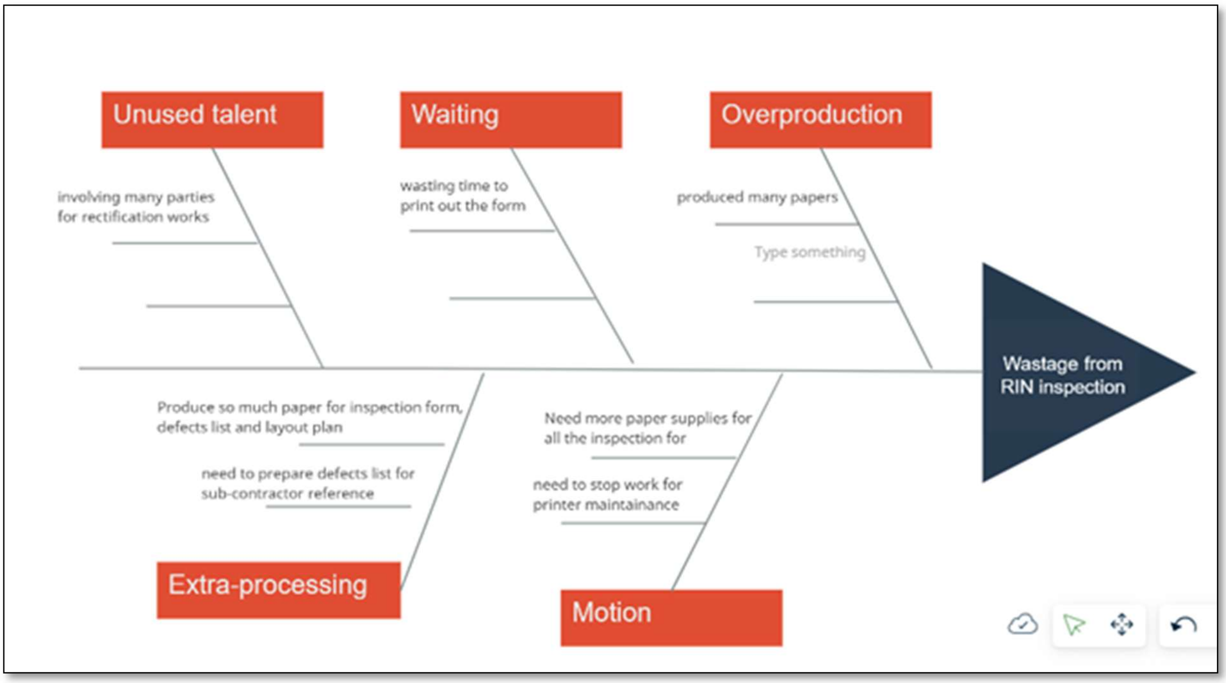


Figure 4. 1 Result Analysis

4.3 ELIMINATE WASTE

Figure 4.2 illustrates the process of lean management to eliminate waste that has been detected. To eliminate waste, the application called e-PCI was built.

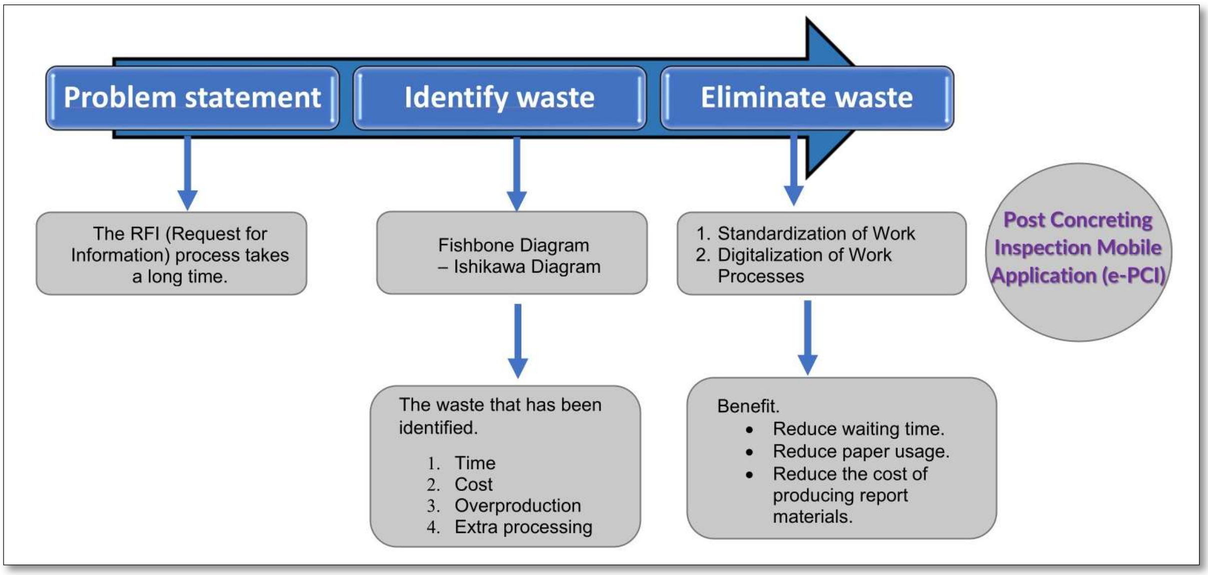


Figure 4. 2 Process of Lean Management to Eliminate Waste

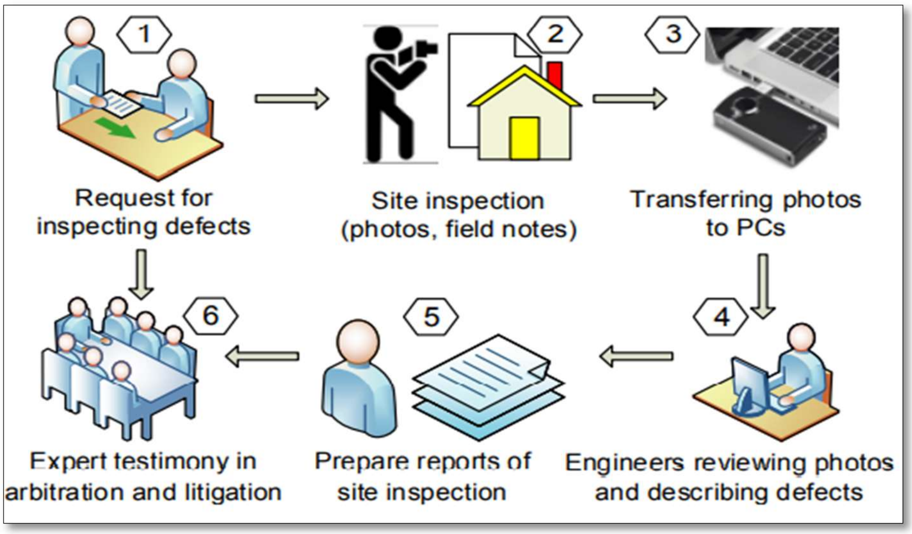


Figure 4. 3 Current RFI Method at Sunway Belfield

Figure 4.3 shows the typical current RFI method for defect inspection and documentation that was used at Sunway Belfield. The parties in dispute are required to investigate and classify defects for the purposes of allocating liabilities for the alleged defects. When a construction defect dispute or litigation arises, both parties must hire construction experts for numerous hours of site inspection, defect classification, and documentation. In addition, they must spend time describing and classifying defects and documenting their findings. The last step can be applied to site inspections for disputes involving construction defects. Therefore, reducing the time, cost, and overprocessing of the defect's inspection, classification, and documentation can be implemented by developing new technology.

Upon observing the conventional method employed at construction sites, it was recognized that there is room for improvement, particularly in the areas of post-concreting inspection and documentation. As a result, a proposal was made to develop a mobile application to address these shortcomings. This improved method, known as the Post Concreting Inspection Mobile Application (e-PCI), is intended to enhance the efficiency and effectiveness of site inspections and Request for Inspection (RFI) documentation in construction projects. The development of this standalone application is an effort to streamline and optimize the inspection and documentation processes related to post-concreting activities.

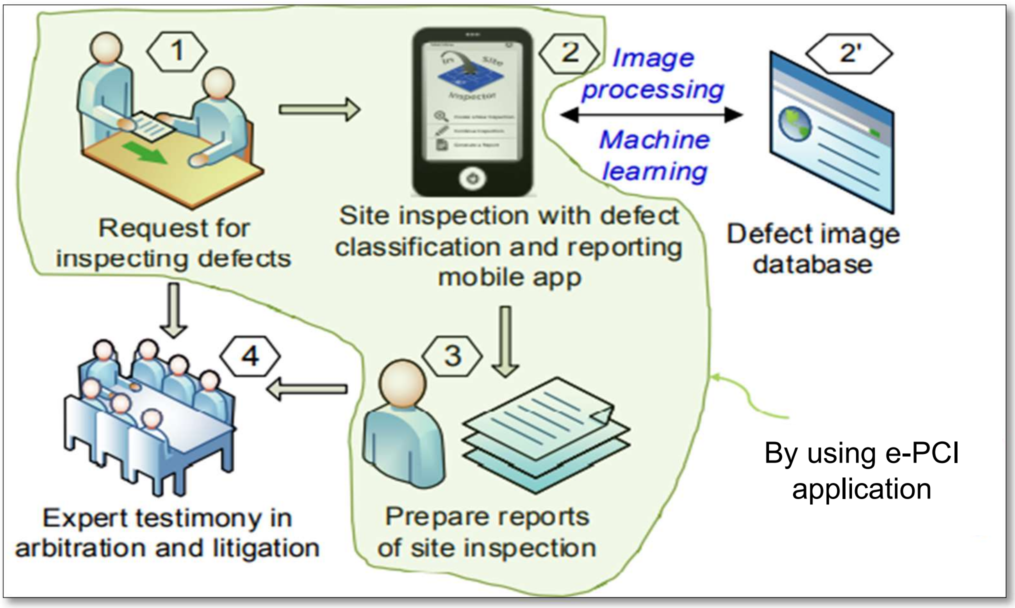


Figure 4. 4 New Method using e-PCI

Figure 4.4 depicts proposed new approach for utilizing the e-PCI (Post Concreting Inspection) method. In the conventional method, the Request for Inspection (RFI) process involves six steps, starting from inspection and concluding with documentation preparation. However, with the implementation of e-PCI, users can streamline the process to just three steps. These steps include requesting an inspection from the Inspector of Work (IOW) or consultant, conducting a site inspection using the mobile application with defect classification and reporting functionality, and finally submitting the post-concreting inspection report to the IOW. By adopting e-PCI, users can significantly reduce paper usage, minimize the time spent on paperwork, and reduce the cost associated with report production.

4.4 POST CONCRETING INSPECTION MOBILE APPLICATION (e-PCI)

4.4.1 Flow Chart Of e-PCI

The flow chart below shows the flow for current practices of using Post Concreting Mobile Application (e-PCI) on site in Figure 4.5. This flow will help users to easily understand well the flow on how to operate the application when doing the inspection and preparing report by using e-PCI.

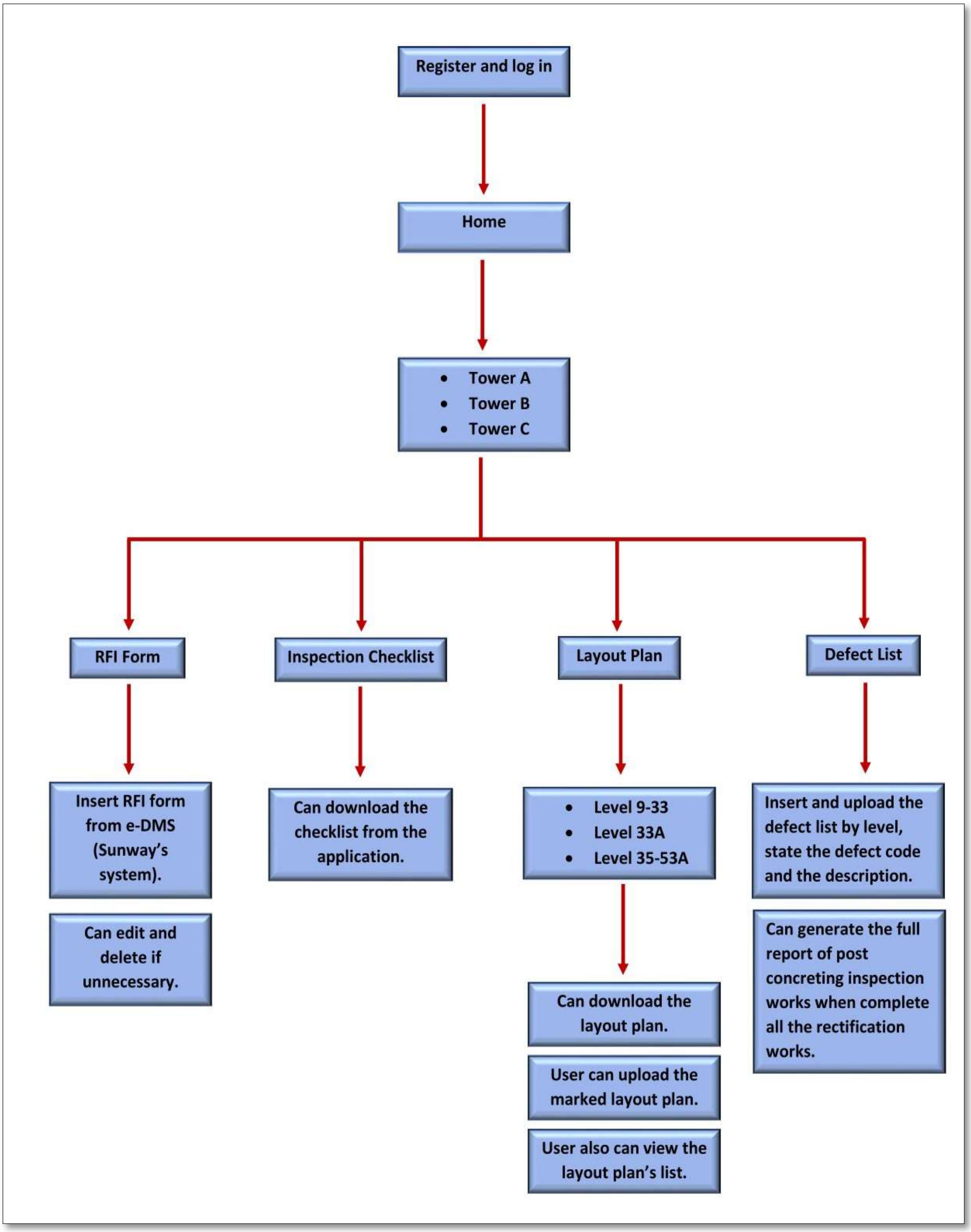


Figure 4. 5 Flow Chart of using e-PCI

4.4.2 Step Using e-PCI

The e-PCI mobile application is created using Flutter, MySQL, and Android Studio. Table 4.1 until 4.8 illustrates the sequential steps involved in utilizing the e-PCI application.

Table 4. 1 Function of e-PCI

No	Figure	Description
1		This is the view from the front page. The user needs to login to continue using the e-PCI.
2		For a new account to be created, registration is required.
3		Then, logging in and clicking the submit button is all that is needed.

Table 4. 2 Function of e-PCI

4		After logging in, the tower where the post-concrete inspection will be conducted can be chosen.
5		Next, click the RFI form to upload the inspection form from Sunway's system (e-dms).  SUNWAY CONSTRUCTION SDN. BHD. REQUEST FOR INSPECTION
6		i. This is the view of the RFI list when it is uploaded by the user. Additionally, a new RFI form can be added based on the inspection floor by clicking on the (+) button. ii. The RFI form can be downloaded by the user by clicking on the download button, and it can be deleted if deemed unnecessary.

Table 4. 3 Function of e-PCI

7		The user needs to insert the RIN number, level of the inspection work, and status of the RFI, which is finalised when the inspection works and the documentation are still on-going and completed when all the reports of the post-concreting inspection are done. After that, click on the submit button.
8		The next step involves users clicking on the inspection checklist button to obtain the inspection checklist form, which will be compiled and brought along during the inspection to be presented to the consultant or work inspector.
9		The inspection checklist, which is available within the application, can be downloaded by users by clicking on the download button.

Table 4. 4 Function of e-PCI

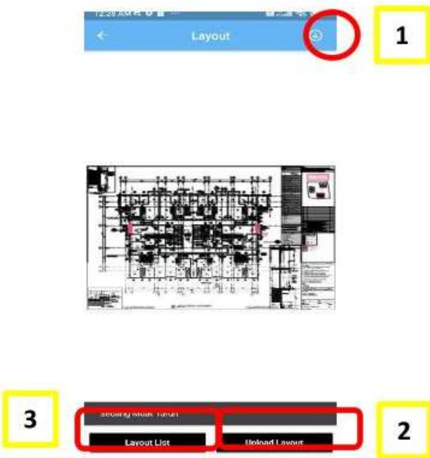
10		In this section, the marked layout plan can be uploaded by the user by clicking on the layout plan button.
11		Any level of the layout plan can be chosen by users based on the inspection requirements.
12		1.The given layout plan can be used by the user by clicking on the download button. 2. The marked layout plan can be uploaded by the user. 3. The layout list can be shown by the user after uploading it.

Table 4. 5 Function of e-PCI

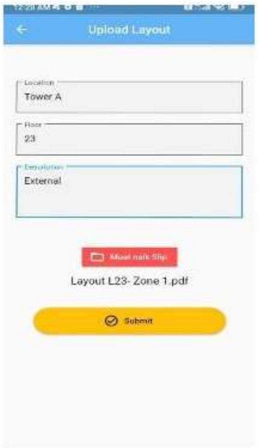
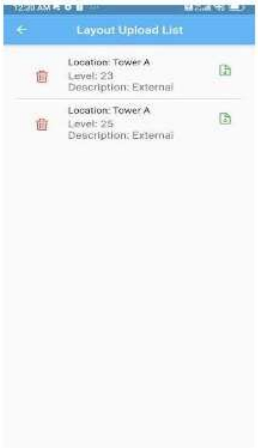
<table>
<tr>
<td>13</td>
<td>
</td>
<td>For uploading the layout plan, all the blank spaces such as location, floor, and the description of the layout plan need to be filled by the user. After that, the submit button can be clicked on to upload it.</td>
</tr>
<tr>
<td>14</td>
<td>
</td>
<td>The view of the uploaded layout plan list is as follows.</td>
</tr>
<tr>
<td>15</td>
<td>
</td>
<td>Next, all the defects can be uploaded by the user in the defect list section.</td>
</tr>
</table>

Table 4. 6 Function of e-PCI

16		After clicking on the defect list button, all the uploaded defect lists will be displayed. 1. New defect lists can be inserted by the user by clicking on the (+) button. 2. To generate the list of all uploaded defects, the user can click on the "Report" button.
17		This is the interface displayed when the user clicks on the (+) button. In this section, the user needs to specify the location of the defect area, select the floor, and provide the defect code along with its description. Additionally, photos of the defects can be uploaded, and once everything is completed, the user can click on the submit button.

Table 4. 7 Function of e-PCI

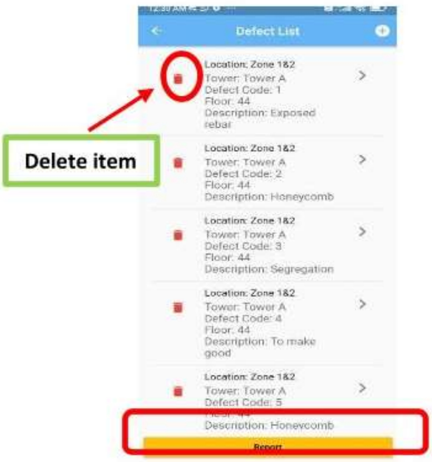
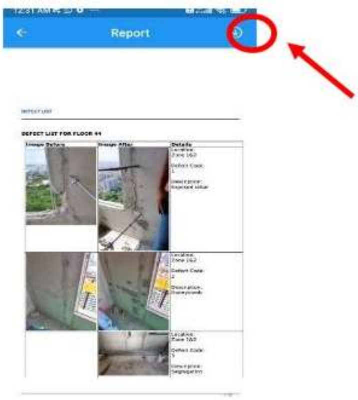
18	 	When following up on all the rectification works, the user can upload photos of the defects that have been rectified. The user will have the ability to view both the "before" and "after" photos of the rectification process.
19		To generate the full report, the user needs to click on the "Report" button.

Table 4. 8 Function of e-PCI

20	 	The user can choose the desired floor to generate the full report. After selecting the floor, they can click on the submit button to obtain the complete report of the defect list.
21		Finally, the defects list will be generated into a full report. The last step is for the user to simply click on the download button located at the top right corner to obtain the report.

4.5 THE EFFECTIVENESS OF e-PCI

To evaluate the effectiveness of the e-PCI, a questionnaire was given to 15 respondents to gather feedback from them. The questionnaire contains demographic questions, the Perceived of Usefulness (PU) and Perceived Ease of Use (PEOU). Perceived usefulness is a feeling that users hold toward the improvement in producing RFI for post-concreting inspection by using e-PCI and Perceived ease of use refers to a level of easiness that users feel when using e-PCI.

Section A, Section B, and Section C formed this questionnaire's sections. In Section A, the demographic profile is discussed. The e-PCI utility evaluation question is situated in Section B. The opinions of the respondents on usability are discussed in Section C.

4.5.1 Demographic Data

The respondents' background is represented by their demographic data, which consists of 4 components as below:

Section A: Personal Information

a) Gender
b) Age range
c) Designation
d) Work experience

i. Gender

Table shows the number of respondents who obtained in this study. The total number of respondents was about 15 persons. Table 4.9 and Figure 4.6 below show the number of respondents by gender.

Table 4. 9 Gender

No	Items	No of respondents	Percentage (%)
1.	Male	12	80
2.	Female	3	20
Total		15	100

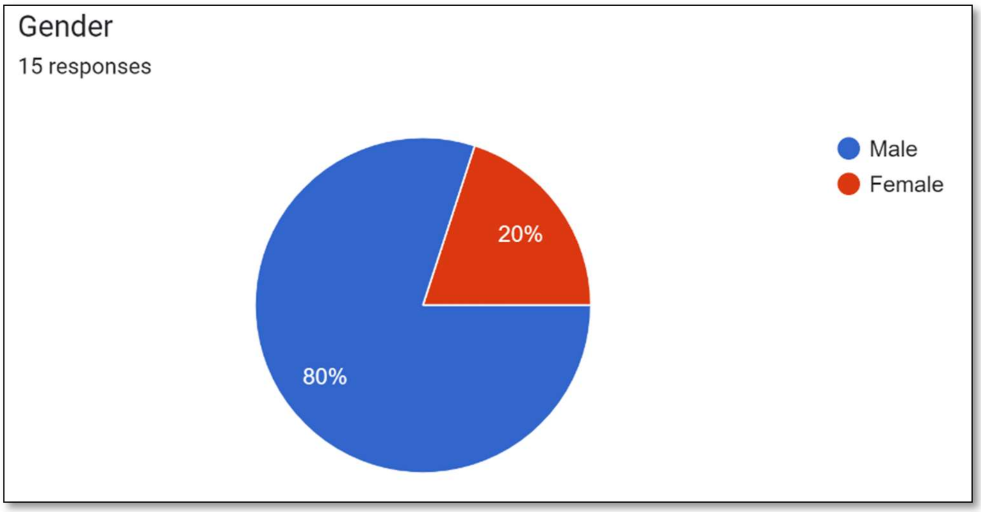


Figure 4. 6 Gender

In this study shows the 80% of the respondents are Male which are 12 respondents and 20% are Female which are 3 respondents. By comparing the percentages, this site had more male respondents than female respondents.

ii. Age range

The age group of respondents included in this study is shown in Table 4.10 below. The 5 age categories were split by the researcher. This category was created to make it easier to analyse the data and locate the respondent at the Sunway Belfield project. So, Figure 4.7 can be used to show the percentage dependent on age.

Table 4. 10 Age Range

No	Items	No of respondents	Percentage (%)
1.	21-25	3	20
2.	26-30	7	46.7
3.	31-35	2	13.3
4.	35-40	1	6.7
5.	41 and above	2	13.3
Total		15	100

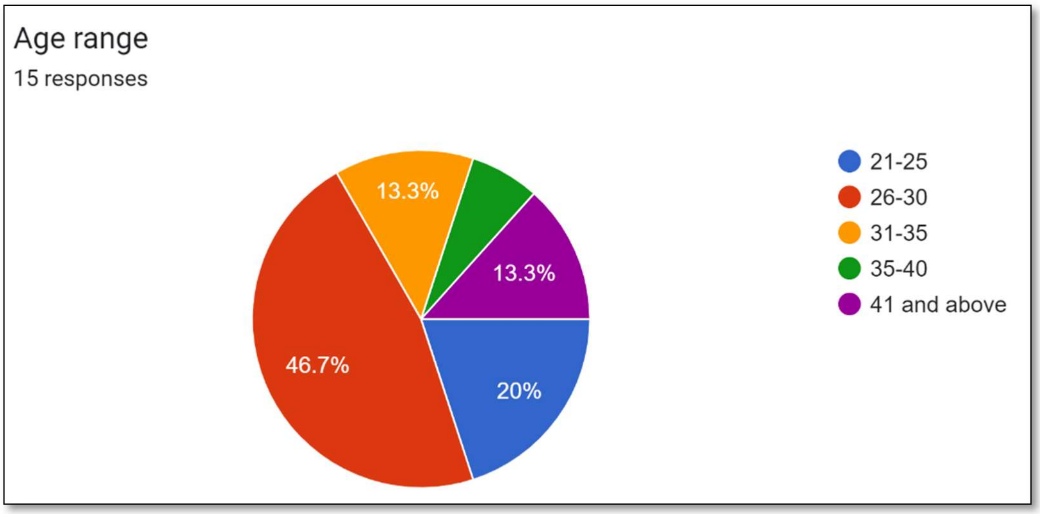


Figure 4. 7 Age Range

The figure shows that the age of the respondents within this study. 20% of the respondents are 21 to 30 years which are 3 respondents. Majority of the respondent are 20% from 26 to 30 years old which are 7 respondents while the age group of 31 to 35 and 41 and above are equal which are 2 respondents. Lastly, there is 6.7% in the group of 35-40 years old.

iii. Designation

The third item in the demographic data is the job position at this study, where there are various positions of Engineers and Supervisors where is responsibility by doing work done progress. Figure 4.8 and Table 4.11 below appointment pie chart illustration and table.

Table 4. 11 Designation

No	Items	No of respondents	Percentage (%)
1.	Project Manager	1	6.7
2.	Assistant Project Manager	1	6.7
3.	Resident Engineer (RE)	1	6.7
4.	Inspector of Work (IOW)	2	13.3
5.	Project Engineer	5	33.3
6.	Quality Assurance & Quality Control (QAQC)	3	20
7.	Site Supervisor	2	13.3
Total		15	100

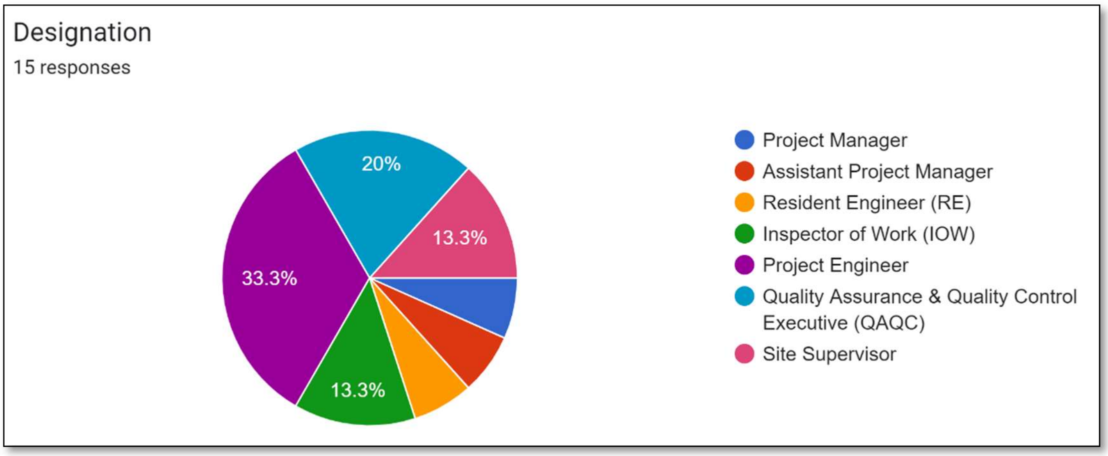


Figure 4. 8 Designation

Figure 4.8 demonstrates that the designation percentage has remained constant at 6.7% only a person is designed for the position of project manager, assistant project manager and resident engineer. While there were equally 13.3% which is 2 respondents are inspector of work and site supervisor participated in the survey. Most of the respondents are project engineer which conclude 33.3% (5) respondents and the remain of 3 respondents participated which are 20% are QAQC. As a result, the survey covered all possible points of view from these 7 positions.

iv. Work Experience

Table 4. 12 Work Experience

No	Items	No of respondents	Percentage (%)
1.	1-2 years	4	26.7
2.	3-4 years	5	33.3
3.	5-6 years	2	13.3
4.	6 years	4	26.7
Total		15	100

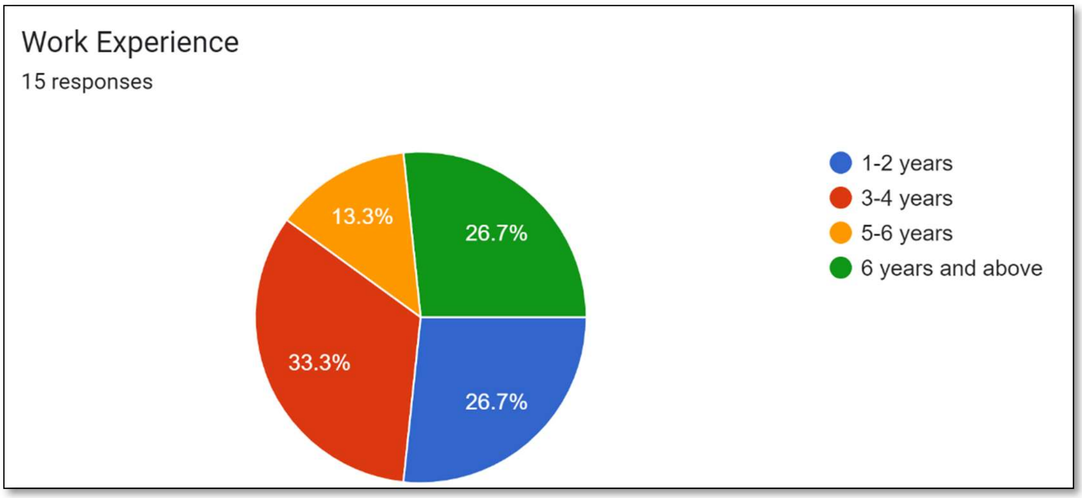


Figure 4. 9 Work Experience

Figure 4.9 illustrated in working experience of the current position in four component of the demographic data and it range from 1-2 years to 6 years and above.

According to the graph above, most respondents had been employed for 3-4 years working experience which is 33.3% (5). However, the respondents who have 1 to 2 years and 6 years and above working experience are equal which are 26.7% (4). The least one was 13.3% (2) which 6 to 6 years' working experience.

4.5.2 Perceived Of Usefulness (PU)

Sections B and C of the questionnaire will be analysed in this phase of the study. The analysis obtained from the questionnaire is displayed in the figures and tables below. These two sections used scale to collect data from respondent perspective on evaluation of usefulness for e-PCI. The scale representing from 1 to 5 are “Strongly Disagree” to “Strongly Agree”.

Perceived usefulness refers to an individual's subjective evaluation of how beneficial a technology or product will be in enhancing their performance or achieving specific goals. It is a key factor in determining whether someone will adopt and use a particular technology. Perceived usefulness is influenced by factors such as personal goals, prior experience, and the perceived impact on productivity. Organizations consider perceived usefulness when introducing new technologies to employees. It is important to note that perceived usefulness is subjective and varies among individuals. Table 4.13 contains the questions pertaining to the Perceived Usefulness (PU).

Table 4. 13 Question for Perceived of Usefulness (PU)

Perceived of usefulness items		
Construct	**Operational definitions**	**Measured items**
Perceived of usefulness (PU)	Perceived of usefulness is a feeling that users hold toward the improvement in producing RFI for post-concreting inspection by using e-PCI.	**PU1**: By using e-PCI will enable user to do the RFI report quickly. **PU2**: By using e-PCI allows users to follow up defects without using paper. **PU3**: By using e-PCI allows user to follow up defects work without produced any wastage. **PU4**: e-PCI on RFI progress useful in

		collecting and receiving information. **PU5**: e-PCI will save time on the RFI's report progress. **PU6**: By using e-PCI would improve my inspection work performance.

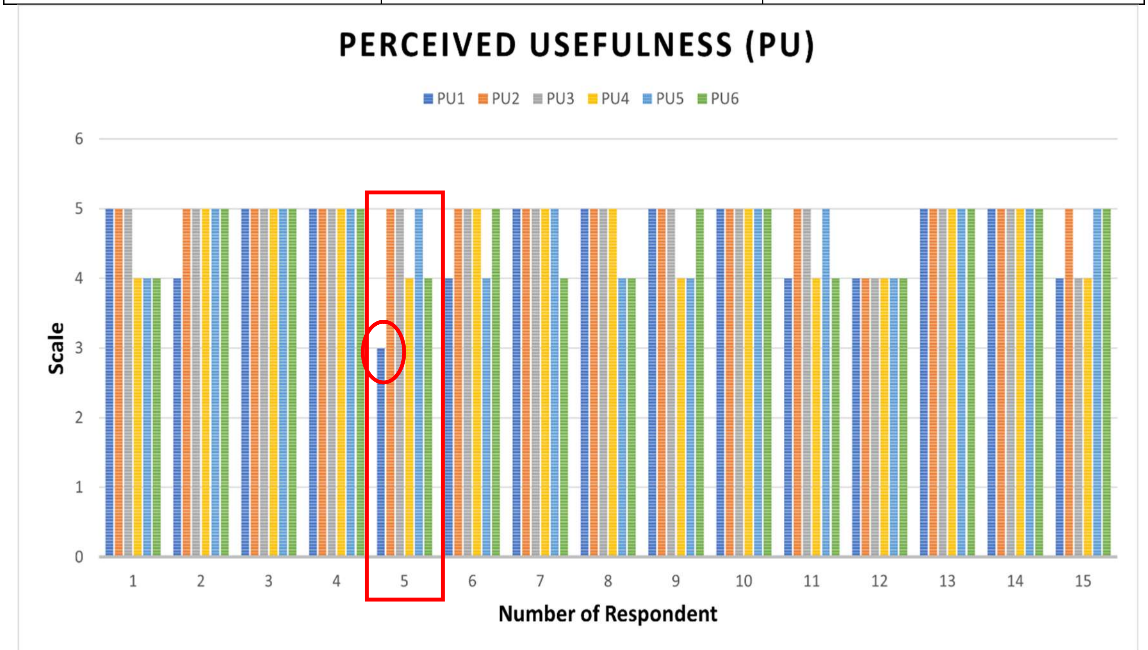


Figure 4. 10 Analysis result for Perceived of Usefulness (PU) questions.

Perceived of usefulness is a feeling that users hold toward the improvement in producing RFI for post-concreting inspection by using e-PCI. From Figure 4.10 above, it is showing bar graph regarding the analysis result for Perceived of Usefulness (PU) question. The 'X' axis of this graph is number of the respondent and "Y' axis is scale. This question has scale which is 1 to 5 and 1 refer to strongly disagree and 5 refer to strongly agree. Most respondents indicated agree and strongly agree, with a scale rating of 4 and 5, regarding the usefulness of e-PCI. However, there was only one respondent who rated question number 1, "**PU1**: By using e-PCI, users can quickly generate RFI reports," with a scale of 3 (Neutral). This suggests that this respondent may not fully agree with the notion that e-PCI enables the prompt generation of RFI reports.

4.5.3 Perceived Ease of Use (PEOU)

Perceived ease of use refers to an individual's subjective evaluation of how effortless it is to use a technology. It influences their willingness to adopt and use the technology. Factors such as user-friendliness, intuitive interfaces, and available support impact perceived ease of use. Organizations aim to enhance perceived ease of use through clear instructions, user-friendly design, and ongoing improvements. However, perceptions of ease of use vary among individuals based on their skills and familiarity with technology. Understanding users' needs and abilities is essential in improving ease of use. Table 4.14 contains the questions pertaining to the Perceived Ease of Use (PEOU).

Table 4. 14 Question for Perceived Ease of Use (PEOU)

Perceived ease of use items		
Construct	**Operational definitions**	**Measured items**
Perceived ease of use (PEOU)	Perceived ease of use refers to a level of easiness that users feel when using e-PCI.	**EU1**: Learning to e-PCI on identify defects would be ease for me. **EU2**: I would find it easy to be produced post-concreting inspection documentation and report by using e-PCI. **EU3**: I would find the RFI progress work be flexible to use. **EU4**: It would be easy for me to become skilful at using e-PCI on post-concreting inspection on site.

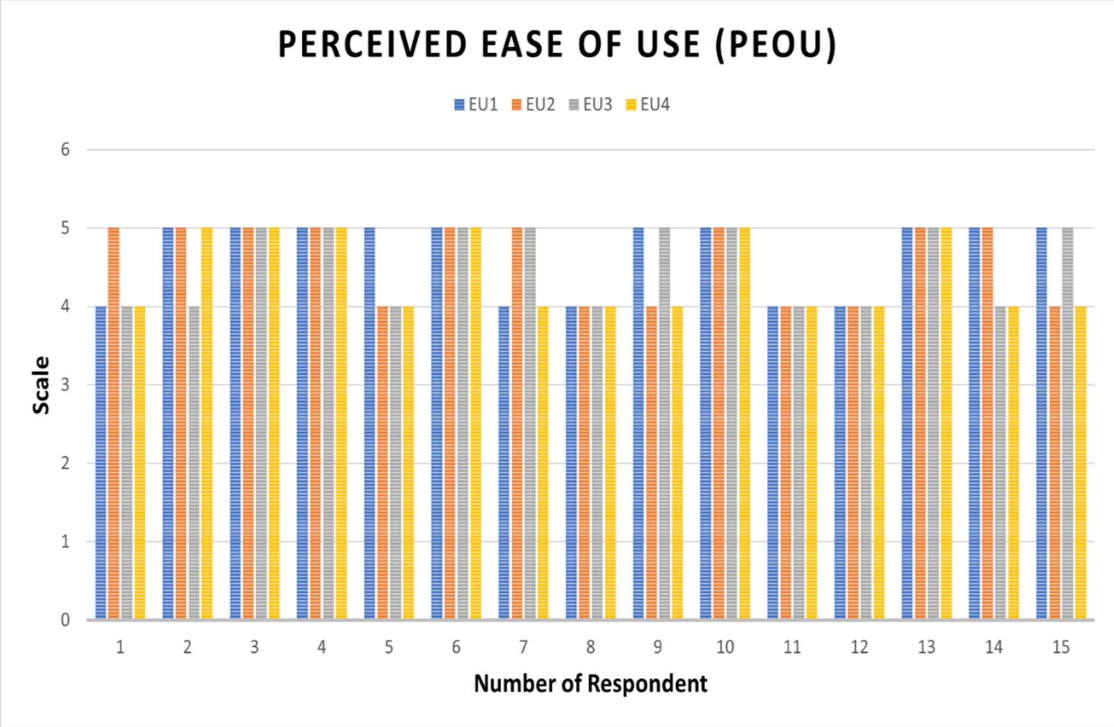


Figure 4. 11 Analysis result for Perceived Ease of Use (PEOU)

Perceived ease of use pertains to the level of ease experienced by users when using e-PCI. The bar graph presented in Figure 4.11 displays the analysis results for the Perceived Usefulness (PU) question. The horizontal axis ('X' axis) represents the number of respondents, while the vertical axis ('Y' axis) represents the scale. This question utilizes a scale ranging from 1 to 5, where 1 indicates strongly disagree and 5 indicates strongly agree. Out of the total questions, 33 received a scale rating of 5 (Strongly Agree), while the remaining 27 questions were rated 4 (Agree) by the respondents.

4.5.4 The Interpretation of Mean and Standard Deviation For The Data Analysis

Table 4. 1 Summarize of Analysis on Effectiveness e-PCI

Demographic				Perceived of Usefulness (PU)						Perceived Ease of Use (PEOU)			
Gender	Age range	Designation	Work Experience	1. By using e-PCI will enable user to do the RFI report quickly.	2. By using e-PCI allows users to follow up defects without using paper.	3. By using e-PCI allows user to follow up defects work without produced any wastage.	4. e-PCI on RFI progress useful in collecting and receiving information.	5. e-PCI will save time on the RFI's report progress.	6. By using e-PCI would improve my inspection work performance.	1. Learning to e-PCI on identify defects would be ease for me.	2. I would find it easy to peprared post-concreting inspection documentation and report by using e-PCI.	3. I would find the RFI progress work be flexible to use.	4. It would be easy for me to become skilful at using e-PCI on post-concreting inspection on site.
Male	26-30	Project Manager	6 years and above	5	5	5	4	4	4	4	5	4	4
Male	31-35	Assistant Project Manager	6 years and above	4	5	5	5	5	5	5	5	4	5
Male	26-30	Project Engineer	3-4 years	5	5	5	5	5	5	5	5	5	5
Male	26-30	Project Engineer	3-4 years	5	5	5	5	5	5	5	5	5	5
Male	26-30	Project Engineer	1-2 years	3	5	5	4	5	4	5	4	4	4
Male	21-25	Project Engineer	1-2 years	4	5	5	5	4	5	5	5	5	5
Female	26-30	Quality Assurance & Quality Control Executive (QAQC)	3-4 years	5	5	5	5	5	4	4	5	5	4
Male	31-35	Site Supervisor	6 years and above	5	5	5	5	4	4	4	4	4	4
Male	21-25	Site Supervisor	1-2 years	5	5	5	4	4	5	5	4	5	4
Male	41 and above	Resident Engineer (RE)	6 years and above	5	5	5	5	5	5	5	5	5	5
Male	35-40	Inspector of Work (IOW)	5-6 years	4	5	5	4	5	4	4	4	4	4
Male	41 and above	Inspector of Work (IOW)	5-6 years	4	4	4	4	4	4	4	4	4	4
Female	26-30	Quality Assurance & Quality Control Executive (QAQC)	3-4 years	5	5	5	5	5	5	5	5	5	5
Female	21-25	Quality Assurance & Quality Control Executive (QAQC)	1-2 years	5	5	5	5	5	5	5	5	4	4
Male	26-30	Project Engineer	3-4 years	4	5	4	4	5	5	5	4	5	4
N				15	15	15	15	15	15	15	15	15	15
Mean				4.53	4.93	4.87	4.60	4.67	4.60	4.67	4.60	4.53	4.40
Standard Deviation				0.64	0.26	0.35	0.51	0.49	0.51	0.49	0.51	0.52	0.51

Table 4. 1 Percentage of Respondent

SCALE	1 STRONGLY DISAGREE	2 DISAGREE	3 NATURE	4 AGREE	5 STRONGLY AGREE
PERCENTAGE OF RESPODENTS (%)					
PU1	0	0	7	33	60
PU2	0	0	0	7	93
PU3	0	0	0	13	87
PU4	0	0	0	40	60
PU5	0	0	0	33	67
PU6	0	0	0	40	60
			1	28	71
EU1	0	0	0	33	67
EU2	0	0	0	40	60
EU3	0	0	0	47	53
EU4	0	0	0	60	40
			0	41	59

Table 4.15 provides a summary of the analysis conducted on the effectiveness of e-PCI. The summary includes the mean and standard deviations for all the collected data. The mean value for all the questions is 4.5 or higher, indicating that the respondents' ratings on the questionnaire were predominantly "strongly agree" (scale 5) for almost all the questions.

Table 4.16 presents the survey results indicating the percentage of respondents evaluating the effectiveness of e-PCI. In Section B, for the Perceived Usefulness (PU) question, 71% of the respondents strongly agreed, while 28% gave a rating of 4 (Agree), and 1% gave a rating of 3 (Neutral). However, no respondents chose scale 1 (Strongly Disagree) or scale 2 (Disagree). Regarding the Perceived Ease of Use (PEOU) question, 59% of the respondents strongly agreed (scale 5), 41% agreed (scale 4), and none of the respondents chose scale 1 to 3.

4.6 CONCLUSION

In summary, the survey results provided valuable insights from the respondents. The analysis of the findings considered demographic criteria such as gender, age group, occupation, and work experience. The objective of evaluating the effectiveness of e-PCI was supported by questionnaire responses, as the respondents agreed with the statements based on their own experiences.

Technology plays a crucial role in leading and improving our daily lives, making tasks more efficient and convenient. It enables individuals to allocate their time to other productive activities. Additionally, the flexibility of using this technology anywhere adds to its advantages. In particular, the work domain benefits greatly from technological advancements, allowing for time savings, access to accurate information, and reduction of wastage.

Overall, the study highlights the positive impact of technology, specifically e-PCI, in terms of effectiveness and convenience in various aspects of work and life.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

Based on the data analyses presented in the preceding chapter, this section provides a summary of the findings, conclusions, and recommendations. The effectiveness of employing the e-PCI for post-concreting inspection at Sunway Belfield, Kg Attap Kuala Lumpur was evaluated based on the extent to which the study's objectives were achieved. In this chapter, the researcher should propose recommendations to enhance and optimize the application for future projects. The utilization of e-PCI facilitated the streamlining of post-concreting inspection tasks and documentation for employees, thereby minimizing time wastage, cost, and excessive material consumption. The application eliminates the need for project engineers and QAQC engineers to rely on paper-based inspection and documentation processes. This approach reduces paper consumption, time, and production costs. Ultimately, e-PCI is a user-friendly application accessible from anywhere, making it convenient for individuals with their devices.

5.2 PROJECT CONTRIBUTION

This study utilizes the design thinking approach as its research framework, which is a problem-solving methodology that focuses on providing solution-based approaches. Design thinking is particularly valuable for addressing complex problems that are poorly defined or unknown by understanding the human needs involved. It achieves this by reframing the problem in a human-centric manner, generating numerous ideas through brainstorming sessions, and adopting a hands-on approach through prototyping and testing.

The utilization of lean tools and techniques by project teams and industry professionals has the potential to reduce or eliminate waste, improve performance, and result in significant cost savings for both the industry and society (Ansah, R. H., 2016). This project has successfully accomplished its objective of identifying wastage in the RFI process, developing an application to reduce wastage, and achieving efficiency in its functionality. Using technology in the construction industry has a significant impact. e-PCI improves efficiency by streamlining processes, automating tasks, and enhancing productivity. It enables faster communication, data processing, and reduces errors, leading to time and cost savings. It also facilitates data driven decision-making through real-time monitoring, predictive analytics, and machine learning, optimizing resource allocation and project performance. Moreover, e-PCI enhances quality control with automated testing, monitoring, and documentation, ensuring defect identification, compliance, and consistent quality throughout the construction process.

However, the primary objective of this study is to assess the effectiveness of the e-PCI. The results indicated that users generally agreed that the e-PCI is more effective compared to the existing method. The current method employed on-site involves using paper as a reference and for submission, resulting in excessive paper usage. Over 50% of the respondents agreed that this application can reduce paper consumption. Additionally, users agreed that the application improves time management as it allows for easy creation of defect lists.

Overall, based on the observations and questionnaire responses, it can be concluded that there are several issues related to capturing close-up pictures of defects. The respondents agreed that these problems occurring at the construction site have a significant impact on their work. The e-PCI was tested at the Sunway Belfield construction site and demonstrated good effectiveness for post-concreting inspection tasks.

5.3 RECOMMENDATION

Based on the findings, the researcher proposes several suggestions as guidelines for enhancing the utilization of e-PCI. Firstly, it is recommended to enable offline usage of the application without requiring an internet connection, while also ensuring its compatibility for use in different projects. This would enhance its usability and convenience in various construction settings.

Secondly, incorporating application notifications to alert device users whenever an engineer uploads pictures of defects is advised. This feature would facilitate prompt action from subcontractors in rectifying identified issues, leading to improved efficiency and timely resolution of problems.

Furthermore, expanding the availability of e-PCI to iOS/Apple users is recommended. This would ensure that a wider range of users can benefit from the application, making it accessible to a broader audience and increasing its overall impact and adoption.

Lastly, it is suggested to consider implementing Lean Management principles in the construction industry to reduce wastage that commonly occurs in construction projects. By adopting Lean Management practices, such as optimizing processes, eliminating non-value-added activities, and improving overall efficiency, the construction industry can minimize resource waste and improve productivity.

These suggestions aim to enhance the functionality, accessibility, and efficiency of e-PCI, while also promoting waste reduction and improved project management practices in the construction industry.

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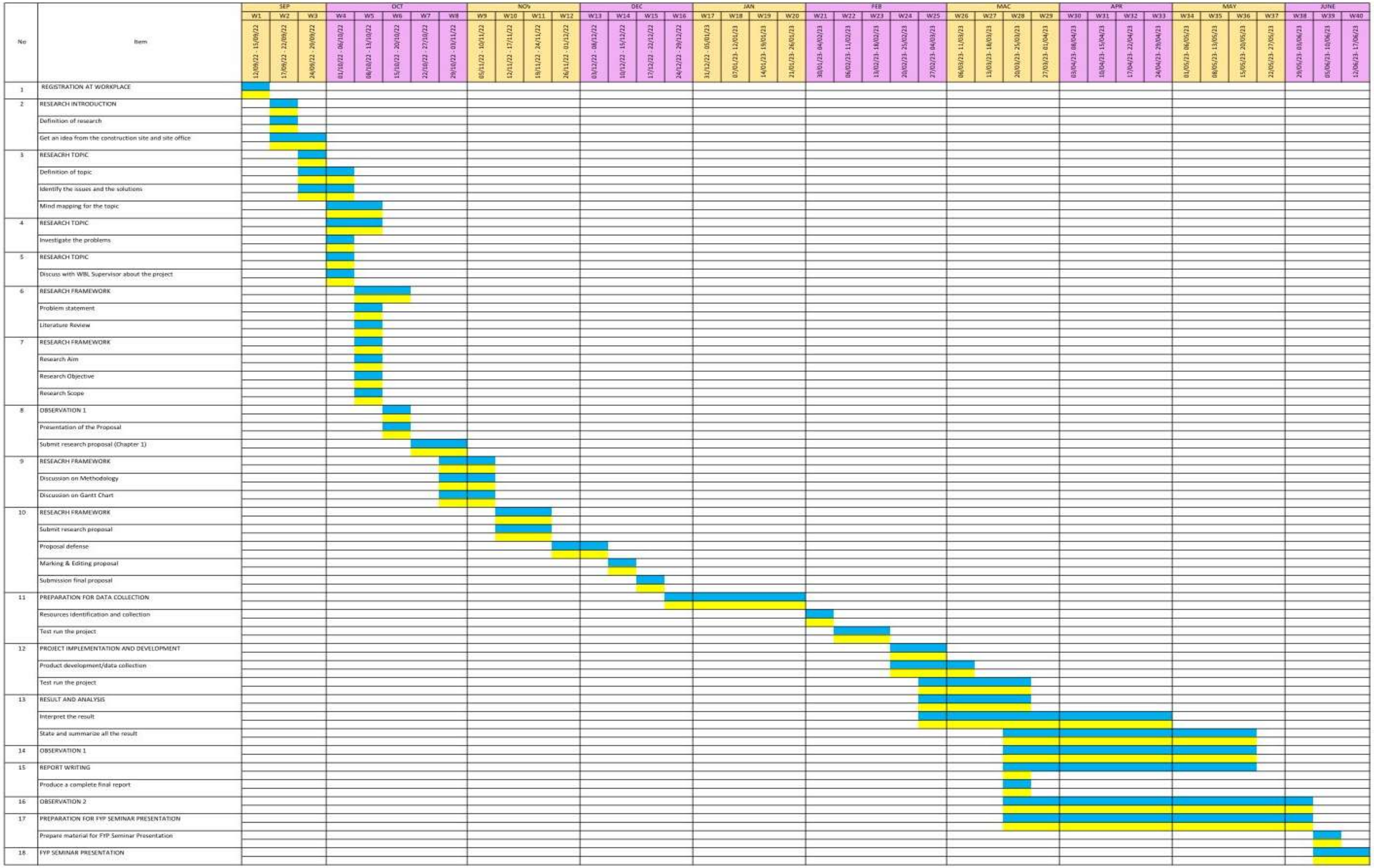
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W33 24/04/23- 29/04/23
W34 01/05/23- 06/05/23
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W36 15/05/23- 20/05/23
W37 22/05/23- 27/05/23
W38 29/05/23- 03/06/23
W39 05/06/23- 10/06/23
W40 12/06/23- 17/06/23
1 REGISTRATION AT WORKPLACE
2 RESEARCH INTRODUCTION
Definition of research
Get an idea from the construction site and site office
3 RESEACRH TOPIC
Definition of topic
Identify the issues and the solutions
Mind mapping for the topic
4 RESEARCH TOPIC
Investigate the problems
5 RESEARCH TOPIC
Discuss with WBL Supervisor about the project
6 RESEARCH FRAMEWORK
Problem statement
Literature Review
7 RESEARCH FRAMEWORK
Research Aim
Research Objective
Research Scope
8 OBSERVATION 1
Presentation of the Proposal
Submit research proposal (Chapter 1)
9 RESEACRH FRAMEWORK
Discussion on Methodology
Discussion on Gantt Chart
10 RESEACRH FRAMEWORK
Submit research proposal
Proposal defense
Marking & Editing proposal
Submission final proposal
11 PREPARATION FOR DATA COLLECTION
Resources identification and collection
Test run the project
12 PROJECT IMPLEMENTATION AND DEVELOPMENT
Product development/data collection
Test run the project
13 RESULT AND ANALYSIS
Interpret the result
State and summarize all the result
14 OBSERVATION 1
15 REPORT WRITING
Produce a complete final report
16 OBSERVATION 2
17 PREPARATION FOR FYP SEMINAR PRESENTATION
Prepare material for FYP Seminar Presentation
18 FYP SEMINAR PRESENTATION

Survey for e-PCI (Post Concreting Inspection Mobile Application)

Hai everyone! I'm Nurul Amni Nazila Binti Suhaimi and this is my final year for Bachelor of Civil Engineering Technology with Honour at Politeknik Ungku Omar. The purpose of the study is to evaluate your experience after using my Final Year Project which is Post Concreting Mobile Application (e-PCI). Your participation will greatly contribute to the success of the survey. I am deeply appreciate your help in participating in this survey, and your responses will remain private and will be used strictly for academic purpose only.

* Indicates required question

Section A: Personal Information

Please tick only one answer on each of the following question

1. Gender *

Mark only one oval.

- Male
- Female

2. Age range *

Mark only one oval.

- 21-25
- 26-30
- 31-35
- 35-40
- 41 and above

3. Designation *

Mark only one oval.

- Project Manager
- Assistant Project Manager
- Resident Engineer (RE)
- Inspector of Work (IOW)
- Project Engineer
- Quality Assurance & Quality Control Executive (QAQC)
- Site Supervisor
- Other: ______________________

4. Work Experience *

Mark only one oval.

- 1-2 years
- 3-4 years
- 5-6 years
- 6 years and above

Section B: Perceived of Usefulness (PU)

Please indicate the extent that each of the following statements reflects how useful e-PCI in your inspection work. Please use this scale to answer the following questions by choosing the most appropriate response.

Capabilities

1. Strongly Disagree
2. Disagree
3. Nature
4. Agree
5. Strongly Agree

5. 1. By using e-PCI will enable user to do the RFI report quickly.

Mark only one oval.

Strongly Disagree

1 ◯
2 ◯
3 ◯
4 ◯
5 ◯

Strongly Agree

6. 2. By using e-PCI allows users to follow up defects without using paper.

Mark only one oval.

Strongly Disagree

1 ◯
2 ◯
3 ◯
4 ◯
5 ◯

Strongly Agree

7. 3. By using e-PCI allows user to follow up defects work without produced any wastage.

Mark only one oval.

	Strongly Disagree
1	⬭
2	⬭
3	⬭
4	⬭
5	⬭
	Strongly Agree

8. 4. e-PCI on RFI progress useful in collecting and receiving information.

Mark only one oval.

Strongly Disagree
1 ◯
2 ◯
3 ◯
4 ◯
5 ◯
Strongly Agree

9. 5. e-PCI will save time on the RFI's report progress.

Mark only one oval.

Strongly Disagree
1 ◯
2 ◯
3 ◯
4 ◯
5 ◯
Strongly Agree

10. 6. By using e-PCI would improve my inspection work performance.

Mark only one oval.

Strongly Disagree
1 ◯
2 ◯
3 ◯
4 ◯
5 ◯
Strongly Agree

Section C: Perceived Ease of Use (PEOU)

11. 1. Learning to e-PCI on identify defects would be ease for me.

Mark only one oval.

Strongly Disagree

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Strongly Agree

12. 2. I would find it easy to peprared post-concreting inspection documentation and report by using e-PCI.

Mark only one oval.

Strongly Disagree

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Strongly Agree

13. 3. I would find the RFI progress work be flexible to use.

Mark only one oval.

Strongly Disagree

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

Strongly Agree

14. 4. It would be easy for me to become skilful at using e-PCI on post-concreting inspection on site.

Mark only one oval.

Strongly Disagree

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

Strongly Agree