POLITEKNIK UNGKU OMAR

SITE PLANNING INDICATOR ASSEMBLY USING AUGMENTED REALTIY (SPIA-AR)

MUHAMMAD SHAFIQ AIMAN BIN SHARIFFUDIN(01BCT20F3032)

A report submitted in partial fulfillment of the requirements for the award of the degree of Bachelor in Civil Engineering Technology with Honors

CIVIL ENGINEERING DEPARTMENT

SEP 2022

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ABSTRACT

Site planning is the most important stage of a construction project and must be completed before any construction work can start. Poor planning and an ineffective site planning system may cause project delays. The current method of site planning at the Loji Rawatan Air (LRA) Sungai Limau project uses Microsoft Project software for the site planning, but there is a lack of direct information, especially in the latest drawing or design amendment, and less accuracy in reading the latest amendment plan, drawing, or design using only 2D drawings. These methods are hard to catch visually and always cause errors in the ordering of goods, especially in terms of sizes, which contribute to delays in the progress of the project's planned work and will affect the cost.Three objectives are to be studied: first, to design the site planning indicator assembly by using augmented reality (SPIA-AR) to access project data; second, to develop the site planning indicator assembly by using augmented reality (SPIA-AR) to access project data; and finally, to test the effectiveness of the site planning indicator assembly by using augmented reality (SPIA-AR) to access project data. Objectives 1 and 2 used AutoCAD 3D and BlippAR to design and develop SPIA-AR; objective 3 used a quantitative method conducted by a survey. Data analysis uses SPSS. The results for objectives 1 and 2 show that SPIA-AR is successful in design and development. The results for objective 3 show that SPIA-AR is used to access project data; the average mean is very high in every effectiveness element; the > 4.80 average mean and the 80.6% average mean highest resulted from a lack of 3D visualization, which causes misunderstanding and poor communication that affects project success. The element on which > 90% of respondents agree the SPIA-AR access project data is efficient site planning to avoid project delays and overruns. The paired T-test showed that the effectiveness of site planning data project access using the SPIA-AR is high compared to the current method, resulting in a 2.11 difference means and a high agreement interpretation. Conclusion for the study: the SPIA-AR to access project data is a systematic medium that needs to be implemented for efficient site planning to avoid project delays and overruns.

Keywords: *Site Planning, Augmented Reality, Project Data, Revit, BlippAR*

ABSTRAK

Perancangan tapak merupakan peringkat terpenting dalam sesebuah projek pembinaan dan mesti disiapkan sebelum sebarang kerja pembinaan boleh dimulakan. Perancangan yang tidak baik dan sistem perancangan tapak yang tidak berkesan boleh menyebabkan kelewatan dan overrun projek. Kaedah perancangan tapak semasa di projek Loji Rawatan Air (LRA) Sungai Limau menggunakan perisian Microsoft Project untuk perancangan tapak, tetapi terdapat kekurangan maklumat langsung, hanya menggunakan lukisan 2D. Tiga objektif perlu dikaji: pertama, untuk mereka bentuk pemasangan penunjuk perancangan tapak dengan menggunakan realiti tambahan (SPIA-AR) untuk mengakses data projek; kedua, untuk membangunkan pemasangan penunjuk perancangan tapak dengan menggunakan realiti tambahan (SPIA-AR) untuk mengakses data projek; dan akhir sekali, untuk menguji keberkesanan pemasangan penunjuk perancangan tapak dengan menggunakan realiti tambahan (SPIA-AR) untuk mengakses data projek. Objektif 1 dan 2 menggunakan AutoCAD 3D dan BlippAR untuk mereka bentuk dan membangunkan SPIA-AR; objektif 3 menggunakan kaedah kuantitatif yang dijalankan secara tinjauan. Analisis data menggunakan SPSS. Keputusan untuk objektif 1 dan 3 menunjukkan bahawa SPIA-AR berjaya dalam reka bentuk dan pembangunan. Keputusan untuk objektif 3 menunjukkan bahawa SPIA-AR digunakan untuk mengakses data projek; av. Purata T adalah sangat tinggi dalam setiap elemen keberkesanan; min purata > 4.80 dan purata purata 80.6% tertinggi disebabkan oleh kekurangan visualisasi 3D, yang menyebabkan salah faham dan komunikasi yang lemah yang menjejaskan kejayaan projek. Elemen di mana > 90% responden bersetuju data projek capaian SPIA-AR ialah perancangan tapak yang cekap untuk mengelakkan kelewatan dan overrun projek. Ujian-T berpasangan menunjukkan keberkesanan capaian projek data perancangan tapak menggunakan SPIA-AR adalah tinggi berbanding kaedah semasa, menghasilkan min perbezaan 2.11 dan tafsiran persetujuan yang tinggi. Kesimpulan untuk kajian: SPIA-AR untuk mengakses data projek adalah medium sistematik yang perlu dilaksanakan untuk perancangan tapak yang cekap bagi mengelakkan kelewatan dan overrun projek.

Kata kunci: Perancangan Tapak, Realiti Ditambah, Data Projek, Revit, BlippAR

LIST OF CONTENT

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

A huge industry, construction includes a wide range of undertakings. There are industrial projects, commercial projects, and residential construction projects. Every project type has distinct difficulties and calls for a particular set of construction employees' talents. There are a variety of construction projects, each with its own special difficulties. There are numerous projects, from little residential ones to huge business and industrial ones. Building projects can be divided into many categories depending on their purpose such as residential, commercial, or industrial, size such as small, medium, or big, or complexity simple or complex. There are several projects, ranging from little improvements to big business expansions.

New buildings and renovations to existing homes are both types of residential construction projects. A new coat of paint to a total gutting and renovation of existing property are just a few examples of the many different remodeling or renovation projects that can be undertaken. There are numerous commercial construction projects, including those for hotels, restaurants, and office buildings. Complex commercial projects can involve numerous contractors and subcontractors. Construction projects for businesses often have a wider scope than those for homes. They might involve brand-new buildings, remodeling, or additions. Commercial projects can be found in a variety of locations, such as office buildings, shops, dining establishments, and lodging facilities. Commercial projects frequently need the knowledge of a certified general contractor because they are frequently complex. Industrial construction projects fall into two categories is new construction and renovation also remodeling. Industrial construction is merely one form of construction project. Both new building and remodeling/renovation projects have perks and problems.

Modern industrial, commercial, management change, and information technology (IT) projects need the planning, coordinating, and administration of numerous complex and varied operations. One thing that unites all projects is the creation of new businesses from concepts and actions. The activities and events leading up to completion can never be foreseen with a hundred percent (100%) confidence due to the ever-present element of risk and uncertainty. There are several instances of projects that have been abandoned before completion, finishe late, or have greatly surpassed their costs. All too often, such disasters occur in all kinds of undertakings in business, industry, and especially the governmental sector.

Project management seeks to foresee or predict as many risks and issues as feasible. It also plans, organizes, and controls operations to ensure that projects are effectively finished despite all risks. This process should begin before any resources are committed, and it should continue until all work is completed. The project manager's main objective is to complete the project on schedule, to the satisfaction of the project sponsor or purchaser as well as all other significant stakeholders, without exceeding the allocated budget or allotted financial resources.

In order to raise the level of living and improve the quality of life for Malaysians, the construction industry is a significant and productive sector of the country's economy. Construction technology innovation has increased as the sector gets ready for the fourth Industrial Revolution (IR 4.0). The construction sector has not done a good job of managing technology succession planning. To build projects more affordably, the construction sector needs to make a radical move to digital procedures. Companies that do not adapt to this change will experience considerable productivity losses, which will make it difficult to continue long-term corporate development. Productivity, agility, innovation, user experience, quality, prices, and income are just a few of the sectors that have benefited from digitization. The construction industry's reluctance to accept new technologies has been a source of worry, despite considerable developments in building methods, materials, job site automation, scheduling strategies, and collaboration platforms like Building Information Modelling (BIM). The construction sector now uses augmented reality (AR) because it streamlines each step of the project. Augmented reality is one of the finest technical developments to hit the construction sector. There are several benefits to employing augmented, especially in site planning.

Loji Rawatan Air *(LRA)* Sungai Limau, also known as "Project Menaiktaraf Loji Rawatan Air Sungai Limau," is located in Baling, Kedah Darul Aman. was suggested in the year 2019 and the formal contract agreement was issued in August 2020, giving the project the go-ahead to be completed. To aid the region with a water deficit, the project is the classification of Bajet Kedah 2020. *LRA* Sungai Limau experienced several delays as a result of Covid-19, which occurred, and to stop the project before it started, it resumed with a new official document in August 2021. To make the paperwork for the zone categorization easier, *LRA* Sungai Limau is divided into numerous systems.

At *LRA* Sungai Limau, structures such as the flocculation and sedimentation tank, the rapid gravity sand filters and filter gallery, the aerator tank, the administration building, and the raised backwash tank will be constructed. Pipe installation is also a part of the Sungai Limau *LRA* Package. A total of 49 km of the project's pipeline connects *LRA* Sungai Limau, where the water intake equipment will be, to the project's end customers in Kg. Batu 8 Tanjung Pari and Kg. Titi Teduri, all of which are situated in Baling. The Development of *LRA* Sungai Limau is divided into numerous systems such as Bakai System, Kg. Bok Bak System and Mukim Siong System.

In Bakai system, there will be a site where pipe installation activities here involve 300-mm MS pipes from Simpang Kg. Kejai to Rumah Pam Bakai (3.5 km), 200-mm MS pipes from Rumah Pam Bakai to Tank Kg. Jernang (4.5 km), and 400-mm MS pipes from Simpang Bukit Sembilan to Tawar (3.5 km). In this Bakai System, the pipe installation distance is approximately 11 km.

In Kg. Bok Bak system, the water treatment plant in Sungai Limau will filter the water and distribute it to the entire surrounding area using pipes that are 19 km long and 500 millimeters in diameter. Next, a 500-mm MS pipe will be installed from LRA Sungai Limau to Kg. Tas Tank along 10.985 km. Next, a 500-mm MS pipe will be installed from *LRA* Sungai Limau to Titi Tenduri Tank (7.757 km). In addition, there will be a site where pipe installation activities here involve a 150-mm MSCL pipe from Simpang Kg. New Tank Bok Bak to Kg. Jernang Tank (3.65 km); a 150-mm MSCL pipe from Tank Pak Bong R1 to Kg. Bok Bak Suction Tank (4.5 km); and a 200-mm MS pipe from Kg. Sadek to Simpang Landak (3.2 km). In this Bakai System, the pipe installation distance is approximately 31 km.

In Mukim Siong System, the water treatment plant in Sungai Limau will filter the water and distribute it to the entire surrounding area using pipes that are 23.775 km long and have diameters of 500 mm MSCL, 350 mm MSCL, 300 mm MSCL, 200 mm MSCL, and 150 mm MSCL. Next, a 300-mm MSCL pipe will be installed from LRA Sungai Limau to the Banggol Saga B5 tank along an 8-kilometer route. Following that, a 500-mm MSCL pipe will be installed from the Banggol Saga B5 suction pumphouse to the Kg. Bukit Sebelah R12 tank (5.275 km). In addition, there will be a site where pipe installation activities here involve 300- to 400-mm MSCL pipes from Kg. Bukit Sebelah R12 Tank to Kg. Weed Tank (4 km). Kg. Lalang Tank will build a new 1.0 megaliter tank. In addition, we installed a 200-mm MSCL pipe from Kg. Hill Next to Kg. Sri Ketangga B12 Tank (3.5 km) and a 1-mm MS pipe from Kg. Sri Ketangga B12 Tank to Tanjung Pari R13 Tank (3 km). In the Mukim Siong system, the pipe installation distance is approximately 31 km. The site focuses to study at *LRA* Sungai Limau, Baling, Kedah Darul Aman. The site construction is constructed is under construction now.

Site planning is the most important stagethe in project management life cycle. Site planning must be completed prior to starting any future construction work. The conclusion of site planning sets the framework and rhythm for all succeeding construction practices. If you look at the definition of site planning, you can understand how important this activity is to the building process. Before engineers begin their job, a series of steps known as site planning must be completed. Poor planning may cause project delays. The current method of site planning in Loji Rawatan Air *(LRA)* Sungai Limau, also known as "Projek Menaiktaraf Loji Rawatan Air Sungai Limau" are used a method that uses the Microsoft project. However, some issues with the *LRA* Sungai Limau project's actual site planning methodology have developed, such as ordering goods that do not comply to requirements and not having a useful progress plan.

The Sungai Limau *LRA* project needs to know how to apply Augmented Reality (AR) for site planning. In recent years, it has grown in favor as a tool for the construction sector as well. With the use of this technology, people can see virtual items superimposed on their perspective of the real world. For site planning, the *LRA* Sungai Limau project plans to be using Augmented Reality (AR). It has gained popularity as a tool for the building industry in recent years as well. People can perceive virtual objects superimposed over their perception of the real

world with the use of this technology. Augmented reality refers to an improvement of the real environment that is made possible by overlaying digital data.

1.2 Problem Statement

One of the most prevalent issues that subcontractors encounter when beginning a site preparation project is a fundamental lack of planning. Each location has a different character, slope, topography, and overall land layout. Loji Rawatan Air (LRA) Sungai Limau, also known as "Project Menaiktaraf Loji Rawatan Air Sungai Limau," was constructed at Baling, Kedah Darul Aman, by Pembinaan Tetap Teguh Sdn. Bhd. (PTT) and using Microsoft Project for the preparation of the site plan. No matter how competent a professional is, every preparation task will invariably have its own set of challenges. Inefficiency is a direct result of inadequate planning. Even if the contractor you choose just shows up on site and wants to get started right immediately, even with a team of specialists wearing matching uniforms, there is a problem. If you choose the right team, they will want to visit and offer some sort of advice. They won't just show up and start setting up the site since they can't know which equipment will function best or what strategy will work best before they have a look at the location.

Ineffective site management may cause project delays. There may have been completed projects with time overruns on every building project in the world. When a construction project is faced with a limitation, it affects the project's three main components time, cost, and quality. Time, cost, quality, and project scope are the main success criteria in project management. Because they lacked effective management at the time, the majority of projects in the past had trouble with those essential indicators of finishing a project within the stated time frame with a constrained budget. Current method only focus by 2D drawing and hard to catch the visual. Project management is, however, made more manageable with the IoT application by digitally tracking the development of the entire project through the visualization 3D model. Project management can better employ project resources, keep track of project progress, monitor vehicle equipment, identify faults and conflicts sooner, deliver real-time reporting, and control project schedules and expenses thanks to the digitization of 3D models.

The current method always causes several problems for *LRA* at Sg. Limau, Baling, and Kedah. The main issue is a lack of direct information, especially in the latest drawing or design amendment, and less accuracy in reading the latest amendment plan, drawing, or design will cause errors in the ordering of goods, especially in terms of sizes. All these problems may cause delays in the progress of planned work. Therefore, the site preparation indicator assembly should be created and developed for a better project management solution in terms of site preparation planning systems. This will enable the project team to obtain information about the location, operator, and activities that need to be completed anytime, anywhere.

The quantitative survey method, which entails interviewing people. Non-numerical data is collected and analyzed using the qualitative technique. to comprehend ideas, viewpoints, or experiences. It may be utilized to get detailed knowledge about a subject or come up with fresh research concepts. Five employees of PTT Infra were questioned about the survey findings for pre-test, and 90% of them agreed that augmented reality should be used to assemble site planning indicators since it is better at regulating time, expense, and site planning. The site planning indicator assembly by using Augmented Reality (AR) must be designed and developed for efficient site planning to align with the IR 4.0 intends to create a viable a digital visualization 3D model

1.3 Objective Of Study

The aim of this objective is to develop the site planning indicator assembly using Augmented Reality (SPIA-AR) to access project data for efficient site planning to avoid project delay and over cost. Hence, to achieve this aim, the objectives listed are:

a) To design the site planning Indicator Assembly using Augmented Reality (SPIA-AR) to access project data.
b) To develop the site planning Indicator Assembly using Augmented Reality (SPIA-AR) to access project data.
c) To test the effectiveness of site planning Indicator Assembly using Augmented Reality (SPIA-AR) to access project data.

1.4 Scope of Study

According to Figure 1.1, the case study focuses on Sungai Limau, Baling. With the help of this application, project managers, site engineers, and site supervisors will be able to learn about the precise duties that must be carried out and the tools that must be used at the project site. These app details will be available for users to utilize for administrative and informational purposes. To make sure that the user will be able to do that work by using the Site Indicator Assemble program, this application will have a lot of potential to be utilized in any site assembly indicator for construction project. This program will be utilized to save data that is BilppAR.

***Figure 1.1**: The location of Sungai Limau Water Treatment Plant, Baling (Google Maps)*

1.5 Significant of The Study

According to studies, lack of planning is one of the errors that project management frequently commits. The Site Indicator Assembly application may assist project managers and engineers with accessing information about the location, operator, and activities that need to be completed at any time and from any location. This application makes it simple for users to find out project details and how it's done.

Without having to interact with the management, project managers, engineers, and other interested parties will also be able to learn more about the function and placement of the machine utilizing this application. This will save time and avoid project delays since all tasks involving the use of machines may be arranged in advance. Users of this application may also guarantee that the essential work will be accomplished perfectly. This is due to the ease with which clients may get results when working on a building site.

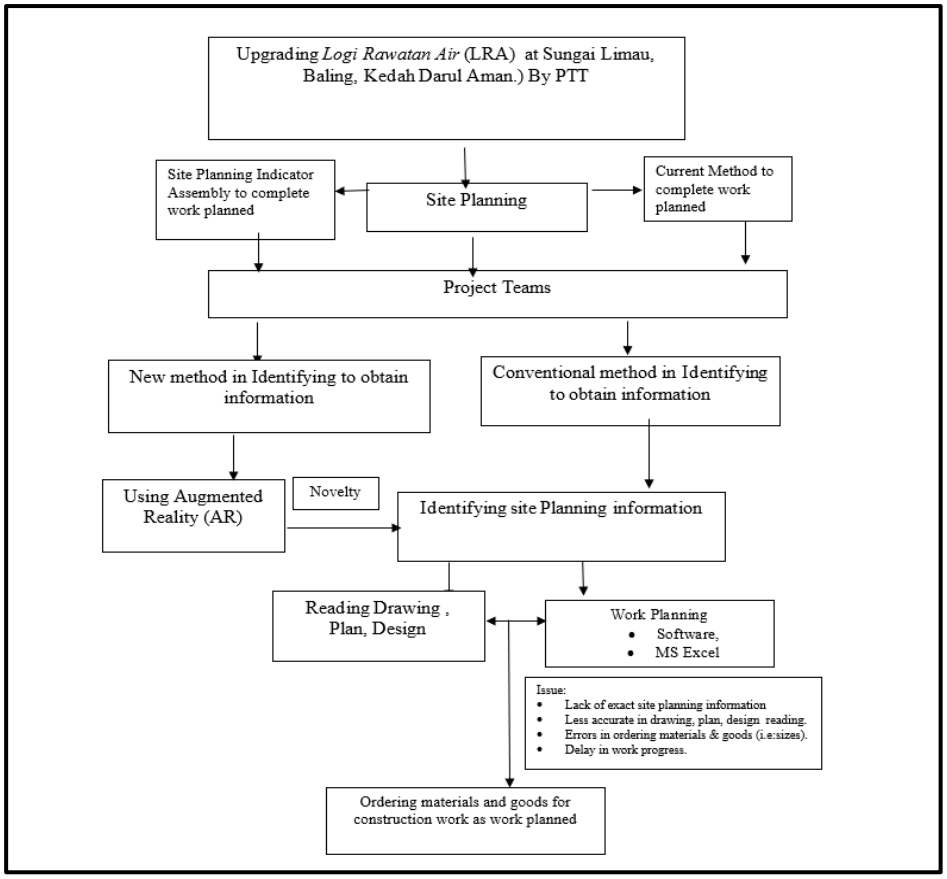

Figure 1.2: *Significant of Study*

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The influence of modern technology on a nation at the vanguard of industrialized nations is astounding. Make use of Malaysian development construction technology to simplify all of the work that has to be done. It is still feasible to minimize the usage of conventional building methods in this technical area. As a consequence, the use of technology in the construction industry will be advantageous since it may increase productivity and save time. Furthermore, it can be used anywhere and makes daily work easier with the touch of a finger thanks to innovations like applications or software systems. In order to identify current research knowledge, the researcher will present a summary of the literature on the conclusion of an ongoing study in this chapter. Predicting a superior resolution to the issue is also suitable in addition to the previous point. A better resolution for the researcher can also come from a prior case study with the other researcher.

2.2 Project Management Problem

Construction delays are described as time overruns that occur after the project's scheduled completion date. These delays can have an effect on both the owner and the contractor, notably in terms of money. Each building project needs to be highly productive. Construction project constraints will have an effect on three key project components, including time, cost, and quality, and as a result, they will reduce productivity. Any project's whole building phase is a crucial time period where a lot of unanticipated events might happen. The cost and completion time of a building project will increase if the unanticipated component that caused the issue is not identified.

There will be delays throughout the project as a result of inadequate planning in the beginning. As a result, skilled labor and a contractor are needed, especially for large and mega projects. The project plan may be accelerated and time burn during delays can be overcome with effective planning and management. According to a prior study, there are a variety of variables that contribute to building project delays in rural locations.

2.2.1 Site Condition

The site condition, which includes subsurface conditions and activities that start at the commencement of the construction project, is one of the elements that might affect the completion time of a construction project. Since the state of natural ground cannot be predicted, comprehensive research and preparation are necessary before a building project is started in order to avoid unforeseen ground problems. There are various difficulties for rural builders because not all construction locations have level ground. The following are some of the challenges in the scenario such as uneven ground, obstruction objects etc utilities and, also the slope.

***Figure 2.1**: Site Condition (Source from Pembinaan Tetap Teguh)*

2.2.2 Internet of Things

The Internet of Things (IoT), a cutting-edge concept for the Internet, was first presented in 1999 by Kelvin Ashton. 2009. It is said to have the ability to connect items over the internet to build a platform that is used to carry out certain tasks Al-Qaseemi et al., 2016. It takes use of internet connectivity and everything around to connect and interact with one another in order to carry out any specific task via the network Gershenfeld et al.,2004. It is a method for making it possible for environmental items to communicate online Gubbi et al., 2013. They used the device's built-in wireless connection to implement everything with everyone at all times and in all places. Additionally, this capability makes it simple to link to the entire environment, which makes using the Internet for monitoring and management easier Ashton, 2009. The application layer, the perception layer, the network layer, and the physical layer are the four levels that makeup IOT in theory.

The perception layer, on the other hand, refers to technology like sensors and

gadgets that connect with other items. The application layer relates to common practices like smart cities, smart transportation, and intelligent housing. Network communication and coverage are both a part of the network layer. The physical layer is made up of the hardware, which includes smart appliances and other gadgets (Kumar, S.A et al., 2017).

Three areas of challenges may be identified when introducing new technology: the introduction strategy, the lack of acceptability, and the lack of knowledge and experience. This study seeks to assess the degree to which construction parties are aware of the application and relevance of IoT. It then analyses the difficulties in integrating IoT into projects and, lastly, establishes the key difficulties in integrating IoT into the construction sector Bari et al., 2019.

Implementing IoT in the construction sector has several advantages. Better execution monitoring, efficient control, greater quality, reduced prices, and quicker turnaround times are a few of these. Real-time data analytics are now accessible, and their use has grown to include making rapid judgements Ning, H.S. et al., 2010; Dave, B et al., 2017. Furthermore, by implementing effective structural monitoring, it enhances crisis management and emergency response Zhao et al., 2018. Environmental problems including trash management, pond contamination, and flood concentration analysis may all benefit from the Internet of Things Wei, C. and Li, Y., 2017.

IoT has been extensively employed in a number of industries, including infrastructure, business, and consumers Yan-Lin, 2010; Perera et al.,2017 It is challenging for the construction industry to absorb and embrace new technology because of the complexity of building projects and the high risk of failure, which restricts the applicability. IoT has been employed in the construction sector despite these difficulties, with one of the most popular applications being the monitoring and control of project executions in a range of projects including bridges, trains, tunnels, onshore and offshore facilities, to name a few Zhong et al., 2017.

It has also been utilized to deliver instantaneous safety alerts and danger identification while providing building performance monitoring during disasters (Ding et al., 2013. Chandanshive et al. 2017 state that they looked into a variety of IoT applications in the building industry, including smart city planning, smart housing, and smart transportation. The most widespread IoT applications in the construction sector, according to BIM Engineering U.S. 2018 as shown in Table 2.1 below.

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BIM Engineering U.S. 2018	
Bil.	Widespread IOT applications in the construction sector,
1	Reduce administrative expenses by providing data-driven options that aid in the production of accurate forecasts, with the data being used to make quick and precise decisions.
2	Real-time monitoring and observation In order to monitor the building process and make precise judgements, data collected from sensors and embedded systems can be employed.
3	For on-site machinery, preventive maintenance is crucial since every breakdown is tracked by the embedded system and sensor to alert the operator to the need for maintenance
4	Monitoring of human resources: IOT helps keep track of the anticipated labour hours for every given task.
5	By supporting decision-makers in lowering cost overruns brought on by excessive use of materials and machinery, construction management IOT helps to reduce downtime and provides advanced communication with all things such as materials and vehicles.
6	On-site safety: IoT enables the surveillance of workers on-site and the monitoring of their movement, which helps identify any potential risks.

Table 2.1: *Widespread IoT applications in the construction sector (BIM Engineering U.S. 2018)*

2.3 The Fourth Industrial Revolution (IR 4.0)

Each industrial revolution from the start of the industrial age in the 1700s has contributed significantly to the growth of modern development. The introduction of mechanical looms, which replaced agricultural industries and were driven by water and steam on mechanical machinery, in the 1700s significantly improved the economic structure. The introduction of electrical electricity in the 1870s led to the development of a significant system known as mass manufacturing. These revolutions were dependent on people being able to do more things thanks to an increase in human

capacities.

The Third Industrial Revolution began in the 1970s with the development of electronics. The transition from analogue electrical and mechanical equipment to modern digital technologies is referred to as the "Digital Revolution." The Digital Revolution, in which people and technology were intertwined, served as the foundation for the Fourth Industrial Revolution (IR 4.0). The technological advance has found novel methods to showcase its skills by fusing the boundaries between biological, digital, and physical things (Davis.,2018). In addition to introducing contemporary methods to help every sector of business, the revolution also promotes sustainability, with renewable energy and energy efficiency serving as two crucial pillars (Hidayatno Aet al., 2019).

Despite the challenges of implementation, renewable energy still accounts for 19.2% of consumption (Conti Jet al., 2016), and energy efficiency is impacted by technology advancements in the sector. The goal of IR 4.0 is to create an efficient and sustainable manufacturing system that is integrated into a sustainable system at a greater degree of complexity (Carvalho Nubia, et al., 2018). (DeMartini M, et al., 2017). Through the use of Industry 4.0, all three aspects of sustainability—social, economic, and environmental—are recognized in the development of a sustainable industry and exploited for long-term competitiveness (Stock et al., 2016). In order to have a short- and long-term influence on sustainability, it is crucial to take tactical, operational, and strategic elements into account (Carlos Oliveira Cruz PG, et al., 2017). By concentrating on areas of specialization, the advancement has changed industrial processes, creating favorable economic possibilities. The German government, which came up with this future notion, supports it by approving the industrial process automation. With the intention of promoting IR 4.0 adoption inside the German manufacturing sectors, "Industries 4.0" is a phrase for the industrial development process made up of automation and data exchange was the first made public (Alalus WS, et al., 2015). An assortment of members from varied backgrounds came together to establish this working group. The German federal government included the IR 4.0 workgroup's strategic application work plan into its 2020 High-Tech Strategy in order to increase German industrial rivalry internationally (Marr B., 2016).

"IR 4.0" refers to the industry's extensive adoption of information and communications technology (ICT), digitalization, and automation. Cyber-physical

systems, the Internet of Things (IoT), cloud computing, and cognitive computing are some of these technologies. Three earlier revaluations that had a substantial influence on the industry's practices and production have all been totally reversed. Before considerable computerization started the third major transition, electricity was the transforming energy in the nineteenth century, and it became more dominant in the twentieth. Three earlier revaluations that had a substantial influence on the industry's practices and production have all been totally reversed. Before considerable computerization started the third major transition, electricity was the transforming energy in the nineteenth century, and it became more dominant in the twentieth. In the twenty-first century, the industry will enter the IR 4.0 period with intelligence as its number-one 17 asset. The talents that blur the lines between the physical, digital, and biological scopes are what constitute IR 4.0. (A.A.F. Saldivar et al., 2017; J. Wan et al., 2015).

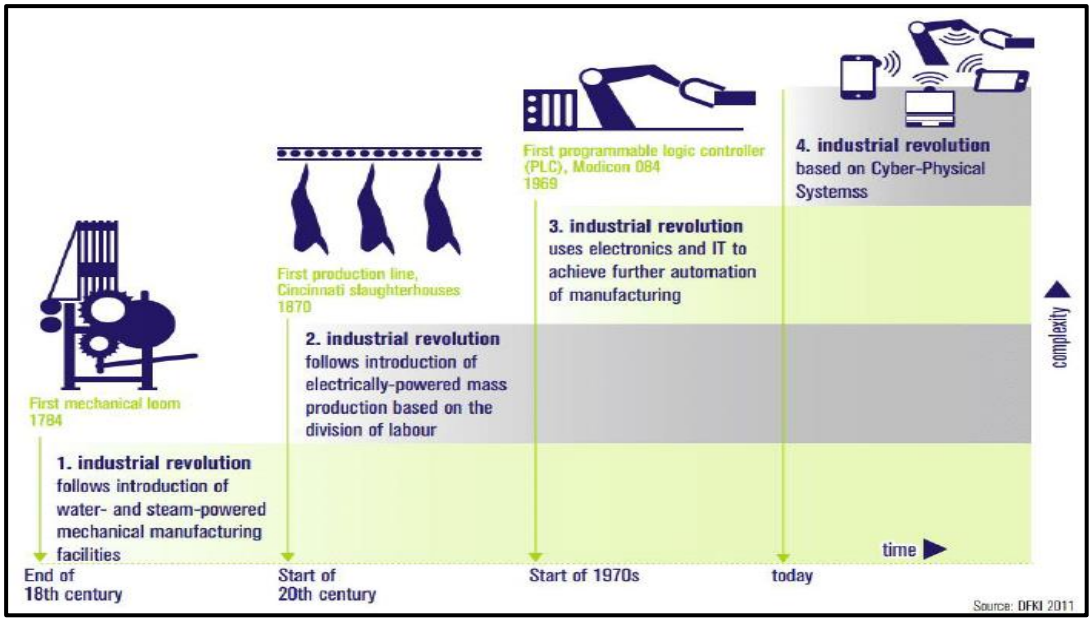


Figure 2.2: *the four stages of industrial revolution*

As demonstrated in Figure 2.2, the fundamental ideas of IR 4.0 were originally released in 2011. It will do so more quickly and with an even greater degree of irreversible change than its three forerunners. There is no official definition for IR 4.0, despite the overemphasis on the perception of it. However, it can also be described as "a new level of value chain organization and management across the lifecycle of products" or "the integration of complex physical machinery and devices with

networked sensors and software, used to predict, control, and plan for better business and societal outcomes" (N. Kudriashov et al., 2016)

2.4 Augmented Reality (AR)

In order to see the full nature of an object or project utilizing a head-mounted display, tablet, or phone, augmented reality, often known as AR, duplicates the real-world environment into a 3D simulation. By displaying an accurate representation of the building site, augmented reality (AR) may help the project team track and monitor the work's progress as well as conflicts and mistakes. The information from the AR helps the project team and construction personnel understand how the building site is progressing according to plan.

2.5 Site Planning

Before beginning any additional building work, site planning must be finished. For the remainder of the construction operations that take place on site, the success or failure of site preparation sets the scene and tone. The term "site preparation" itself is sufficient to illustrate the significance of this task in the building-construction process. It is also strongly advised to use construction schedule software because it has received more attention recently (Chitkara, 2015).

Additionally, a series of operations and tasks that must be finished prior to engineers starting their job are referred to as site preparation (Construction, 2020). For instance, the existing building must be torn down if new development is needed on a site that was once used as a gym house. The site preparation will be made simpler and a new building will be built as a result. All tasks are easy to do when the location is adequately prepared. The site must be prepared if a structure to be constructed near numerous subterranean pipelines. By preparing the site, contractors may better understand where to dig and where not to. It will prevent any issues brought on by subterranean pipe bursts. Using project management in construction is crucial because it lowers the likelihood of mistakes and delays, which can result in expensive reworks (Construction, 2020). The following five phases are necessary to establish a site preparation strategy for building projects.

2.5.1 Site Clearing

Site clearance is the initial stage in site preparation. It is necessary to grade and clean the entire

site. Trees are being felled, buildings are being destroyed, and any subsurface utilities are being removed. Because they can affect the next building process, these obstacles shouldn't have have existed in the first place. The success of the project may be in jeopardy if the clearance of the site is unsuccessful. Therefore, it needs to be resolved once and for all.

2.5.2 Site Surveying

The task of surveying the site and pinpointing the precise placement of the future road project or other constructions falls to a surveyor. Although it is frequently necessary for zoning and permitting procedures, surveying land may not be an option. The process of translating the contractor's set of drawings into an accurate depiction of the project site is known as surveying.

2.5.3 Soil Testing

Soil testing is one of the most crucial steps that must be taken before the land is bought. In order to evaluate the soil's capacity for water absorption and assess its structural strength, its primary composition should be identified. The site engineer must insist on carrying out all relevant soil testing procedures before starting any structural construction. The only choice could be to hunt for a different site with soil suited for the projects if the soil at the current location is unsuitable for future initiatives

2.5.4 Site Plan Design

After the soil testing is finished, the required drainage and septic tanks should be erected. The design will then be altered to show where the fixtures and septic tanks are located. A permanent record of the subsurface spaces should also exist. It is believed that a building site is living and breathing. As a result, it alters every day as the locations of the water tanks gradually move. A lot of times, subterranean rock formations induce changes. It has been demonstrated that a good crew scheduler may be a helpful tool when creating a site plan. The site layout also shows all recently built access roads for construction equipment and temporary storage sites. The building's future location is also shown on the site plan. Contrary to previous site preparation steps, revisions are made in the office, and the site plan is constantly updated in the field.

2.5.5 Site Investigation

Geotechnical site investigations are carried out to characterize the rock, soil, and groundwater conditions of any proposed sites. A geotechnical site investigation is definedas evaluating site conditions and collecting data in order to construct and structure's foundation. Typical

examples include parking lots, bridges, roads, and buildings.

2.6 Site Monitoring

It guarantees that the project's progress and the atmosphere of the building site remain smooth and on track at all times, site monitoring is a crucial step in the construction process (Institute, 2017). Monitoring of human and machine activity on a construction site is separated into two categories: tracking worker and machinery activity (Boje et al., 2020). The goal of using IoT for monitoring is to help the project team remain on schedule and automatically record the vast amounts of data over the whole project lifecycle that they are unable to handle manually (Kim et al., 2015). Additionally, data from tracking machines and people is gathered through the Internet of Things utilizing GPS, RFID, sensors, and drones.

The national organization responsible for standardization and accreditation is called Department of Standards Malaysia (STANDARDS MALAYSIA). The Department's primary responsibility is to foster and promote standards, standardization, and accreditation as a way to boost industrial efficiency and development, benefit public health and safety, safeguard consumers, facilitate domestic and international trade, and advance international cooperation in the field of standards and standardization. Malaysian Standards are created through a consensus-building process by committees made up of a fair representation of producers, users, consumers, and other interested parties, depending on the topic at hand.

2.7 Building Information Modelling (BIM)

A recent technological development in the construction sector, building information modelling (BIM), enhances the planning, design, construction, and documentation processes to create, analyze, build, and manage the project lifecycle (Ahmad Latiffi et al., 2014). To see the full image of the project, in which all project information from various aspects is combined, the process begins with producing, utilizing, and exchanging project information via a digitalization system of a 3D model (Tang et al., 2019). "Visualization, coordination, simulation, optimization, and plotting abilities" are the five major traits of BIM (Alaloul et al., 2018). BIM is also helpful for enhancing project performance by spotting conflicts and mistakes early on before the project starts and for enhancing teamwork, communication, and decision-making. The digitalization system and data integration in cloud computing are two IoT components that are crucial for ensuring information and software compatibility in relation to IoT applications.

2.8 Stakeholders in Construction Project

Construction project stakeholders are individuals or groups/organizations who have some aspects of right or ownership in the project and can contribute to it; or will incur or justifiably perceive they will incur a direct benefit or loss as a result of either the works during the project or the outcome of the project. The narrow definition of stakeholders is only useful for identifying those stakeholders with direct stakes and economic relationships with the project and excludes those without direct economic relationships but may be capable of influencing the project implementation process. Customers can alter their purchasing patterns, suppliers can alter how they manufacture and distribute their products, and governments can alter the laws and regulations. The secret to a company's long-term success is ultimately managing relationships with internal and external stakeholders.

2.8.1 Pembinaan Tetap Teguh (PTT)

Pembinaan Tetap Teguh (PTT) is one of the Malaysia's leading constructions companies that specialized in Earthworks and Infrastructure works. With their focus on green and environmental - friendly construction, work ethics, occupational health and safety, PTT offers competitive creative solutions not least for the most challenging and impactful assignments. Pembinaan Tetap Teguh (PTT) guiding principle is to provide genuine value to its clients and engage them in close, long-term partnerships that result in exceptional performance in the upkeep, innovation, and development of the built environment. PTT as a main contractor oversees and manages the construction of a building project. The work is delivered under a contractual agreement. There are a number of forms of contract and it is important to understand, the role of the Main Contractor will vary depending on the type of construction contract.

2.8.2 Pembinaan Tetap Teguh Jentera (PTT INFRA)

Pembinaan Tetap Teguh Infra (PTT INFRA) is a subsidiary company under Pembinaan Tetap Teguh (PTT). A subsidiary is a company that is owned or controlled by a parent or holding company. The main scope of this subsidiary company is to manage all the equipment’s including repair and service under Pembinaan Tetap Teguh. PTT INFRA also own equipment and rent their equipment’s to holding company which are PTT. In PTT, there are about 400 equipment’s including rental.

2.8.3 Stakeholders Involved

Kedah State of Government

Kedah Government is capitalized in Alor Star where all the majority of sector offices are based up. State of Kedah has purposed and announced the improvement of Water treatment Plant of Kedah in the Budget Plan for Kedah of 2020.

2.8.3.1 Malaysian Public Work Development (JKR)

Jabatan Kerja Raya JKR is one of our clients which is involved in this project the role played by them is giving us permission to place our pipe at their Right-of-Way (ROW), Provides with resources towards the project. They are the Inspector of Work for this project.

2.8.3.2 Syarikat Air Darul Aman (SADA)

SADA is another one of our clients which plays a major role in this development working side by side to help us complete this project in the end we will hand over the project to SADA for them to provide the water to the residence area. Provides with resources towards the project. SADA are the Client of this project.

2.8.3.4 Sepakat Setia Perunding Sdn Bhd

Sepakat Setia Perunding plays a role as our consultant which gives us advice and guidesus towards the start until the completion of the project. Provides consulting towards anactivity as for no failure to happen.

2.8.3.5 Widad Builders Sdn Bhd (WIDAD)

Widad builders plays a role as a main contractor who has been chosen by the clients tocarry out the project of the Water Treatment Plant. the company that will provide the funds for the project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter's aim is to outline the strategies and tactics used to manage contract-related papers as effectively as possible. The study location, sample size, demographic, research design, data collection, data analysis, and hypothesis were all covered in this chapter. Additionally, in order to achieve the goals of this study, data from primary sources (such as a survey questionnaire) and secondary sources will be gathered (a literature review). In order for others to learn from and build upon in future research, many approaches or discoveries from this field are mainly published in journals.

Using this tool, the quantity surveyor at the main office, the consultant, the site manager, and any related staff members may all be kept informed about the progress of the work as well as documents like progress claims, drawings, and takings. You may easily access any project-related files or photographs using this application at any time and from any location. This program is designed to boost productivity and save time without causing any delays. to evaluate the inadequacies of the Site Indicator Assembly and how effectively, in comparison to the conventional technique, it performs at resolving conflicts between project goals and headquarters at the construction site

A number of questionnaires will be given to each member of the PTT contract department team and the on-site crew. Then, they may comment on how well the database handled the problem at the construction site between the offices. Before the questionnaire is distributed to all pertinent PTT employees, workers should download the mobile application database to their smartphones and install the database system on the construction site. To achieve the study's goals and objectives, the research method is divided into four basic steps, namely research literature review, study the site and identify the related documents, the design thinking process and data analysis

3.2 Design Research

The framework of the research methods and procedures a researcher selects is known as the research design. Because of the design, researchers may concentrate on choosing procedures for their investigations that are suited to the topic matter. Planning and observation require this methodology. It is important to monitor the implementation process to spot any potential issues early on. If there is a crucial problem that is a significant reason why the task cannot be implemented, changes must be made. Last but not least, controls must be put in place to guarantee a consistent flow.

The design of a research topic identifies the style of study, including experimental, survey, correlational, semi-experimental, review, and its sub-types, experimental design, research problem, and descriptive case study. Data gathering, measurement, and analysis are the three primary types of study designs. The research design will be determined by the type of research challenges a business is experiencing, not the other way around. Which tools to use and how to apply them are decided upon during the design phase of research.

Effective research often reduces data bias and boosts confidence in the veracity of the information gathered. In experimental research, the ideal outcome is typically thought to be a design that results in the lowest possible margin of error. The fundamental components are:

i. Accurate purpose statement
ii. Techniques to be implemented for collecting and analyzing research
iii. The method applied for analyzing collected details
iv. Type of research methodology
v. Probable objections for research
vi. Settings for the research study
vii. Timeline
viii. Measurement of analysis

As a result, the goal of design research is to discuss and clarify the methodology employed by the researcher in order to create a plan of study that enables correct evaluation in carrying out the usability utilizing the digital tracking system for site indicator assembly. Figure 3.2.1 below show the flow of research design to design and develop the site planning indicator assembly (SPIA-AR).

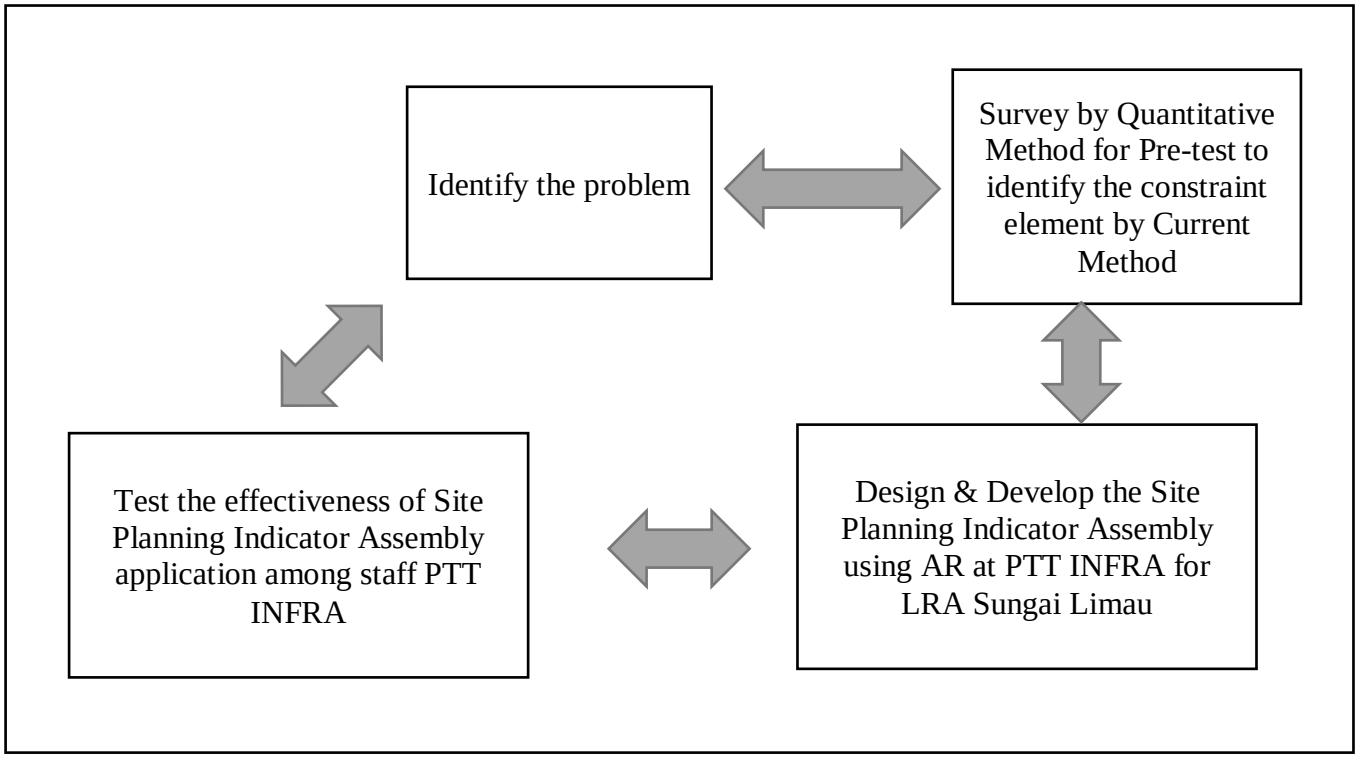


Figure 3.2.1: *Flow of Research Design*

Table 3.1: Design Research

Objectives	Method	Instrument	Analysis	Expected outcome
1. To design the site planning Indicator Assembly by using Augmented Reality (SPIA-AR) to access project data.	Photo by PDF and JPEG, also BlippAR	i. Quantitative ii. Google Form iii. Respondents	• 3D Augmented Reality • BlippAR	To design the site planning Indicator Assembly using Augmented Reality (SPIA-AR) to access project data for efficient grasp in final site planning.
2. To develop the site planning Indicator Assembly by using Augmented Reality (SPIA-AR) to access project data.	Develop	i. Revit ii. BlippAR	Efficient for site planning and saving time and cost.	To develop the site planning Indicator Assembly using Augmented Reality (SPIA-AR) to access project data for efficient site planning to avoid project delay and over cost.
1. To test the effectiveness of site planning Indicator Assembly by using Augmented Reality (SPIA-AR) to access project data.	Survey	i. Quantitative ii. Questionnaire iii. Respondents iv. Google Form	SPSS Software i. Reliability Test ii. Frequency Analysis iii. Descriptive Analysis • Excel-Average mean • Paired T-test	To test the effectiveness of site planning Indicator Assembly using Augmented Reality (SPIA-AR) to access project data for efficient site planning.

3.3 Development Of Research

In this study, the development of the research is represented by a research framework. The flow of research framework development for this project is shown in Figure 3.3.1. The diagram shows the progression of research from literature review through problem statement identification, innovation ideation, system or product invention, testing, and efficacy assessment.

Through the process of finishing of the study, four (4) phases of approach will be used:

Phase 1-Problem Discovery and Literature Reviews.

Phase 2-Method of collection data

Phase 3 –Production of System (Testing of Data, Analysis and Interpretation of Data)

Phase 4- Final Outcome (Achieve the objectives).

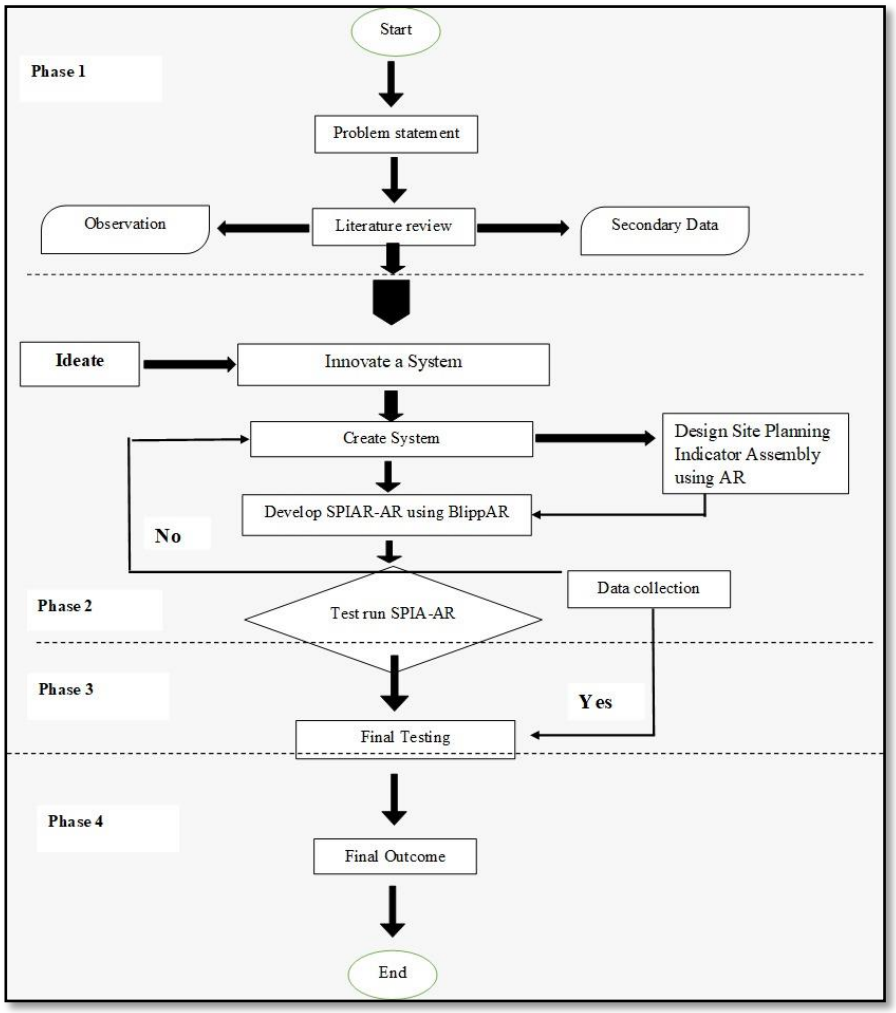


Figure 3.2: *Flow of Research Framework*

The project was carried out using this framework as a reference. The procedure in this study is divided into multiple sections, as shown in the figure. This development research takes a process-based strategy from site planning indicator assembly application's inception to completion. Create a flowchart for this system during this step to make sure the project runs smoothly and according to plan. The details of research development as show in Figure 3.3.2 below.

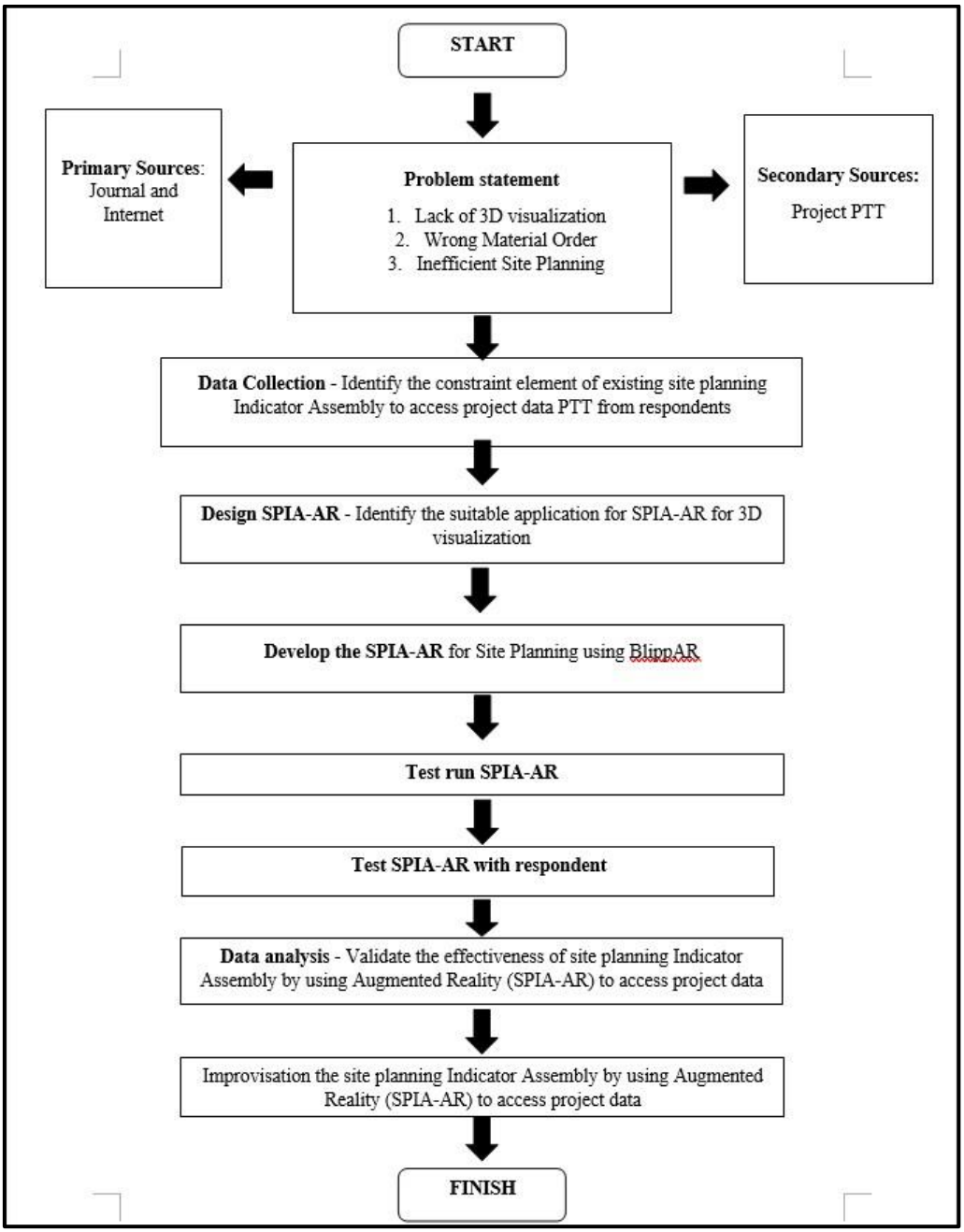


Figure 3.3: *The details of research development*

This study's methodology is broken down into multiple parts, each of which will be detailed in depth. In addition, various approaches were utilized to conduct interviews, study

the results of research studies, conduct a literature review, create a questionnaire, and preview the project's progress. Throughout the process of finishing this project, four phases of approach will be used in Figure 3.4 Research flow of Methodology:

Phase 1 – Problem Discovery and Literature Reviews

Phase 2 – Method of Collection Data (Primary Source and Secondary Source)

Phase 3 – Production of System (Testing of Data, Analysis and Interpretation Of Data), and Recommendation and Conclusion

Phase 4 – Final Outcome (Archive the Objectives)

3.3.1 Research Flow of Methodology

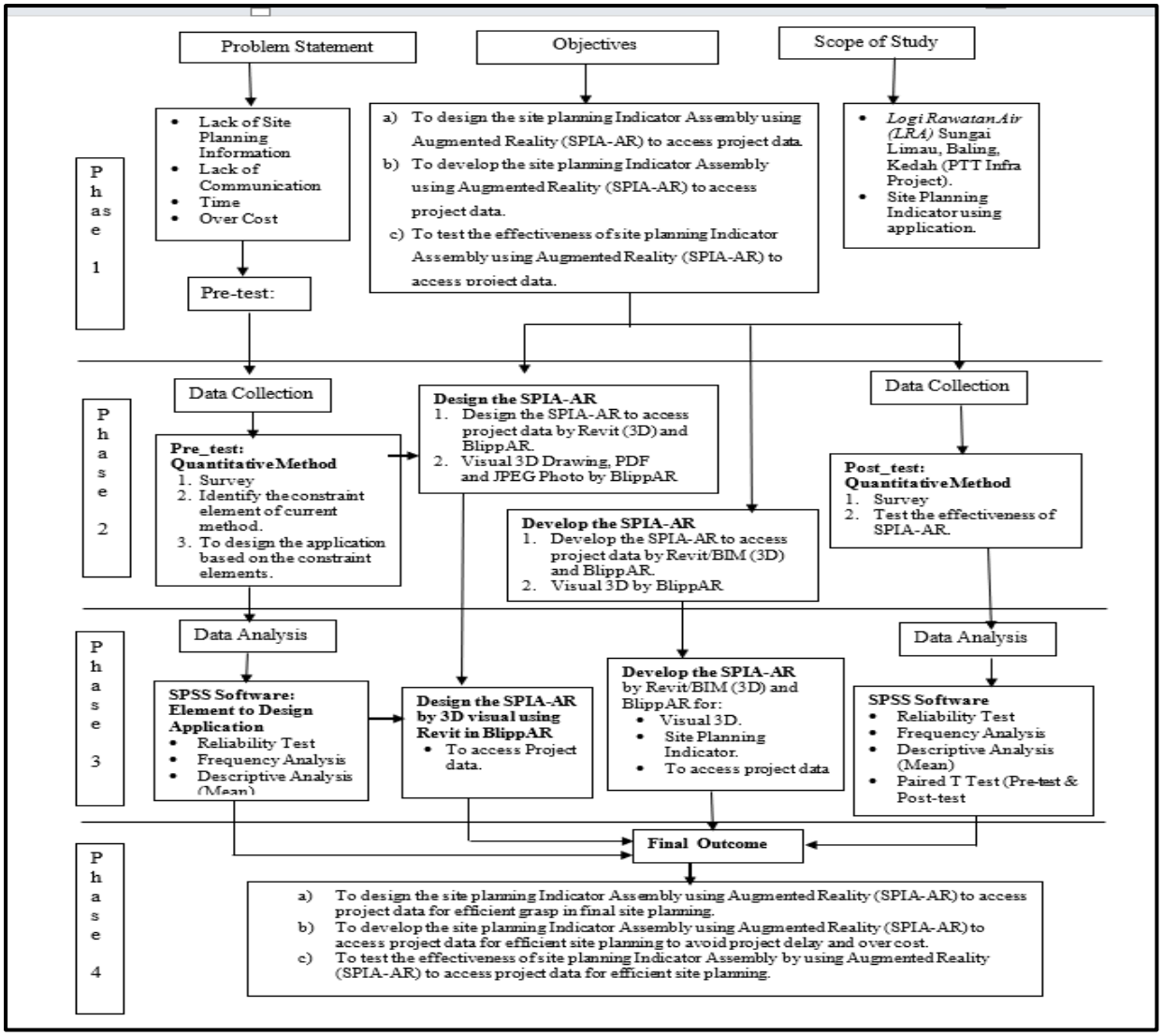


Figure 3.4: *Research flow of Methodology*

Phase 1- Problem Discovery and Literature Reviews

The most significant aspect of this phase is to plan the design and analysis of the project that will be created. This phase focuses on gathering information for the project's growth as well as meeting with the supervisor and mentor. The completion of this step takes at least two weeks.

Phase 2–Method of Collection Data

The major aim of this phase is to evaluate and contrast the prior and latest applications on the market. Fact-finding techniques, questionnaires, and oral interview are all used in the analysis. The information gathered will be utilized to construct the model, prototype, and go on to the following stages.

Phase 3–Production of System

Following the completion of the website application, numerous activities will be carried out to guarantee that the system is thoroughly tested to verify the application can use to trace documents.

Phase 4–Final Outcome

The final outcome of phase 4 is final outcomes are results that occur from creating e-STC. They are the changes in policies, people, and communities that aim to achieve with this application. Outcomes can be positive or negative, and they can happen unintentionally. These statements are specific and measurable, letting you know when you have accomplished your goal. While they lead to creation, the final outcomes focus more on the broad mission

3.4 Data Collection

The methods of collecting section includes comprehensive instructions on how to use a Google Form to gather data from a questionnaire. In this study, the quantitative approach was applied. By employing this technique, we can rapidly and accurately gather data while also expanding the breadth of our data analysis. All facets of the site, responders, and study methodology will be covered. This information guarantees that the project's goals can all be met.

3.4.1 Location

This study will be conducted at the site that is being developed under PTT in Project LRA Sungai Limau because the analyst believes that the organization chosen is the best one to know the circumstances, situations, and problems facing the construction site between headquarters. Respondents are related individuals who are in charge of construction and are also involved in structural and infrastructural work.

3.4.2 Respondents

According to SAGE research methodology, respondents are people who participate in a survey, an interview, or submit information that will be used to analyze data for a research project. Respondents must agree to give informed permission in order to participate, regardless of their age, which is established by the parameters of the study. Foremen and workers from the procurement department were among the responders who were given a survey to complete.

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970

Figure 3.5: *The sample size by Krejcie & Morgan 1970 (Sources from Google search)*

The sample size was determined using Krejcie and Morgan Table (1970) whereby for population of 30 respondents, 28 samples were adequate.

3.4.3 Questionnaire Survey

The questionnaire was used by researchers to gather data for this investigation. A Google form might be used to collect data. When researchers are aware of the needs of the study, the questionnaire is a useful tool for data collection. The Google Form URLs will be sent to the responders in order to disseminate the questionnaire.

The questionnaire for this study is split into Section A and Section B, which are the two primary portions. Section A will concentrate on the respondent's demographic data, and Section B will concentrate on the standards for generating site planning indicator assembly series. The usage of site monitoring apps on construction sites, including implementation, employee knowledge, and employee engagement, will also be tested in all areas of the questionnaire. Table 3.6.3 is a collection of details regarding the

questions in this questionnaire.

Table 3.2: *Distribution of the questionnaire items fthe or pre-test*

Section	Aspects of evaluation
A	Demography
B	Constraint elements of existing method in site planning at PTT INFRA
C	The Need Of Site Planning Indicator Assembly Using Augmented Reality (SPIA-AR) for efficient for site planning and saving time and cost.

Table 3.3*: Distribution of the questioner items for post-test*

Section	Aspects of evaluation
A	Demography
B	Elements for the need of Site Planning Indicator Assembly Using Augmented Reality (SPIA-AR)
C	SPIA-AR access project data for efficient site planning.

Table 3.4:*Likert scale items*

Scale	Description
1	Strongly Disagree
2	Disagree
3	Satisfactory
4	Agree
5	Strongly Agree

3.4.4 PreTest

Following the completion of the Google Form survey construction, a test survey was run to make sure respondents could access it. Google form used to collect the data. Two

respondents are included in the trial test to ensure an efficient method of gathering data. Google Form URLs were used to disseminate the survey to responders.

3.5 Technology Acceptance Model (TAM)

The technology acceptance model (TAM) is a theory of information systems that describes how people come to accept and use technology. Regarding logy acceptance model (TAM) is a theory of information systems that describes how people come to accept and use technology. Regarding Foley, Curley, and Barr (1984), Sharda, Barr, and McDonnellems that describes how people come to accept and use technology. Regarding Foley, Curley, and Barr (1984), Sharda, Barr, and McDonnell (1988, the acceptance and usage of information technology may result in both immediate and long-term benefits for organisations and individuals, such as enhanced performance, financial and time efficiency, and convenience. In this study, the Technology Acceptance Model (TAM) was applied to measure the validity of the survey. The major goal was to shed light on the mechanisms behind technology acceptance, forecast behavior, and give a theoretical explanation for effective technology deployment.

Besides that, to discover, define, and validate variables and measurements that would be highly correlated with system utilization Several studies designed, pre-tested, and validated multi-item measures for perceived ease of use and perceived utility based on past empirical research on human behavior and information system management.

3.5.1 Perceived ease of use

According to Davis in “Information Management and PSM Evaluation System”, perceived ease of use is defined as a measure in which a person believes that a computer can be easily understood and used. Meanwhile, perception of ease is defined as the extent to which a person believes that by using technology will be free of a business so that if person believe that the information system easy to use then he will use it and vice versa (Jogiyanto,2008).

3.5.2 Perceived usefulness

According to Davis, perceived usefulness is defined as a measure by which the use of technology is believed to provide benefits to the person using it and the perception of usefulness as the subjective ability of future users where using a specific application system will improve performance in the organizational context. Usability perception is

a level where one believes that the use of a particular technology will provide benefits or provide a positive impact that will be obtained when using the technology

3.5.3 Behavioral intention

Behavioral intention to use is tend behavior of a person in doing technology. Interest in behavior can be seen from the level of technology use so it can be predicted from the attitude and attention. The motivation to keep using such technology, as well as the desire to motivate other users

3.6 Data Analysis

Data analysis is the systematic application of statistical and/or logical methods to describe and illustrate, condense, summarize, and evaluate data. Depending on the industry and the objective of the research, there are several approaches and strategies for doing analysis. Both quantitative and qualitative techniques of research serve as the foundation for all of these many approaches to data processing.

The data will be collected and then calculated using the Statistical Package for the Social Sciences (SPSS) program. The data will be shown using tables and a pie chart showing the response rates. Additionally, SPSS has a number of statistical techniques that may be applied, like:

i. Descriptive statistics, including methodologies such as frequencies, cross-tabulation, and descriptive ratio statistics
ii. Numeral outcome prediction methods such as linear regression
iii. Prediction for identifying groups, including methodologies such as cluster analysis and factor analysis.

3.6.1 Reliability test

Sekaran &Bougie (2016), the reliability of a measure indicates the extent to which it is without bias (error free) and hence ensures consistent measurement across time and across the various items in the instrument. In other words, the reliability of a measure is an indication of the stability and consistency with which the instrument measures the concept and helps to assess the “goodness” of a measure.

3.6.2 Frequency test

A frequency table depicts the distribution of data based on variable options. Frequency charts can help to identify which alternatives appear frequently in the dataset. Frequency test is useful for gaining a better grasp of each variable and determining whether variables need to be recoded. A frequency table has no formula because it displays the count of each choice in a variable.

3.6.3 Descriptive test

Descriptive test is used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually every quantitative analysis of data. Descriptive test is used to present quantitative descriptions in a manageable form. In a research study may have lots of measures. Or may measure many people on any measure. Descriptive statistics help us to simplify large amounts of data in a sensible way. Each descriptive statistic reduces lots of data into a simpler summary.

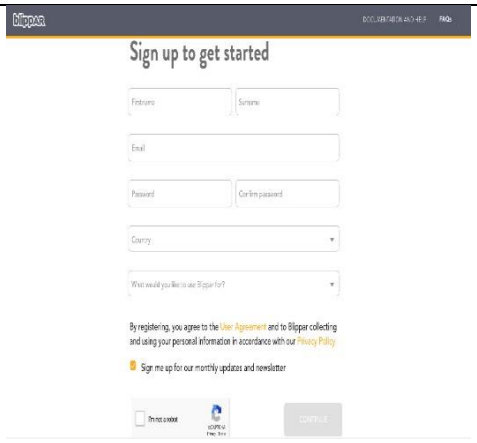
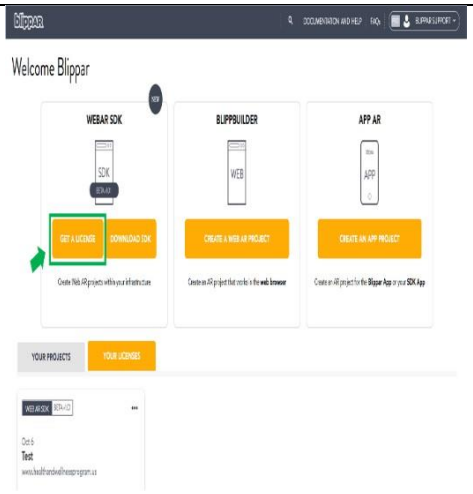
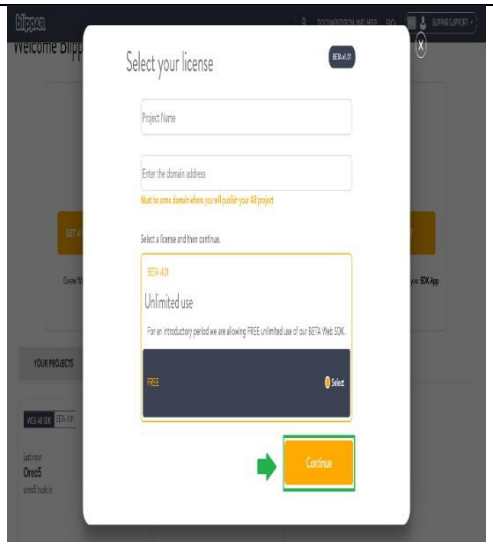
3.6.4 Mean and Average Mean

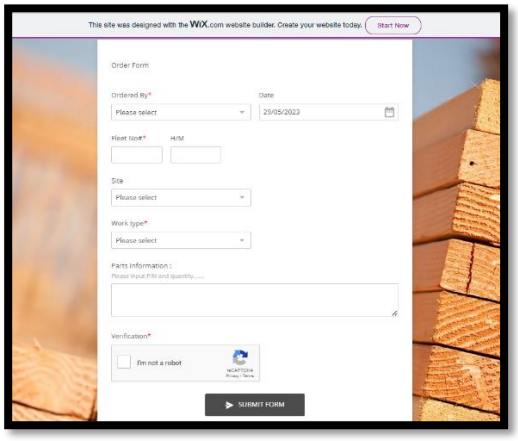
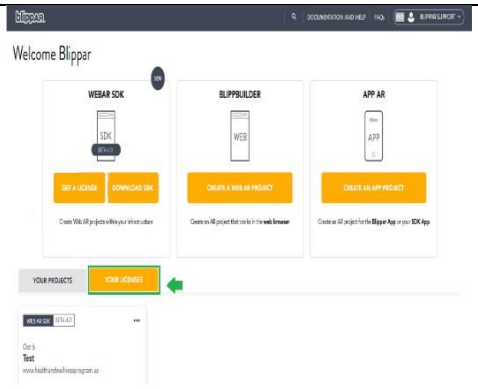
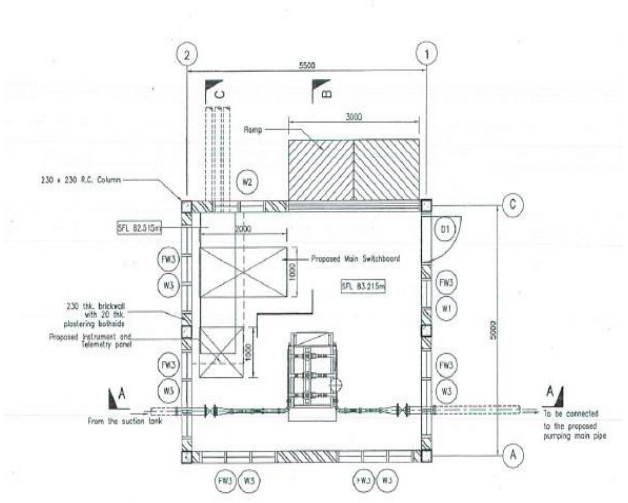
A form of average is the mean (or arithmetic mean). It is calculated by adding the values and dividing the total number of values by the number of values. The term "average" refers to the value derived by dividing the total of a collection of quantities by the number of quantities in the set. The square root of the variance yields the standard deviation. Another measure of variability is the average deviation, often known as the mean absolute deviation.

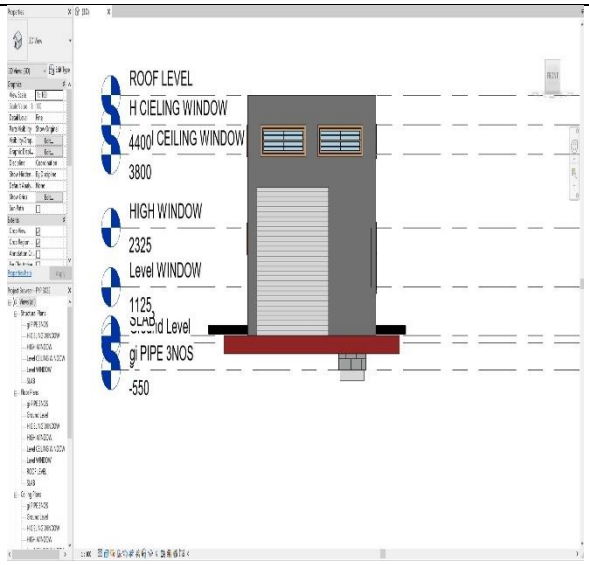
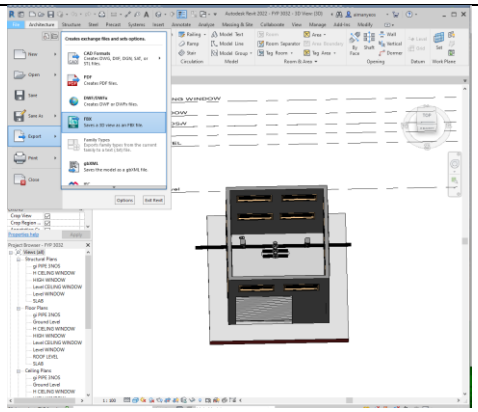
3.6.5 Paired T-test

When determining the difference between two variables, a paired t-test is utilized. Time is commonly used to separate these two elements. When there are two data values in paired measurements, the test can be employed. For example, pre-test and post-test results were collected and will be utilized to calculate the final result. Furthermore, the distribution of discrepancies between the matched measurements should be normal.

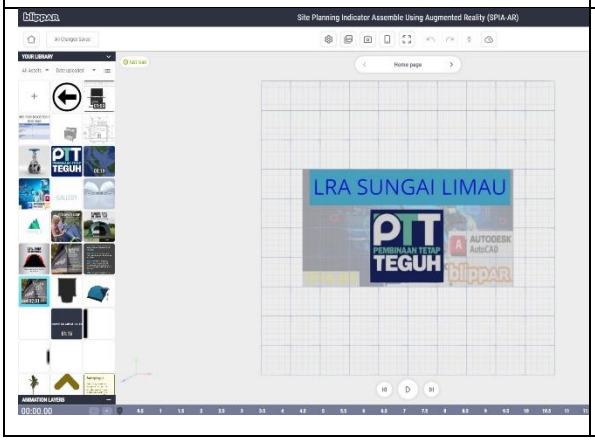
3.7 Design the Site Planning Indicator Assembly using Augmented Reality

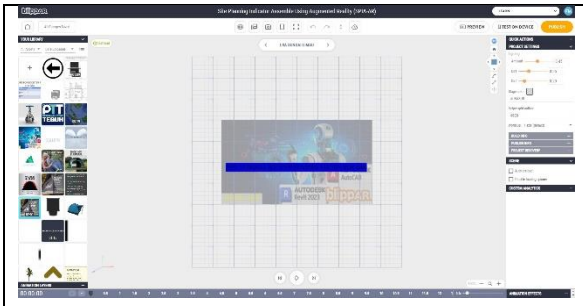
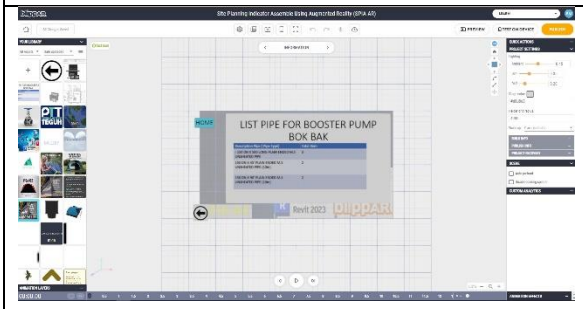
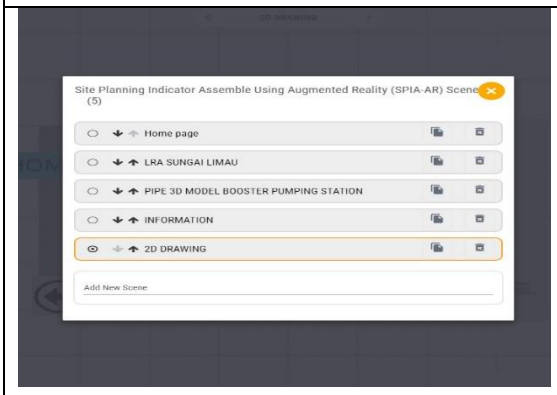
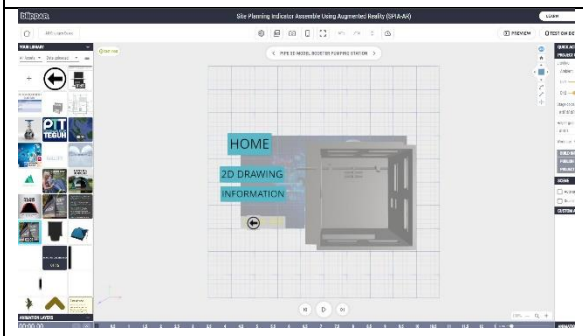
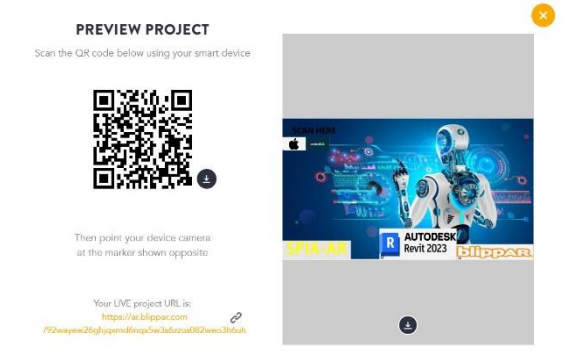
Process	Work Description
	Step 1: **Create an account with BlippAR** Create an account using an email.
	Step 2: Once you are logged in, under WebAR SDK, select "Get A License."
	Step 3: Give your project a name and enter the domain where you will host the AR experience. The WebAR SDK will always be free to get started with, and during our beta it was free to publish with unlimited views. Click "Continue" to generate a licence key. You will need this key when you are building the AR experience. There is no need to write this down, as the key will be emailed. to you and be available on the Hub.

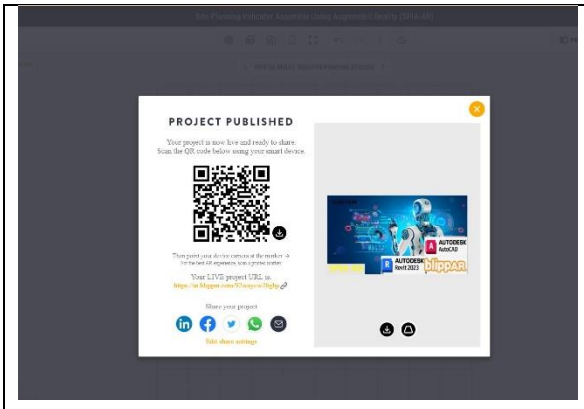
	Step 3: Download the WebAR SDK and follow theinstalling the SDK.
	Step 4: If you need to find the licence key again, you can always find it (and manage other aspects of this project) under "Your Licenses" on the Hub.
	Step 5: Download Autodesk Revit (download as student license)
	Step 6: Do study 2D construction drawing and measure it with Site Engineer. (Make sure that dimension is correct)

	Step 7: Use Autodesk Revit for change the 2D drawing to 3D.
	Step 8: Export 3D Revit using FBX. BlippAR only accept/available for FBX and certain file only.

3.8 Develop Site Planning Indicator Assembly using Augmented Reality

Prototype	Explanation
	Login to BlippAR and open new project. Choose the desired marker you wish to upload. It can alternatively 'Drag and Drop' your marker, marker is important to recognize your project.

	Click ‘text’ to put your desire design and interface. Put text related to your project and information.
	Edit your text and put action (on touch) on the text. You can also edit the text properties and effect to make it more interactive.
	Click the scene page to edit or add another scene. Every scene must relate to your project and repeat the previous steps to edit your scene accordingly.
	You can add or link the image with other platform such as YouTube, twitter, or other websites.
	You can preview your project before publishing it to make sure your content were placed accordingly.

	Publish the project once done to start use your AR.

3.9 Summary

This chapter covers the study's information and data-gathering techniques, which may be summed up. The gathered data will be evaluated to determine the results. This chapter also emphasizes the setting, participants, research methodology, data analysis, and procedures of the assessment process.

According to analysis, the use of technology is better than the current method. In comparison, the current method uses "WhatsApp" to update the method of statement (MOS), confirm the latest work done, and confirm material orders, which can lead to overlooking. In terms of adaptability, this site planning indicator assembly is convenient, easy, and straightforward to use. In the long run, it becomes beneficial to all the procurement department project planners, project managers, site engineers, site supervisors, and workers when they want to update the latest work done, order and delivery material dates, and start new planning for ordering material from the supplier for incoming progress.

Additionally, the strategies that will be employed will be completely provided in light of the difficulties that already exist, as well as the choice of suitable methods when implemented and adaptable to the region. This is based on all previous research as well as on information that is currently accessible from books, interviews, and personal experiences. The process flow that will be used for this project and adapted to the working environment on site will be attached after this chapter.

CHAPTER 4

DATA AND ANALYSIS

4.1 Introduction

The researcher should have a notion of what the project's projected outcome will be in this chapter. It is also one of the pre-project planning activities, and researchers considered carefully evaluating what data will be generated throughout the project's execution. The researchers want to be sure that the information they gather will assist them achieve the goals they have established. In addition, demographic information for the respondent of the survey also has been explained further into this chapter. Ouantitative method by distributing the questionnaire to more than 30 respondents had given the feedback and process by SPSS. Result had been analysis by Paired T test. The Site Planning Indicator Assembly by using Augmented Reality is anticipated to help achieve the following goals.

For Objective 1, To design the site planning Indicator Assembly by using Augmented Reality (SPIA-AR) to access project data. Objective 2, which is to develop the site planning Indicator Assembly by using Augmented Reality (SPIA-AR) to access project data and to answer Objective 3, which was To test the effectiveness of site planning Indicator Assembly by using Augmented Reality (SPIA-AR) to access project data.

4.2 To identify the constraint element of current method

4.2.1 Data Collection

This study presents the findings of a questionnaire issued to respondents, who included project managers, engineers, site supervisors, assistant managers, quantity surveyors, and others, to determine the necessity for a site indicator assembly by using augmented reality (SPIA-AR). This questionnaire is divided into two sections: Section A and Section B. Section A contains demographic information. Section A contains demographic information. In Section B, issues related to existing methods This questionnaire has been distributed to 30 Respondents by PTT management team, site, and headquarters by Google Form through links.

4.2.2 Demographic Data

Section A is a demographic data section that includes five questions on the respondents backgrounds. The respondents of pre and post questionnaire was same. The items as follow:

a) Gender

b) Age

c) Position

d) Work Experience

e) Position / Post

4.2.2.1 Gender

This research included 21(70.00 percent) male respondents and 9 (30.00 percent) female respondents. Male respondent exceed female respondents by a wide margin, as seen by the proportion. This is because a male, rather than a women, dominated the responses at the Pembinaan Tetap Teguh (PTT) working on the construction site, whereas most of the females are quantity surveyors in the office. The number of respondents by gender is shown in Table 4.1 below.

Table 4.1: *The number of respondents by gender*

No.	**Gender**	**No. of Respondent**	**Percentage (%)**
1	Male	21	70.00
2	Female	9	30.00
Total		30	100.00

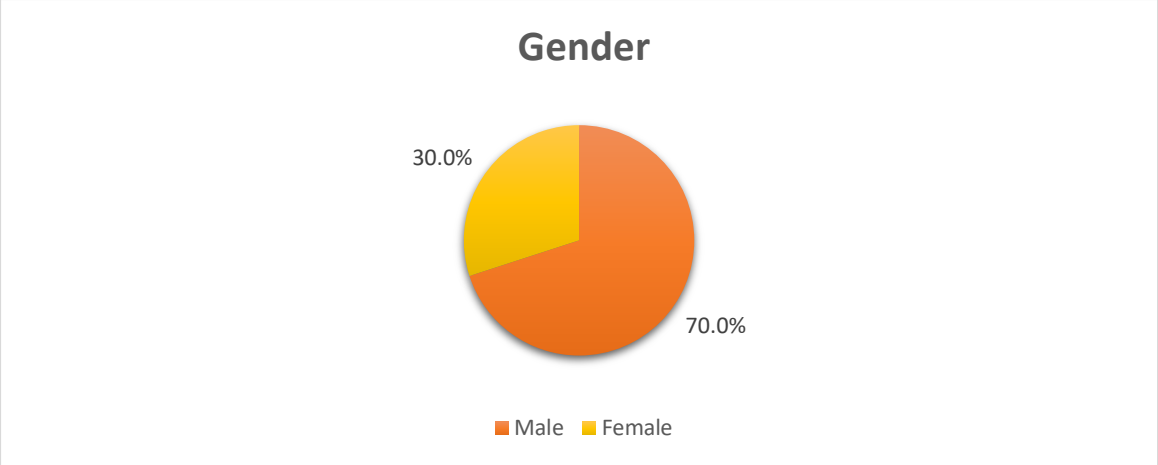


Figure 4.1: *The percentage of respondents by gender*

4.2.2.2 Age

Table 4.2 shows the age groupings of the respondents in this research. The age groups were divided into four categories by the researchers. This section was formed to assist with data processing and identifying respondents on the job site. In this survey, the age group 35-44years old has the most responses, with 10 more than 30 percent (33 percent), followed by 25-34 years old, which has 9 respondents (30 percent) different 3 respondents than 45-54 years old (20 percent). Only two responders (10 percent) are under the age of 18-24 years old. There isn't a single person above the age of 64 who has responded.

Table 4.2: *the number of respondents by gender*

No.	**Age**	**No. of Respondent**	**Percentage (%)**
1	18-24 years old	3	10.00
2	25-34 years old	9	30.00
3	35-44 years old	10	33.3
4	45-54 years old	6	20.0
5	55-64 years old	2	6.7
6	65 years old or older	0	0
Total		30	100.00

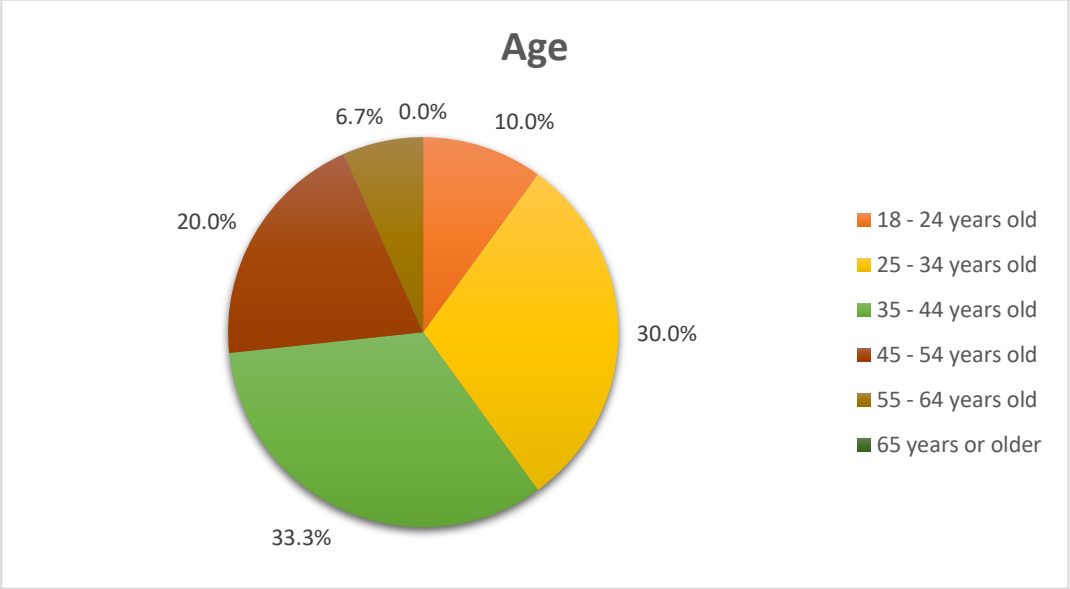


Figure 4.2: *The percentage of respondents by age*

4.2.2.3 Position / Post

The job title at the construction site, which comprises Project Manager, Site Engineer, Site Supervisor or Assistant Senior Project Manager, Quantity Surveyor, and Others, is the final piece of demographic information. Table 4.4 shows that Site Engineer had the most respondents, with 8 respondents (26.2 percent). The Site Clerk came in second with 6 replies (20 percent). The quantity surveyor is placed third, with 5 respondents (16 percent), followed by Site Supervisor and Environmental Officer with 3 responses (10percent) and Safety and Health Officer with 2 respondents (6.7 percent). Project Manager and Assistance Project Manager with 1 response (3.3 percent) for each one

Table 4.3: *the number of respondents by gender*

No.	Position	No. of Respondent	Percentage (%)
1	**Project Manager**	**1**	**3.3**
2	**Site Engineer**	**8**	**26.2**
3	**Quantity Surveyor**	**5**	**16.7**
4	**Site Clerk**	**6**	**20**
5	**Admin Executive**	**2**	**6.7**
6	**Site Supervisor**	**3**	**10**
		3	**10**

7 **8** **9**	**Environmental Officer** **Assistance Project Manager** **Safety and Health Officer**	**1** **2**	**3.3** **6.7**
Total		**30**	**100.00**

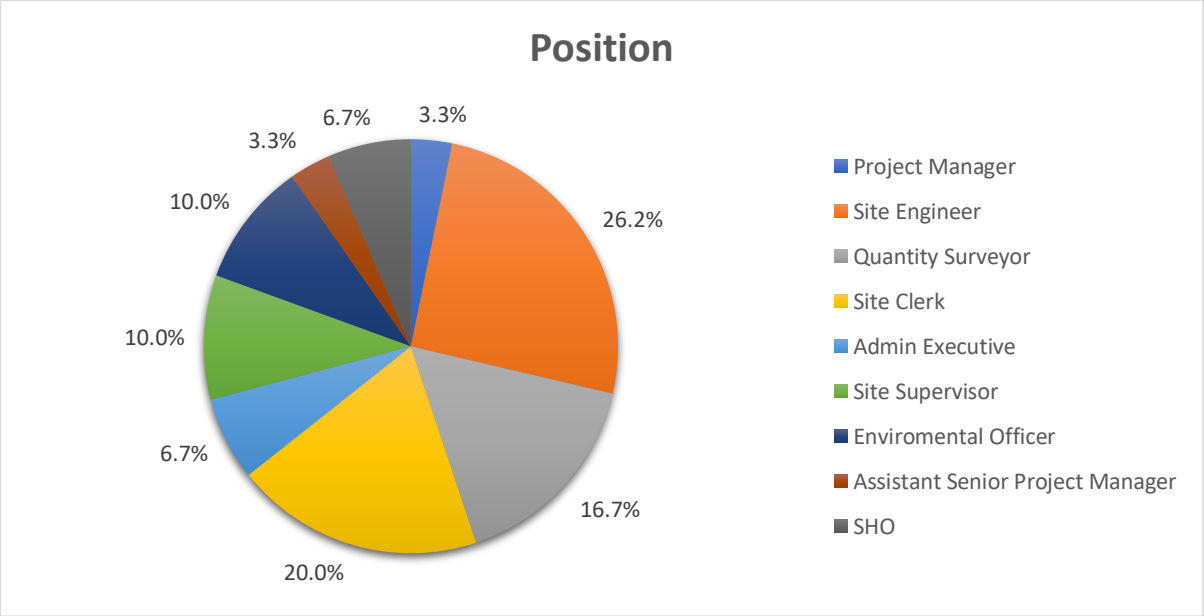


Figure 4.3: *the number of respondents by position*

4.2.2.4 Work experience

Majority respondents in this survey (48.3 percent) had 2-5 years of building experience. There are 14 respondents with 6-10 years of job experience, accounting for 30 percent of the total, and 4 respondents with below 2 years of work experience (6.7 percent). The number of responses by experience is shown in Table 4.4 below

Table 4.4: *The number of respondents by work experience*

No.	Age	No. of Respondent	Percentage (%)
1	< 2 years	4	6.70
2	2 - 5 years	14	36.70
3	6-10years	9	30.00
4	>10 years	2	26.7
Total		30	100.00

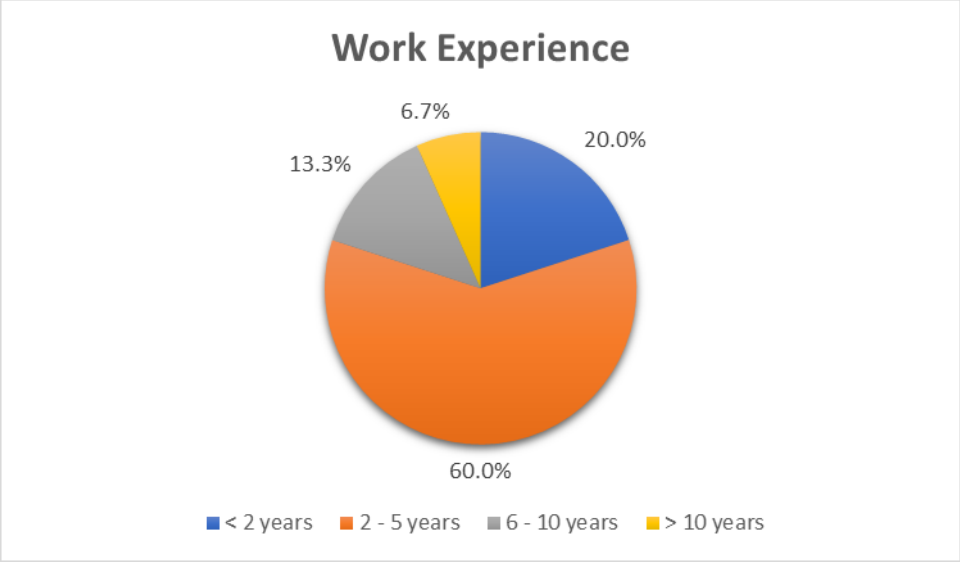


Figure 4.4: *the number of respondents by work experience*

4.2.2.5 Constrain elements of the current method

Table 4.5: *The Constrain elements of the current method*

No	The Constrain elements of the current method	Issues Related to the current method	Scale Likert				
			Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
1	2D Drawing is easy.	2D Drawing has sufficient data or information (only portrayed in two dimensions) is easy.	3.3%	96.7%	0.0%	0.0%	0.0%
		2D drawings, changes towards design are easy.	10.0%	86.7%	0.0%	3.3%	0.0%
		It will be easy for non-technical individuals to understand the design in 2D drawings	16.7%	80.0%	0.0%	3.3%	0.0%
		Average:	10.0%	87.8%	0.0%	2.2%	0.0%

4.2.2.6 Current method is systematic to checking process

Table 4.6: *Current method is systematic to checking process*

No	The Constrain elements of the current method	Issues Related to the current method	Scale Likert				
			Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
2	Checking process	The checking process for 2D Drawing is fast	6.5%	90.0%	0.0%	3.5%	0.0%
		It is suitable to consider all available design alternatives while using 2D drawings and sketches because of their limits in visualization.	3.5%	93.1%	0.0%	3.5%	0.0%
		2D drawing could help to create the prototype for spotting the problem	6.0%	90.0%	0.0%	4.0%	0.0%
		Average:	5.3%	91.0%	0.0%	3.7%	0.0%

4.2.3 Respondent Perspective

Section B presents the respondents' perspectives on the existing manner of document storage and tracking system. Respondents were asked to choose their level of agreement on a scale of 1 to 5. This survey displays the results of a questionnaire distributed to respondents, which included Managers, Engineers, Site Supervisors, and others, to determine what team needs to improve construction productivity and what system criteria that team will want to develop to

monitor construction productivity. Below table shown the data collection of issues related to existing method.

Level of Agreement				
Strongly Disagree	**Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1	**2**	**3**	**4**	**5**

Table 4.7: *Issues Related by Existing Method*

No	Manual Method	Scale Likert					
		Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree	Total
1	2D Drawing has sufficient data or information (only portrayed in two dimensions) is easy.	3.3%	96.7%	0.0%	0.0%	0.0%	100.0%
2	2D drawings, changes towards design are easy.	10.0%	86.7%	0.0%	3.3%	0.0%	100.0%
3	It will be easy for non-technical individuals to understand the design in 2D drawings	16.7%	80.0%	0.0%	3.3%	0.0%	100.0%
4	2D drawing can be employed towards digital prototype.	6.5%	90.0%	0.0%	3.5%	0.0%	100.0%

5	The checking process for 2D Drawing is fast	6.5%	90.0%	0.0%	3.5%	0.0%	100.0%
6	It is suitable to consider all available design alternatives while using 2D drawings and sketches because of their limits in visiualization.	3.5%	93.1%	0.0%	3.5%	0.0%	100.0%
7	2D drawing could help to create the prototype for spotting the problem	6.0%	90.0%	0.0%	4.0%	0.0%	100.0%
8	2D Drawing provides more collaboration with different disciplines involved in the same project	6.0%	90.0%	0.0%	4.0%	0.0%	100.0%
9	Lack of 3D visualization which causes misunderstanding and poor communication that might not affects project success	6.0%	90.0%	0.0%	0.0%	4.0%	100.0%
10	2D alone design environment will maximise time to market and cost	4.2%	93.3%	0.0%	2.5%	0.0%	100.0%

11	2D drawing method always provide correct material order and may help reduce cost and project delay.	3.4%	96.6%	0.0%	0.0%	0.0%	100.0%
12	Do you possess in-depth understanding of BIM? (Building Information Building)	4.8%	93.1%	0.0%	2.1%	0.0%	100.0%
13	Lack of BIM understanding in BIM (BIM Information Building) help to create faster digital prototype	3.4%	96.6%	0.0%	0.0%	0.0%	100.0%

4.2.4 Data Analysis

SPSS stands for Statistical Package for the Social Sciences, and it is used by a variety of academics to analyse complicated statistical data. SPSS will be used to analyse data in this study. The systematic use of statistical and logical methods to explain, show, compress, summarize, and assess data. Data analysis is used by researchers to reduce data to a story and examine it to get perspectives. Data analysis aids in the reduction of enormous amounts of data into smaller, more digestible chunks (parts).

4.2.4.1 Reliability Test for Current Method

The qualities of measuring scales and the items that comprise the scales may be studied using reliability analysis. The Reliability Analysis process computes a variety of regularly used measures of scale reliability as well as information on the relationships between scale items. Inter-rater reliability estimates can be computed using intraclass correlation coefficients

Table 4.8 *Range of reliability and its coefficient of Cronbach's Alpha*

No	Coefficient of Cronbach's Alpha	Reliablity Level
1	> 0.90	Excellent
2	0.80 - 0.89	Good
3	0.70 - 0.79	Acceptable
4	0.60 - 0.69	Questionable
5	0.50 - 0.59	Poor
6	< 0.50	Unacceptable

Table 4.9: *Reliability Test Cronbach's Alpha Based on Standardized Items*

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.955	0.944	13

4.2.4.2 Frequency Analysis for Existing Method

Descriptive statistics are statistics that summarize or characterize the features of a data collection. It also divided into two types of measurements: measures of central tendency and measures of variability (or spread). Furthermore, central tendency measures describe the center of a data collection. Variability or spread measures describe the dispersion of data within a set.

Table 4.10: *Frequency Analysis for existing method*

Manual Method	Scale Likert				
	Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
2D Drawing has sufficient data or information (only portrayed in two dimensions) is easy.	1	29	0	0	0
2D drawings, changes towards design are easy.	1	28	0	1	0

It will be easy for non-technical individuals to understand the design in 2D drawings	3	26	0	1	0
2D drawing can be employed towards digital prototype.	2	27	0	1	0
The checking process for 2D Drawing is fast	2	27	0	1	0
It is suitable to consider all available design alternatives while using 2D drawings and sketches because of their limits in visualization.	1	28	0	1	0
2D drawing could help to create the prototype for spotting the problem	2	27	0	1	0
2D Drawing provides more collaboration with different disciplines	2	27	0	1	0

involved in the same project					
Lack of 3D visualization which causes misunderstanding and poor communication that might not affects project success.	2	27	0	0	1
2D alone design environment will maximize time to market and cost.	1	28	0	1	0
2D drawing method always provide correct material order and may help reduce cost and project delay.	1	28	0	0	1
Do you possess in-depth understanding of BIM? (Building Information Building)	1	28	0	1	0
Lack of BIM understanding in BIM (BIM Information	1	28	0	1	0

Building) help to create faster digital prototype					

Table 4.11: *Percentage of the respondents agree and disagree with the current method*

Manual Method	Usage				
	Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
2D Drawing is easy	10.0%	87.8%	0.0%	2.2%	0.0%
Produce digital prototype	6.5%	90.0%	0.0%	3.5%	0.0%
Checking process	5.3%	91.0%	0.0%	3.7%	0.0%
Less collaboration	6.0%	90.0%	0.0%	4.0%	0.0%
Misunderstanding	6.0%	90.0%	0.0%	0.0%	4.0%
Materials order	3.8%	95.0%	0.0%	1.3%	0.0%
BIM knowledge	4.1%	94.9%	0.0%	1.1%	0.0%

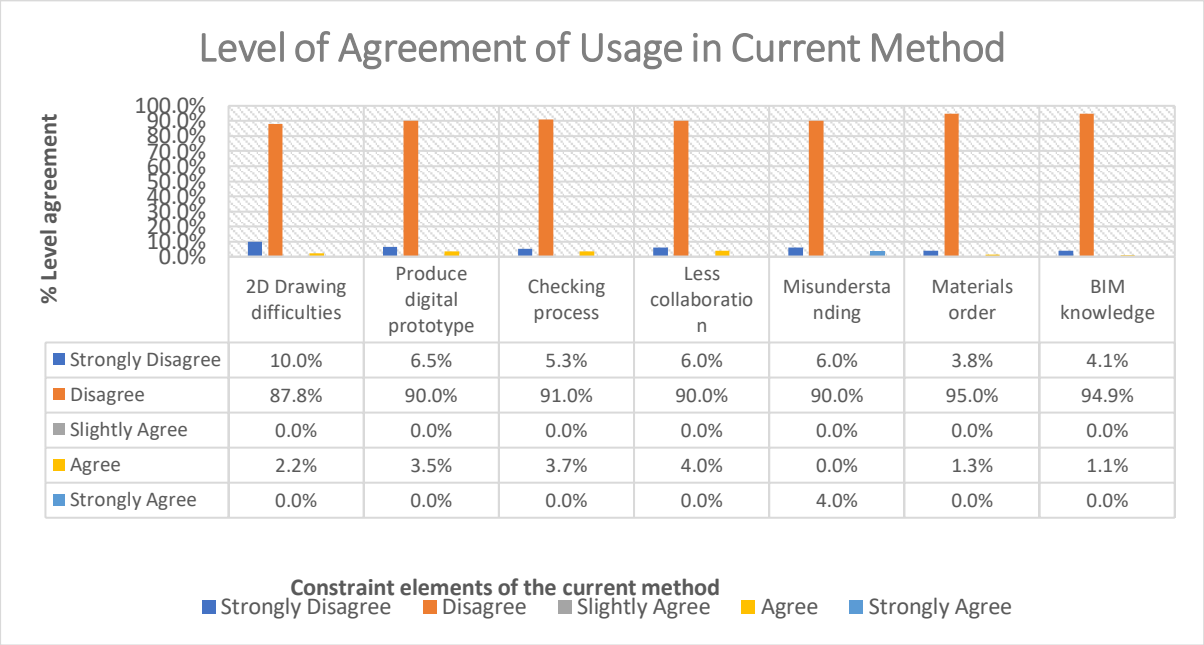


Figure 4.5: *Percentage of level agreement of current method*

Figure 4.5 shows the percentage of respondents who do not agree with the use of current

methods. From the percentage that shows that they need a Site Planning Indicator Using Augmented Reality for site.

4.2.4.3 Descriptive Test of Average Mean

Descriptive statistics are those that describe or characterize a data set's properties. It also distinguishes between two sorts of measurements: measures of central tendency and measures of variability (or spread). Furthermore, central tendency a data set's focus point is described by measurements. Variability or spread measures describe the dispersion of data within a collection.

Table 4.12: *Issue related to current method*

	N	Mean		Std.	Variance
	Statistic	Statistic	Std. Error	Deviation	Statistic
2D Drawing is easy	30	1.97	0.033	0.183	0.033
	30	1.90	0.056	0.305	0.093
	30	2.03	0.076	0.414	0.171
Produce digital prototype	30	1.97	0.089	0.490	0.240
Checking process	30	2.00	0.083	0.455	0.207
	30	2.03	0.076	0.414	0.171
	30	2.00	0.083	0.455	0.207
Less collaboration	30	2.00	0.083	0.455	0.207
Misunderstanding	30	2.03	0.112	0.615	0.378
Materials order	30	2.03	0.076	0.414	0.171
	30	2.07	0.106	0.583	0.340
BIM knowledge	30	2.03	0.076	0.414	0.171
	30	2.03	0.076	0.414	0.171

Table 4.11 show the result of respondent related to constraint elements of existing method in PTT INFRA at Sungai Limau project. There are 7 constrains element of existing method. The data was generated by using SPSS Software, version 26.

Table 4.13: *Mean and average mean of the categories for constrain element in existing method*

No	Constraint elements of the current method (PRE-TEST)	Mean	Average Mean	Average Mean (%)
1	2D Drawing is easy	1.97	1.97	13.99
		1.9		
		2.03		
2	Produce digital prototype	1.97	1.97	14.01
3	Checking process	2.00	2.01	14.30
		2.03		
		2.00		
4	Less collaboration	2.00	2.00	14.23
5	Misunderstanding	2.03	2.03	14.44
6	Materials order	2.03	2.05	14.58
		2.07		
7	BIM knowledge	2.03	2.03	14.44
		2.03		
Total Average		**2.01**	**14.06**	**100**

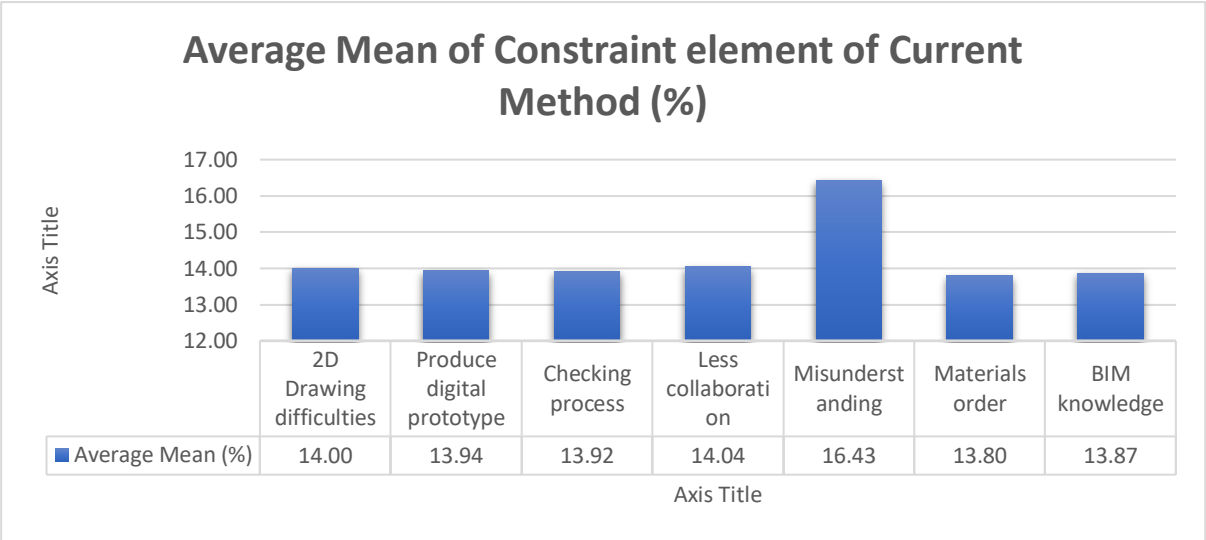


Figure 4.6: *Percentage of average mean*

According to the statistics in Table 4.12, Table 4.13 and Figure 4.6 above, the greater percentage rate of average mean, the require SPIA-AR for Site Planning is misunderstanding with 16.43%. Second, Less collaboration with 14.04%. Third, 2D drawing difficulties with 14.00%. Fourth, Produce digital prototype with 13.94%. Fifth, checking process with 13.92%. Next, BIM knowledge with 13.87% and last one material order with 13.80%.

Table 4.14: *Usability of current method*

Variables	**Mean**	**Interpretation**
2D Drawing is easy	1.98	Low
Produce Digital Prototype	1.93	Low
Checking process	1.97	Low
Less collaboration	1.97	Low
Misunderstanding	1.93	Low
Material order	1.98	Low
BIM knowledge	1.98	Low

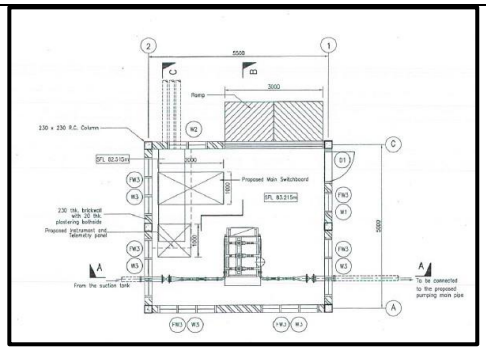
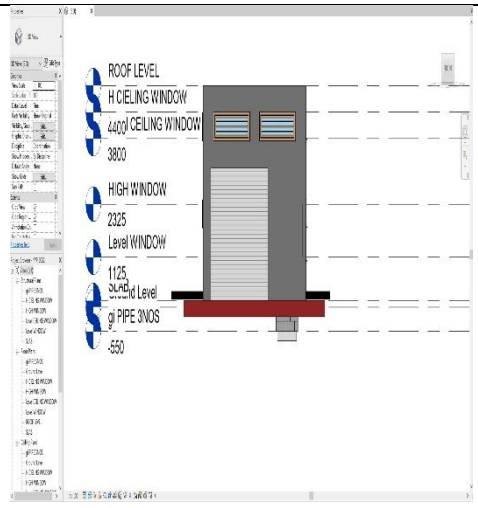
Table 4.13 above shows, respondent level of usability toward current method shows for all variables tested the mean score were less than 2.50 meaning that the usability level of existing method was very low. It needs systematic and efficient system. However, an electronic system is important to use in construction industry which need to achieve IR 4.0 which include the constraint element, 2D Drawing difficulties, Produce Digital Prototype, Checking Process, Less Collaboration a nd require a systematic tracking center for site requisition machinery spare parts order for more efficient of ordering material. Therefore, SPIA-AR is needed to be developed to solve the issue of related to

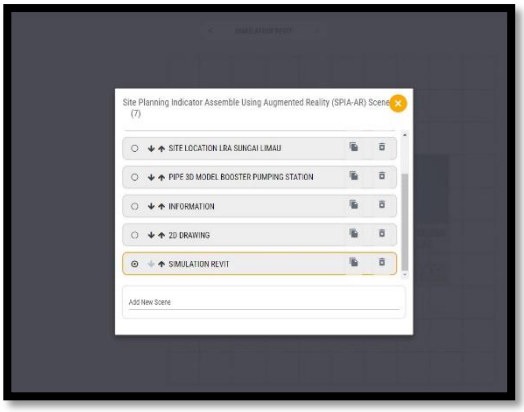
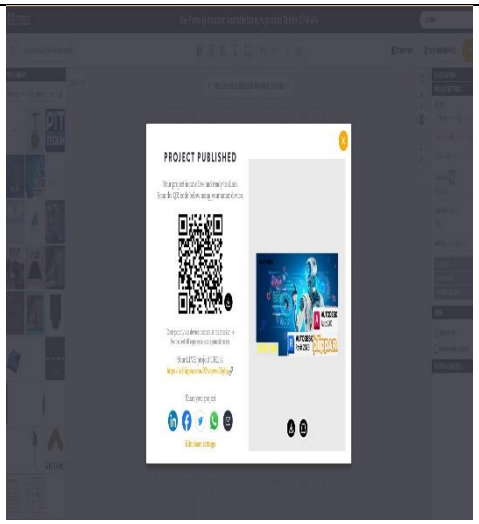
existing method in PTT INFRA in Sungai Limau for more efficient of planning and ordering material.

4.3 To design the Site Indicator Assembly Using Augmented Reality (BlippAR)

The Internet of Things (IoT) has a broad intensity of things like sensors, cameras, signaling equipment, etc. It will ensure to solve client requests effectively and build up the correct directions. Internet of things connects the devices & humans with the learning of innovation. The IoT will be set up in a Web Development industry to make web architecture and User Interface is more creative and interactive. In develop the Site Planning Indicator Assembly, BlippAR were selected as a web builder that will be used to develop this invention. BlippAR is easy to use and use internet access which can be used via mobile phone, computer, laptop, and tablet to access this website.

Table 4.15: *The process to design SPIA-AR*

Process Design	Work Description
	Step 1: **Pick Drawing construction project 2D based on Scope Study** Measure it all with our engineer and project manager.
	Step 2: **Convert 2D construction drawing to Revit** Draw the drawing on Revit with right measurement.

	Step 3: **3D model to BlippAR** After complete Revit, Save as threw FBX. The purpose to use BlippAR is must to use FBX.
	Step 3: **Design Application** Create section with information
	Step 4: **SPIA-AR to be Design** After all work has been complete, the project in BlippAR are design to enter by all our employee during the project start.

4.3.1 Method to develop Site Planning Indicator Assembly Using Augmented Reality (BlippAR)

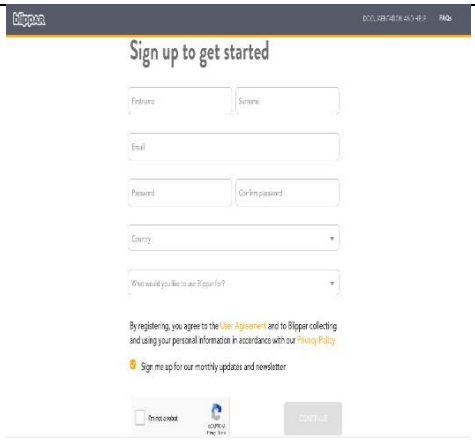
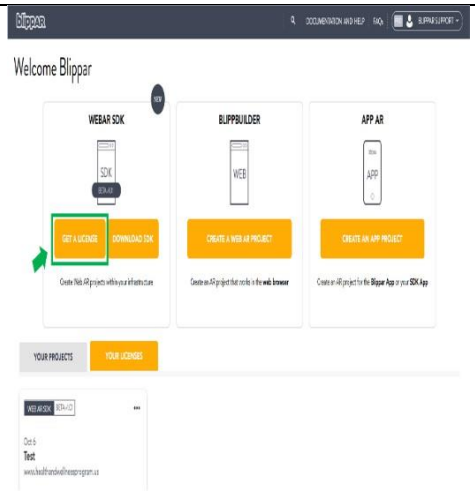
The existing method depends on one of the most prevalent issues that subcontractors encounter when beginning a site preparation project is a fundamental lack of planning. Besides that, issue is a lack of direct information, especially in the latest drawing or design drawing. Also Lack of 3D visualization which causes misunderstanding and poor communication that affect project success. less accuracy in reading the latest drawing plan, drawing, or, especially in design will cause errors in the ordering of material terms of sizes and specification. In conclusion, a more

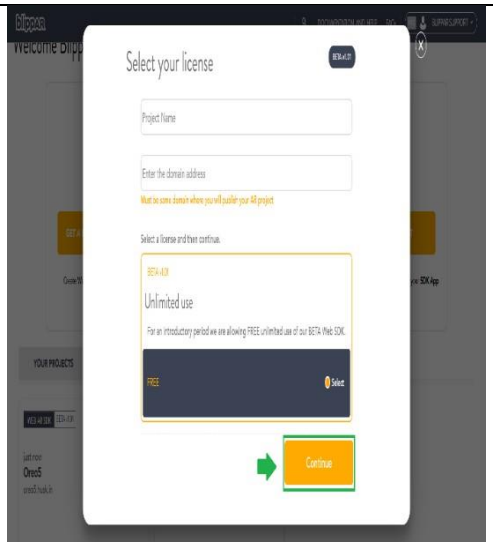
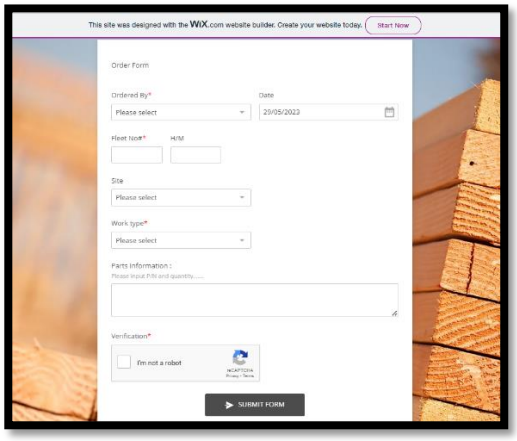
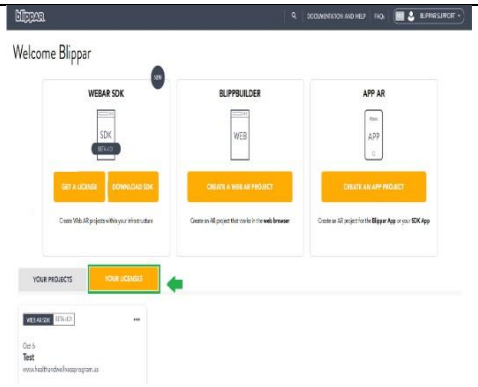
systematic and centralized method is required to overcome this issue that PTT INFRA in Sungai Limau department is having.

4.3.2 To Develop Site Planning Indicator Assembly Using Augmented Reality (SPIA-AR) to access project data.

Before creating the application SPIA-AR, the initial step is to design it using BlippAR. This demonstrates how the applications will execute each section. This application also serves as a sample before being created by BlippAR and as a guideline for making it simpler to produce by BlippAR. The design of the SPIA-AR will be demonstrated using the component BlippAR.

Table 4.16: *The process to design SPIA-AR*

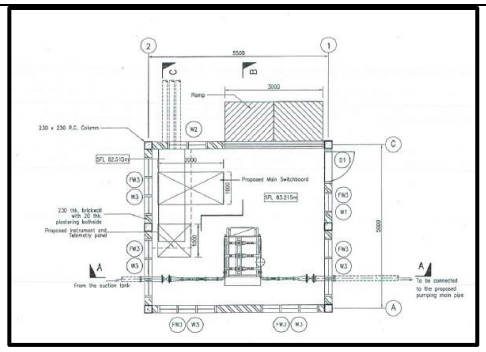
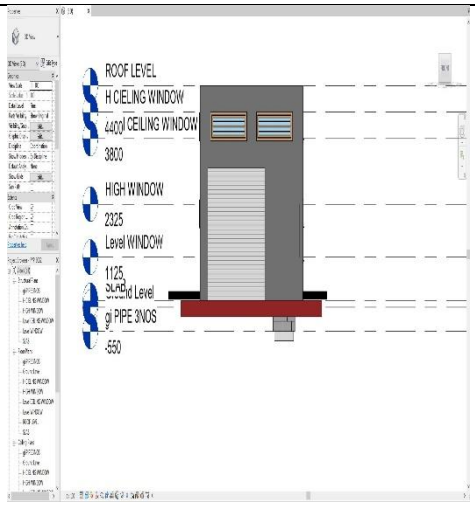
Process Develop	Work Description
	Step 1: **Create an account with BlippAR** Create an account using an email.
	Step 2: Once you are logged in, under WebAR SDK, select "Get A License."

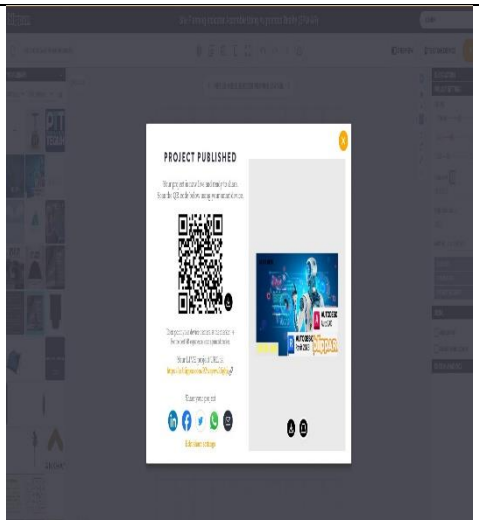
	Step 3: Give your project a name and enter the domain where you will host the AR experience. The WebAR SDK will always be free to get started with, and during our beta it was free to publish with unlimited views. Click "Continue" to generate a licence key. You will need this key when you are building the AR experience. There is no need to write this down, as the key will be emailed. to you and be available on the Hub.
	Step 3: Download the WebAR SDK and follow theinstalling the SDK.
	Step 4: If you need to find the licence key again, you can always find it (and manage other aspects of this project) under "Your Licenses" on the Hub.

4.3.3 Final Product of Site Planning Indicator Assembly Using Augmented Reality

The product was successfully developed by using BlippAR. Based on the aim of the objective is to design the site planning indicator assembly by using augmented reality (SPIA-AR) to access project data. The product needs to be achieved the objective of efficient of planning.

Table 4.17: *The process to design SPIA-AR*

Process Develop	Work Description
	Step 1: **Pick Drawing construction project 2D based on Scope Study** Measure it all with our engineer and project manager.
	Step 2: **Convert 2D construction drawing to Revit** Draw the drawing on Revit with right measurement.
	Step 3: **3D model to BlippAR** After complete Revit, Save as threw FBX. The purpose to use BlippAR is must to use FBX.
	Step 3: **Design Application** Create section with information

	Step 4: **SPIA-AR** After all work has been complete, the project in BlippAR can be enter for all our employee during the project start as design.

4.4 To test the effectiveness of site planning indicator assembly using Augmented Reality (SPIA-AR) to access project data.

4.4.1 Data Collection

The questionnaire and an interview that were done at the headquarters and the site office provided the information for the study's results and statistics, which are presented there. This chapter also discussed the outcomes of the project's goals. It will include the findings for the goals and state whether or not the goals were achieved.

4.4.2 Data Analysis

From the data collected from both questionnaires, by using the Microsoft Excel. This will come out with the mean and standard deviation of the results. Mean or also known as statistical mean is to essentially means average value and can be calculated by adding the data points in a set and then dividing the total by the number of values. Excel average function does the exactly sum all the values and divides the total by the count of numbers. And, standard deviation is a set of numbers that tells how far the numbers from their mean. The numbers are eventually the same which there is no variation. As for the result, the numbers have a standard deviation of zero.

SPSS stands for Statistical Package for the Social Sciences, and it is used by a variety of academics to analyze complicated statistical data. SPSS will be used to analyze data in this study. The systematic use of statistical and logical methods to

explain, show, compress, summarize, and assess data.

4.4.3 Frequency Analysis For SPIA-AR

Frequency analysis is a generic approach of analysis that is used widely in science, not just in social measurement research. In addition, it is a subfield of statistics that examines the frequency of events and assesses measures like central tendency, dispersion, percentiles, and so on. obtaining the analysis frequency date with SPSS. The drawbacks with the current technique are listed in the table below

Table 4.17: *Effectiveness of SPIA-AR to access project data result*

No	The Constrain elements of the SPIA-AR method	Related to the SPIA-AR method	Scale Likert				
			Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
1	2D Drawing difficulties	2D Drawing has little data or information (only portrayed in two dimensions)	0.0%	0.0%	0.0%	93.5%	6.5%
		2D drawings, changes toward design are challenging.	0.0%	0.0%	0.0%	93.5%	6.5%
		It will be challenging for non-technical individuals to understand the current design in 2D drawings	0.0%	0.0%	0.0%	90.3%	9.7%
		Average:	0.0%	0.0%	0.0%	92.4%	7.6%

2	Produce digital prototype	2D drawings cannot be used to produce digital prototypes in faster time.	0.0%	0.0%	0.0%	93.3%	6.7%
3	Checking process	The checking process for 2D Drawing takes time.	0.0%	0.0%	0.0%	96.7%	3.3%
		It is challenging to consider all available design alternatives while using 2D drawings and sketches because of their limits to understand	0.0%	0.0%	0.0%	90.3%	9.7%
		Current 2D drawing takes time to create the prototype for spotting the problem.	0.0%	0.0%	0.0%	93.5%	6.5%
		Average:	0.0%	0.0%	0.0%	93.5%	6.5%
4	Less collaboration	Current 2D Drawing provides less collaboration with different disciplines involved in the same project	0.0%	0.0%	0.0%	90.3%	9.7%
5	Misunderstanding	Lack of 3D visualization which causes misunderstanding and poor communication that affects project success.	0.0%	0.0%	0.0%	19.4%	80.6%

6	Materials order	2D drawing method always cause wrong material order may cause over cost and project delay.	0.0%	0.0%	0.0%	100.0 %	0.0%
		2D alone design environment will maximum time to market and cost during	0.0%	0.0%	0.0%	90.3%	9.7%
		Average:	0.0%	0.0%	0.0%	95.2%	4.9%
7	BIM knowledge	The site planning indicator assembly need to design and develop for efficient site planning to reduce data collecting time on site.	0.0%	0.0%	0.0%	96.7%	3.3%
		Understanding in BIM (BIM Information Building) is important to create faster digital prototype.	0.0%	0.0%	0.0%	96.7%	3.3%
		Average:	0.0%	0.0%	0.0%	96.7%	3.3%

In Section B, the respondent's opinion on the minimize of monitoring construction productivity is offered. On a scale of 1 to 5, respondents were asked to indicate how much they agreed with Table 4.16. Table 4.16 displays the respondent's viewpoint on the currently used procedure for dealing with e-QTP-related difficulties. On a scale of 4 (agree) and 5 (slightly agree), the majority of respondent's state.

4.4.3.1 Reliability Test

The features of measuring scales and the elements that make up the scales were studied using reliability tests. The Reliability Test approach produces a number of commonly

used scale reliability indicators as well as information on scale item correlations. Interclass correlation coefficients can be used to construct inter-rate reliability estimates

Table 4.8 *Range of reliability and its coefficient of Cronbach's Alpha*

No	Coefficient of Cronbach's Alpha	Reliablity Level
1	> 0.90	Excellent
2	0.80 - 0.89	Good
3	0.70 - 0.79	Acceptable
4	0.60 - 0.69	Questionable
5	0.50 - 0.59	Poor
6	< 0.50	Unacceptable

Table 4.18: *Reliability Test Cronbach's Alpha Based on Standardized Items*

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.960	0.952	13

4.4.3.2 Average Mean

In research, the fundamental characteristics of the data are described using descriptive statistics. The sample and the measurements are briefly summarized by them. This serves as the foundation for nearly all quantitative analyses of data when combined with straight forward graphical analysis. Normal distinctions between descriptive and inferential statistics exist. In this project are only describing what is or what the data indicates when we use descriptive statistics.

Table 4.19: *Descriptive Test of average mean of SPIA-AR*

	N	Mean		Std.	Variance
	Statistic	Statistic	Std. Error	Deviation	Statistic
2D Drawing difficulties	30	4.10	0.056	0.305	0.093
	30	4.07	0.046	0.254	0.064
	30	4.10	0.056	0.305	0.093
Produce digital prototype	30	4.07	0.046	0.254	0.064
Checking process	30	4.03	0.033	0.183	0.033
	30	4.10	0.056	0.305	0.093

	30	4.07	0.046	0.254	0.064
Less collaboration	30	4.10	0.056	0.305	0.093
Misunderstanding	30	4.80	0.074	0.407	0.166
Materials order	30	4.00	0.000	0.000	0.000
	30	4.10	0.056	0.305	0.093
BIM knowledge	30	4.03	0.033	0.183	0.033
	30	4.03	0.033	0.183	0.033

Table 4.20: *Average Mean of SPIA-AR*

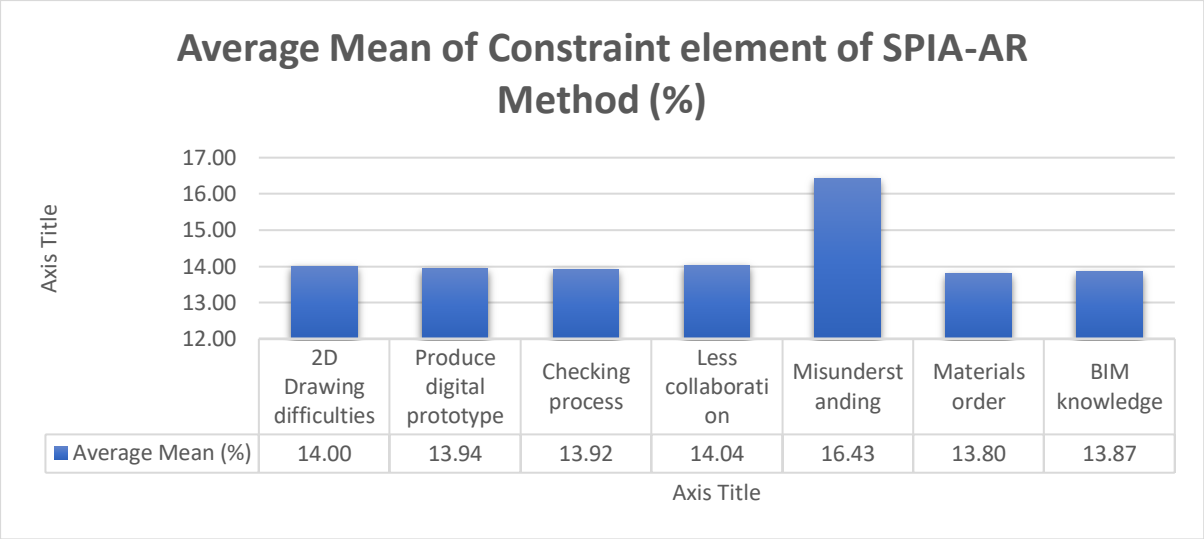
No	Mean Range	Interpretation
1	**4.51 - 5.00**	**Very High**
2	**3.51 - 4.50**	**High**
3	**2.51 - 3.50**	**Medium**
4	**1.51 - 2.50**	**Low**
5	**1.00 - 1.50**	**Very Low**

Table 4.21: *Percentage of Average Mean of SPIA-AR*

No	Constraint elements of the SPIA-AR method	Mean	Average Mean	Average Mean (%)
1	**2D Drawing difficulties**	**4.10**	**4.09**	**14.00**
		4.07		
		4.10		
2	**Produce digital prototype**	**4.07**	**4.07**	**13.94**
3	**Checking process**	**4.03**	**4.07**	**13.92**
		4.10		
		4.07		
4	**Less collaboration**	**4.10**	**4.10**	**14.04**

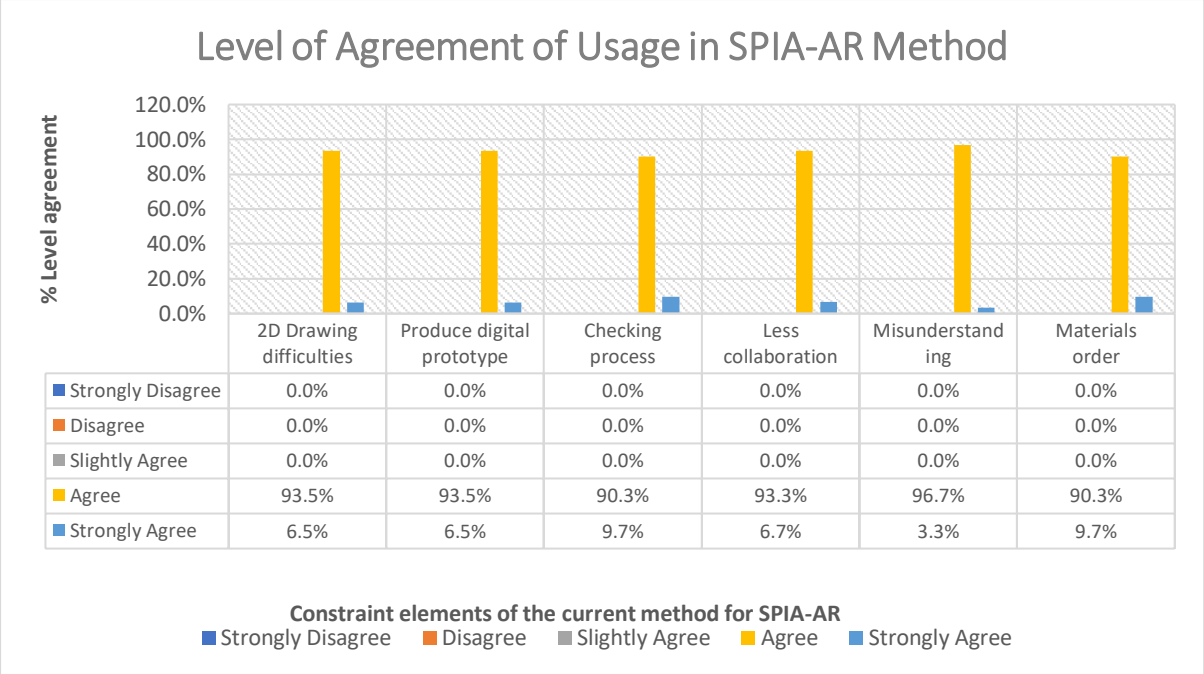
5	**Misunderstanding**	**4.80**	**4.80**	**16.43**
6	**Materials order**	**4.03**	**4.03**	**13.80**
		4.03		
7	**BIM knowledge**	**4.00**	**4.05**	**13.87**
		4.10		
Total Average		**4.12**	**29.21**	**100**

Table 4.22: *Average Mean of SPIA-AR*



According to the statistics in Table 4.21, Table 4.23 and Figure 4.6 above, the greater percentage rate of average mean, the require SPIA-AR for Site Planning is misunderstanding with 16.43%. Second, Less collaboration with 14.04%. Third, 2D drawing difficulties with 14.00%. Fourth, Produce digital prototype with 13.94%. Fifth, checking process with 13.92%. Next, BIM knowledge with 13.87% and last one material order with 13.80%.

Table 4.23*: Level of Agreement of Usage in SPIA-AR method*



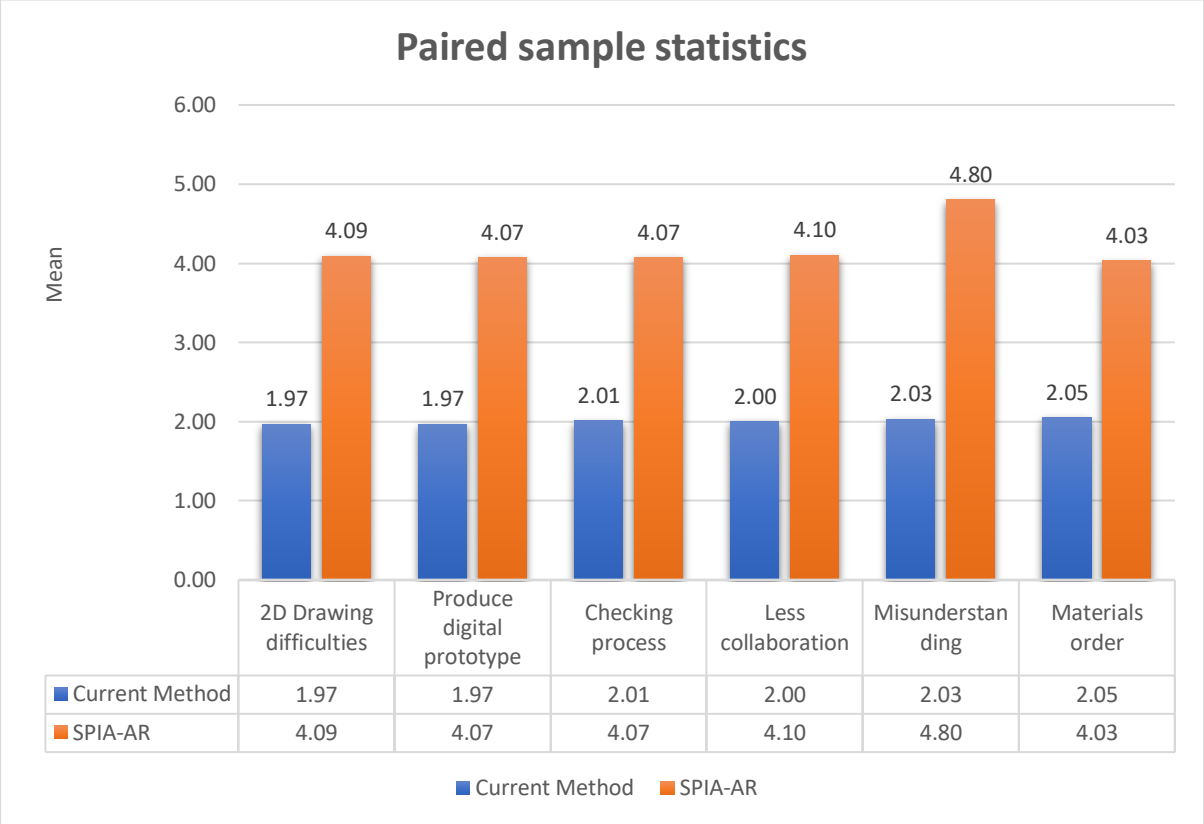
4.4.3.3 Paired T-test Analysis

Table 4.24: *Paired sample statistic*

	Paired sample statistics	
	Mean	
Effectiveness category	Current Method	SPIA-AR
2D Drawing difficulties	1.97	4.09
Produce digital prototype	1.97	4.07
Checking process	2.01	4.07
Less collaboration	2.00	4.10
Misunderstanding	2.03	4.80
Materials order	2.05	4.03
BIM knowledge	2.03	4.05

Figure 4.7: Paired sample statistic

/



CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

Based on the data analyzed in the previous chapter, this chapter provides a summary of the findings, conclusions, and recommendation. The effectiveness of the Site Planning Indicator Assembly Using Augmented Reality more efficient of planning to order material at suppliers in PTT at LRA Sungai Limau. It was assessed by establishing how well some of the study's objectives were met.

5.2 Conclusion

In this study, design thinking is used as the research framework. Design thinking is a process of design methodology that provides a solution-based approach to problem solving. It is really useful in tackling complex problems that are ill-defined or unknown by understanding the human needs involved by re-framing the problem in human-centric ways by creating many ideas in brainstorming sessions.

The aim of this study is to design the site planning Indicator Assembly by using Augmented Reality (SPIA-AR) to access project data for more efficient of site planning. From oral interview, observation, and questionnaire data, it shows that the problems when lack of direct information, especially in the latest drawing or design drawing to site and somehow lack of 3D visualization which causes misunderstanding and poor communication that affect project success. From the findings, it shows that the existing method to be misunderstanding.

The first objective of the study is to design Site Planning Indicator Using Augmented Reality at PTT INFRA in Sungai Limau Project. From the findings, it shows that a Site Planning Indicator need to design a 3D model condition on site, to reduce lack of miscommunication and understanding on site and to ordering material on site.

The second objective is to develop the Site Planing Indicator Assembly using Augmented Reality. In Chapter 3, Methodology has reviewed the methodology during the study specially to design website for development of the SPIA-AR. The SPIA-AR develop by using BlippAR which is a website builder to user view the 3D model and documents. It is also friendly user that can be access everywhere using gadgets.

To evaluate the effectiveness of Site Planning Indicator Assembly Using Augmented Reality, a survey is distributed using Google Form as the last objective to target respondents. Based on the results, the respondents agree that the SPIA-AR is effective for more efficient of 3D visualization and reduce wrong material order.

Overall, from the findings of the oral interview, observation, and questionnaire, it can be determined that they have roughly problems with wrong material at site. All of the problems that occur give an impact on the respondents. The SPIA-AR was trialed at PTT INFRA at Sungai Limau and found to be effective in the planning process and user friendly.

5.3 Advantages of Using SPIA-AR for access project data for efficient site planning

There are a few advantages by using Site Planning Indicator Using Augmented Reality which is smooth communication between Site Engineer and Project Manager to gain information without any misunderstanding on detail material on site before ordering the stuff. Moreover, using Site Planning Indicator Assembly Using Augmented Reality also helps site engineer on site and other can order material without any lack of ordering material. Next, the data on SPIA-AR is property and casual that only workers such as project manager, site engineer, qaqc can enter the user by got a password so that not simply user can access the website.

1. Site Planning Indicator Assembly Using Augmented Reality (SPIA-AR) is online website storage and can be used with gadgets. This system is user-friendly where the system can be access anywhere and anytime.
2. Only authorize person or webmaster can enter the website by using username and password.

5.4 Recommendations for the Improvement of using SPIA-AR for access project data

In conclusion, the questionnaire survey revealed that the majority of respondents expressed satisfaction with the prototype of the application designed for project monitoring in site construction. This positive feedback indicates that the prototype has effectively met the expectations of the users.

Furthermore, the survey results suggest that the application has the potential to significantly enhance the efficiency of project planning in site construction. The anticipated benefits include improved planning capabilities, enhanced productivity, and better tracking of work progress. These factors are crucial in ensuring the timely identification of issues, effective coordination among team members, and overall optimization of project execution.

However, it is important to note that these conclusions are based on the survey responses obtained from a specific sample of respondents. To validate and generalize these findings, further testing and feedback collection from a broader range of stakeholders in the construction industry would be beneficial.

Overall, the positive response from the majority of respondents indicates that the prototype holds promise for improving project planning efficiency in site construction. Further development and refinement of the application based on this feedback are likely to yield positive outcomes and contribute to enhanced project management practices in the construction field

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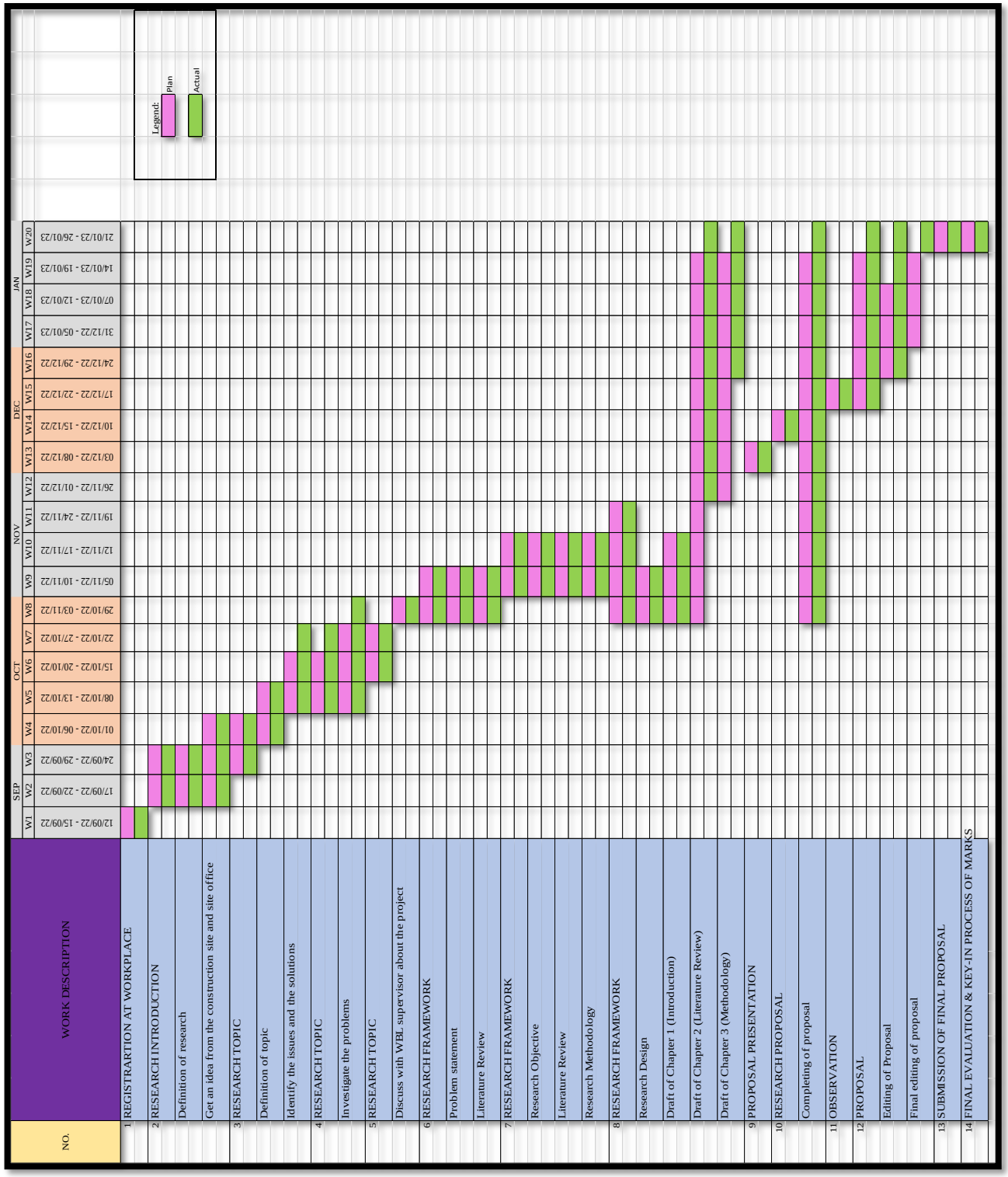
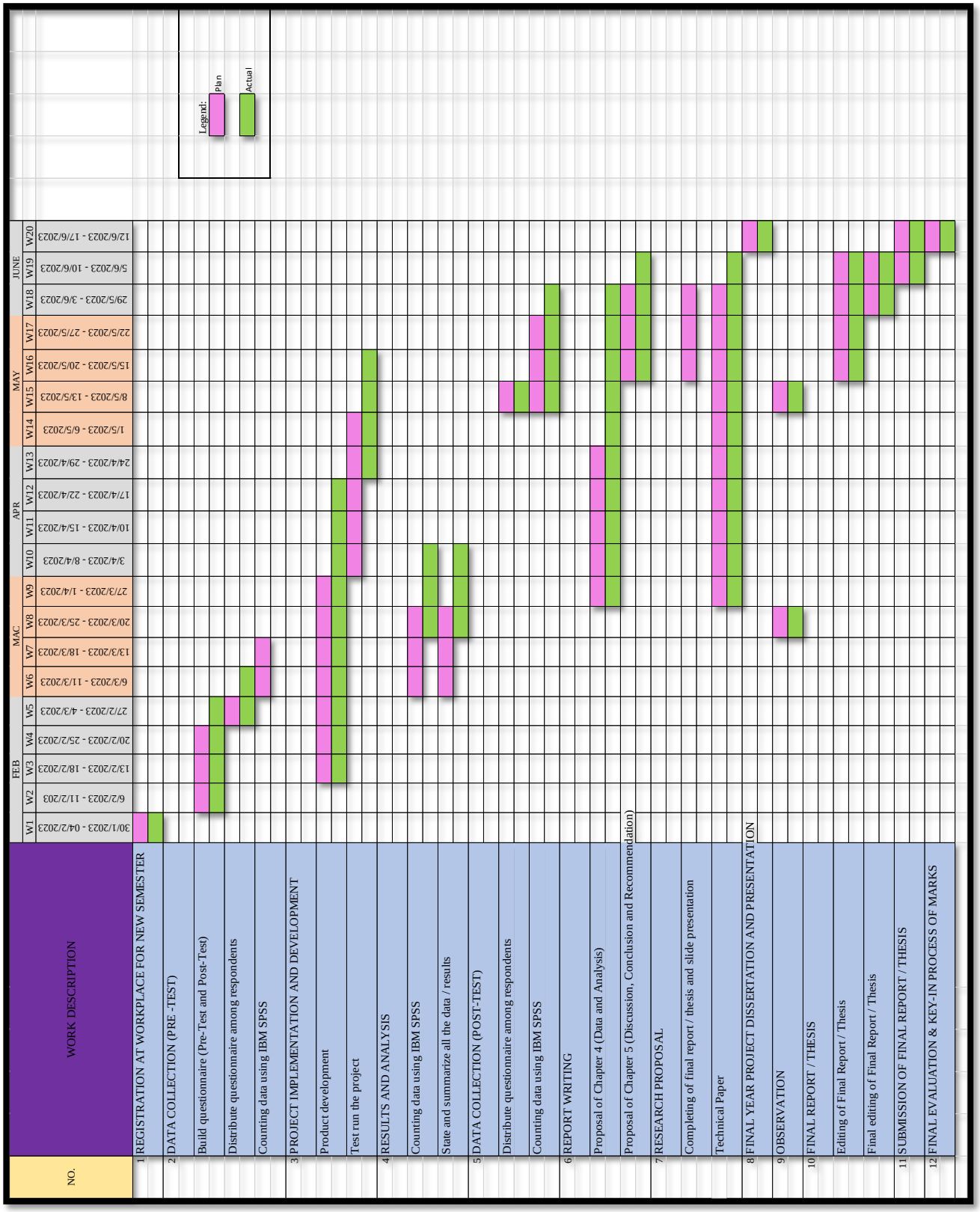
APPENDIX

APPENDIX A

Gantt Chart Semester 7



Gantt Chat Semester 8



APPENDIX B

BCT 83010 - FINAL YEAR PROJECT

TITLE OF TOPIC : Site Planning Indicator Assembly using Augmented Reality

Survey Questionnaire

A part of my study Final Year Project for Bachelor of Civil Engineering Technology (BCT) at Politeknik Ungku Omar (PUO), Ipoh, Perak. I am Muhammad Shafiq Aiman Bin Shariffudin (01BCT20F3032), and I am conducting a survey of pre-test questionnaire. In order to overcome the needs of digital medium to be design and develop the Site Planning Indicator Assembly using AR for Project LRA Sg. Limau.. Thankyou.

Supervisor's Name: Pn. Noraziah Binti Hamid

Name Student : Muhammad shafiq aiman Bin Shariffudin ID : 01BCT20F3032

Section A: Personal Information

Please tick only one answer on each of the following question.

1. Age

[ ] 18-24 years old

[ ] 25-34 years old

[ ] 45-54 years old

[ ] 65 years old and above

[ ] 55-64 years old

2. Work Experience

[ ] < 2 years

[ ] 6-10 years

[ ] 2-5 years

[ ] 10 years or above

3. Job Position

[ ] Project Manager [ ] Site Supervisor

[ ] Site Engineer [ ] Site Clerk

Section B: Pre Questionnaire

Please use this scale to answer the following questions by circling the most appropriate response.

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

The Constrain elements of the SPIA-AR method	Related to the SPIA-AR method	Scale Likert				
		Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
2D Drawing difficulties	2D Drawing has little data or information (only portrayed in two dimensions)					
	2D drawings, changes toward design are challenging.					

	It will be challenging for non-technical individuals to understand the current design in 2D drawings					
	Average:					
Produce digital prototype	2D drawings cannot be used to produce digital prototypes in faster time.					
Checking process	The checking process for 2D Drawing takes time.					
	It is challenging to consider all available design alternatives while using 2D drawings and sketches because of their limits to understand					
	Current 2D drawing takes time to create the prototype for spotting the problem.					
	Average:					
Less collaboration	Current 2D Drawing provides less collaboration with different disciplines involved in the same project					

Misunderstanding	Lack of 3D visualization which causes misunderstanding and poor communication that affects project success.					
Materials order	2D drawing method always cause wrong material order may cause over cost and project delay.					
	2D alone design environment will maximum time to market and cost during					
	Average:					
BIM knowledge	The site planning indicator assembly need to design and develop for efficient site planning to reduce data collecting time on site.					
	Understanding in BIM (BIM Information Building) is important to create faster digital prototype.					
	Average:					

BCT 83010 - FINAL YEAR PROJECT

TITLE OF TOPIC : Site Planning Indicator Assembly using Augmented Reality

Survey Questionnaire

A part of my study Final Year Project for Bachelor of Civil Engineering Technology (BCT) at Politeknik Ungku Omar (PUO), Ipoh, Perak. I am Muhammad Shafiq Aiman Bin Shariffudin (01BCT20F3032), and I am conducting a survey of post-test questionnaire. In order to overcome the needs of digital medium to be design and develop the Site Planning Indicator Assembly using AR for Project LRA Sg. Limau. Thankyou.

Supervisor's Name: Pn. Noraziah Binti Hamid

Name Student : Muhammad shafiq aiman Bin Shariffudin ID : 01BCT20F3032

Section A: Personal Information

Please tick only one answer on each of the following question.

4. Age

[ ] 18-24 years old

[ ] 25-34 years old

[ ] 45-54 years old

[ ] 65 years old and above

[ ] 55-64 years old

5. Work Experience

[ ] < 2 years

[ ] 6-10 years

[ ] 2-5 years

[ ] 10 years or above

6. Job Position

[ ] Project Manager [ ] Site Supervisor

[ ] Site Engineer [ ] Site Clerk

Section B: Post Questionnaire

Please use this scale to answer the following questions by circling the most appropriate response.

1	**2**	**3**	**4**	**5**
Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree

The Constrain elements of the current method	Issues Related to the current method	Scale Likert				
		Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree
2D Drawing is easy	2D Drawing has sufficient data or information (only portrayed in two dimensions)					
	2D drawings, changes towards design are easy.					
	It will be easy for non-technical individuals to understand the design in 2D drawings					

	Average:					
Produce digital prototype	2D drawing can be employed towards digital prototype.					
Checking process	The checking process for 2D Drawing is fast					
	It is suitable to consider all available design alternatives while using 2D drawings and sketches because of their limits in visiualization.					
	2D drawing could help to create the prototype for spotting the problem					
	Average:					
Less collaboration	2D Drawing provides more collaboration with different disciplines involved in the same project					
Misunderstanding	Lack of 3D visualization which causes misunderstanding and poor communication that affects project success					

Materials order	2D alone design environment will maximise time to market and cost during					
	2D drawing method always provide correct material order and may help reduse cost and project delay.					
	Average:					
BIM knowledge	Do you possess in-depth understanding of BIM? (Building Information Building)					
	Lack of BIM understanding in BIM (BIM Information Building) help to create faster digital prototype					
	Average:					