IMPACT OF ARTIFICIAL INTELLIGENCE (AI) SYSTEM IMPLEMENTATION IN THE CONSTRUCTION INDUSTRY: CASE STUDY OF KLANG VALLEY

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MAY 2023

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A research project submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF BUILDING AND PROPERTY MANAGEMENT (HONS)

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF ACCOUNTANCY AND MANAGEMENT DEPARTMENT OF BUILDING AND PROPERTY MANAGEMENT

MAY 2023

DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) The word count of this research report is 10000 words.

Name of Student: Student ID: Signature:

  Chan Huey Min   1904019   *Hueymin*

Date: 3/5/2023

Acknowledgement

I want to express my gratitude to all the individuals who have provided me with assistance and encouragement during the course of my research. Their valuable guidance and support have been instrumental in ensuring the successful and efficient execution of my research.

Above all, I would like to express my gratitude towards Dr. Elia Syarafina Binti Abdul Shakur, who served as my project supervisor and offered her valuable assistance during the research process. She has been an excellent mentor to me, guiding me through the report-writing process to ensure that everything is accurate and progressing as planned. Her support and advice have been crucial in enabling me to finish this report on schedule. Besides, I would like to express my gratitude towards Puteri Ameera binti Mentaza Khan for giving me valuable advice during my Final Year Project Viva.

Additionally, I am thankful for the help provided by my colleagues and family members, who played a significant role in collecting the data for my research. They helped to distribute the survey form to the appropriate participants, which boosted the study's dependability and facilitated timely data analysis.

In addition, every of the respondents' assistance was greatly appreciated. They are critical to the data gathering process, and they are willing to spend their time to complete the questionnaire. Last but not least. Their encouragement and support are the fuel that keeps me going.

Furthermore, I am immensely grateful for the assistance of each and every respondent. Their participation was essential to the data collection process, and their willingness to devote time to complete the questionnaire is highly valued. Finally, their encouragement and support have been a tremendous source of motivation for me throughout this research endeavour.

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List of Abbreviations

AI   Artificial Intelligence

NLP   Natural Language Processing

ML   Machine Learning

ANI   Artificial Narrow Intelligence

AGI   Artificial General Intelligence

AR   Augmented Reality

VR   Virtual Reality

BIM   Building Information Modelling

AEC   Architect, Engineering and Construction

GCPs   Ground Control Points

RII   Relative Important Index

SPSS   Statistical Package for Social Sciences

Preface

I have prepared the UKMZ3036 project report as a part of my undergraduate program in Building and Property Management. The research aims to achieve two primary objectives. Firstly, to identify the significant factors that could have an impact on the implementation of Artificial Intelligence (AI) systems in the Klang Valley construction industry. Secondly, to evaluate the most crucial factor that could bring improvements to the implementation of AI systems in the Klang Valley construction industry. Since Artificial Intelligence is a critical component of the construction industry, it is essential to determine the factors that affect its implementation in this field.

Nowadays, there seems to be a lack of awareness among individuals regarding the impact of AI system implementation on the construction industry in Malaysia. The understanding of the importance of AI implementation in the construction industry, which is crucial for economic growth. Thus, I have undertaken a research investigation to identify the factors that impact the implementation of Artificial Intelligence in the construction industry. The research aims to determine the main factor that affects the implementation of AI systems and evaluate the most critical factor that can improve AI implementation in this industry. The findings of this research may prove helpful in achieving the objective of identifying the primary impact of AI implementation in the construction industry.

Abstract

The implementation of Artificial Intelligence (AI) systems in the construction industry has been a topic of interest in recent years due to its potential to improve efficiency, productivity, and safety. This study aims to investigate the impact of AI system implementation in the construction industry, using Klang Valley as a case study. The study will explore the current use of AI systems in the industry, identify the challenges faced by construction companies during implementation, and evaluate the impact of AI systems on the industry's productivity, cost, and safety and security. The study will be conducted through undergo a survey with industry experts and the employees in construction industry. The findings of this study will provide insights into the benefits and limitations of AI systems in the construction industry, which can be used to guide future implementation and policy decisions.

Chapter 1 Introduction

1.1 Introduction

The growth of the construction industry is limited due to several complex challenges, such as high implementation costs, safety and security concerns, and a shortage of skilled labour, which affects productivity. Additionally, the industry is among the least digitized globally, making it challenging to address these challenges effectively. However, the industry is now adopting Artificial Intelligence (AI) as a transformative solution. AI has been implemented in Malaysia since the fourth industrial revolution to enhance project delivery quality. It is believed that AI has the potential to enhance project quality, reduce project duration, costs, and design by introducing advanced technology to the construction industry.

1.2 Research Background

In the 1950s, Alan Turing, a British polymath, discovered the potential of utilizing mathematics in Artificial Intelligence (AI). He believed that if humans could use existing knowledge to make decisions and find solutions, then robots and machines could do the same as well. This led to the establishment of Computing Intelligence and Machinery, which focused on creating AI machines and measuring their intelligence, organized logically along these lines.

From 1957 to 1974, Artificial Intelligence (AI) made significant progress as computers became more capable of storing and processing data at a faster and cheaper rate. In the meantime, machine learning algorithms were established, and humans became more proficient at defining algorithms to solve different problems. This progress led to the Defense Advance Research Project Agency (DARPA) sponsoring AI research at various institutions, with a particular focus on a device that could process vast amounts of data and transcribe and translate it into human language. At that time, expectations and optimism were high, although only a structural proof of concept had been achieved, and natural language processing, abstract thought, and self-recognition still required considerable work.

During the 1980s, the interest in Artificial Intelligence (AI) was renewed among professionals because of two reasons: the enlargement of the range of algorithms available and a surge in financial support. In this era, John Hopfield and David Rumelhart developed deep learning techniques that enabled computers to learn and reason like humans, while Edward Feigenbaum developed expert systems that emulated human decision-making. Once programme is functioned, these systems could guide non-experts step-by-step on how to react in specific cases. Up to now, the expert systems were widely applied in various industries especially in construction industry.

In generation between 1990s and 2000s, AI accomplished various objectives, including significant achievements in 1997. During that year, the computer program Deep Blue, created by IBM, defeated Gary Kasparov, the reigning world chess champion, which was a notable milestone in the progress of intelligent decision-making software. Furthermore, in the same year, the introduction of the 'Windows' software, which incorporated speech recognition capabilities, brought about a new level of convenience for users and propelled the development of spoken language interpretation technology forward. (Anyoha, 2020)

From the 2000s onwards, various industries such as retail, manufacturing, healthcare, life science, and construction have gradually adopted Artificial Intelligence (AI) systems. In particular, the construction industry has begun to embrace Artificial Intelligence (AI) to enhance its success rate in the initial tender process. Artificial Intelligence (AI) is capable of analysing project bids based on past project data, identifying successful practices, and avoiding failures encountered in previous projects. These learning procedures have the potential to increase a construction company's chances of winning bids, improve profitability, and enhance project value compared to the previous decades when Artificial Intelligence (AI) was not integrated into the construction industry.

1.3 Problem Statement

In this problem statement section, there are several challenges would encounter by the related firms and employees in construction industry. below will discuss the

three mains' challenges currently encountered by firms and employees in construction industry when implementing artificial intelligence system in the construction project.

Although Artificial Intelligence (AI) has the potential to enhance security and prevent the leakage of confidential information, it is also vulnerable to manipulation by cybercriminals and privacy violations. This poses significant economic and financial risks, as any exposure of confidential information could impact the project's budget, schedule, and quality, such as supply chain, logistics, procurement, and more. In addition to cybersecurity concerns, the safety of construction workers may also be compromised, leading to accidents, injuries, or even fatalities. For instance, computer vision systems that recognize automated construction equipment may misclassify workers at heights, resulting in safety hazards. Hence, it is the responsibility of construction companies to implement Artificial Intelligence (AI) in construction with minimal or no safety risks to ensure the safety of both the workforce and equipment.

Implementing Artificial Intelligence in construction can bring positive benefits, but cost is a significant challenge that construction companies face. Certain Artificial Intelligence (AI) systems, including robotics, can come with a significant initial cost to obtain accurate data, and ongoing upkeep such as system maintenance and talent wages should also be considered (Regona et al., 2022). Small construction businesses and subcontractors may face significant risks when investing in Artificial Intelligence (AI) system, as it requires significant commitment to research and development in a competitive industry. To make informed decisions, construction firms should evaluate cost savings and return on investment. As Artificial Intelligence (AI) system spreads throughout the industry and gains acceptance, costs are anticipated to decrease, making it more affordable for smaller businesses. (Akinadea, 2021)

Additionally, the lack of skilled workers is a major challenge for construction companies when implementing Artificial Intelligence (AI) in the construction industry. According to a research statistic department in 2022, the number of employees in the construction industry has decreased from 1.5 million in 2015 to 1.38 million in 2021 (Statista Research Department & 5, 2022). This is

because young people nowadays are less interested in the construction industry, leaving behind older employees who are closer to retirement. As the older generation of employees retire, less experienced new generations are required to fill their roles to replace the previous retire employees. This creates a phenomenon in which there are fewer new entrant employees and older generation employees may not have the stamina to manage the Artificial Intelligence (AI) system. Therefore, the shortage of skilled labour is the primary factor that affects the productivity of construction projects.

According to the literature review, there are three major challenges that hinder the implementation of Artificial Intelligence (AI) systems in the construction industry. This report will discuss proposed strategies and recommendations to address these challenges and improve Artificial Intelligence (AI) systems in the construction industry.

1.4 Research question

This study able to answer questions in relation to Artificial Intelligence system in the construction industry, such as:

1. What are the main factor that will bring impacts of implementing AI system in the construction industry in Klang Valley?

2. What are the most main factor that will bring impacts improving AI system in the construction industry of Klang Valley?

1.5 Research objective

General objective: To determine factors of how AI system influences the construction sector in Malaysia.

Specific objective:

1. To identify the main factor that will bring impacts of implementing Artificial Intelligence (AI) system in Klang Valley construction industry.
2. To evaluate the most main factor will bring impacts to improve Artificial Intelligence (AI) system in Klang Valley construction industry.

1.6 Significance of study

The significance of this research topic is to investigate how the implementation of Artificial Intelligence (AI) systems affects the construction industry in Malaysia. The research aims to provide reliable and evidence-based information that can be utilized in various fields to inform decision-making, policy development, and practice. This is particularly important in the construction industry where decisions can greatly impact the quality of construction.

Moreover, rresearch supports academic study which provides future researchers and scholars with access to the latest research findings, enabling them to build upon existing knowledge and contribute to the construction field. From that, it can improve and update the research and journal with the latest findings and information and specifically in Malaysia construction industry instead of the information from foreign country.

Last, there is a knowledge gap resulting from insufficient research on the effects of the adoption of AI systems in construction by certain relevant entities, such as the government and developers. These entities can employ the results of the study as a reference to enhance the general performance of the construction industry in Malaysia.

1.7 Chapter layout

To achieve this goal, the study will be structured into five chapters that will encompass different stages of the research process, including identifying the research problem, conducting a thorough literature review, collecting, and analysing data, and drawing conclusions based on the findings. In essence, the study is designed to provide reliable, evidence-based information that can be used to inform decision-making, policy development, and practice in various fields, particularly in the construction industry, where decisions can significantly affect the quality and safety of construction projects. Therefore, the research will involve a

rigorous and systematic approach that will help to uncover the challenges and opportunities associated with the adoption of AI in the construction industry in Malaysia.

Chapter 1 provides the comprehensive discussion of the research background, problem statement, research question, research objective, significance of the study, chapter layout, as well as a conclusion. This chapter serves as an introduction that provides the readers with an initial understanding of the research issue and direction. It outlines the rationale for the study, identifies the specific problem that the research aims to address, and formulates a research question that the study seeks to answer. Additionally, this chapter lays out the significance of the research and explains how the study will contribute to existing knowledge in the field. Finally, it presents a summary of the chapter layout, providing the readers with an overview of what to expect in the subsequent chapters.

In Chapter 2 of the research report, the focus will be on evaluating the impact of the Artificial Intelligence (AI) system in the construction industry in Malaysia. The primary objectives of this chapter are to assess how AI is influencing different aspects of the construction industry, such as safety and security, productivity, and cost. To achieve these objectives, a comprehensive literature review will be conducted to identify and evaluate the existing research studies relevant to the impact of AI in the construction industry. The literature review will provide valuable insights into the different ways that AI can contribute to the construction industry and help overcome the challenges faced by this industry. Furthermore, the review will help identify gaps in the current knowledge and point to areas for further investigation. The study will draw on evidence-based research to support the findings and conclusions in this chapter.

Chapter 3 will elaborate on the research design that will be used for the study, including the data collection method, research methodology, and analysis techniques. This chapter will also detail how the poll questions will be created and disseminated to ensure that the study is conducted with utmost accuracy and reliability. Additionally, it will outline the procedures and processes that will be followed to obtain the most relevant and accurate data for the research question. It

is important to have a well-designed and executed research plan to ensure that the study's findings are valid, reliable, and generalizable to the population of interest.

In Chapter 4, the focus will be on the outcomes of the research conducted on the factors that have a significant impact on the construction industry in Malaysia. The data collected and analysed will be used to achieve the research objective. The results will provide insights into the areas that need attention and improvement in the construction industry and will serve as a basis for making recommendations and proposing solutions. This chapter will also highlight the limitations of the study and suggest directions for future research. The analysis of the data collected will be presented in a clear and concise manner, making it easy for readers to comprehend and draw conclusions.

In Chapter 5 discusses the overall conclusion and final outcome of the research based on the data analysis and findings gathered throughout the study. The conclusion will focus on summarizing the key points and answering the research question, while also providing insights into the implications of the results for the construction industry in Malaysia. Additionally, this chapter will offer suggestions for further research on this topic and any limitations of the study that should be addressed in future research. Ultimately, this chapter will provide a comprehensive and informative end to the study, tying together all of the previous chapters and providing a clear understanding of the research and its implications.

1.8 Conclusion

The research background in this topic highlights the current problem in the construction industry. Furthermore, the study's primary objective has been clearly articulated, which is to gain a comprehensive understanding of the central theme. In the upcoming Chapter 4, the research will reach deeper into the subject matter by examining and analysing the findings and experiences of previous researchers. This approach aims to provide an in-depth and thorough discussion on the implications and effects of AI systems in the context of the construction industry specifically in Malaysia.

Chapter 2 Literature Review

2.0 Introduction

Artificial Intelligence (AI) is a technology that mimics human intelligence by utilizing algorithms to analyse vast amounts of data. This technology can address concerns such as cost overruns, productivity, and safety issues in construction projects, leading to increased client satisfaction. Not only that, AI can also enhance communication between different parties and reduce training costs, materials, and time using NLP and cognitive computing theory. AI can support various services from conception, design, bidding, financing, managing transportation, operation, and asset management throughout the entire construction project. In Malaysia, AI systems are already widely used by construction industry professionals such as contractors, architects, developers, and engineers.

2.1 Artificial Intelligence (AI)

Artificial Intelligence (AI) involves creating devices that imitate human intelligence and behaviour, including the ability to learn and solve problems. This can also apply to computers that exhibit human-like thought processes. Good quality of AI should be capable of reasoning and creating action plans that effectively achieve desired goals. Machine Learning (ML) is a subset of AI that uses computer programs to automatically learn from and adapt to new data without human intervention. For instances, deep learning systems accomplish this self-directed learning by analysing large amounts of unstructured data such as text, photos, or videos. (Frankenfield, 2022)

In this generation, the importance of innovation in the construction industry to address urban sustainability challenges in a world that is rapidly urbanizing. However, the construction industry has been one of the least innovative sectors, resulting in limited productivity and growth over the past few decades. This is due to the industry's low level of digitization compared to other sectors like manufacturing, retail, and healthcare. The construction industry has experienced a

meagre 1% growth in productivity annually in the last twenty years, which has led to concerns about the industry's efficiency.

2.1.1 Type of Artificial Intelligence

First and foremost, Artificial Intelligence (AI) can be categorised into 3 types. The first type is Artificial Narrow Intelligence (ANI), which includes all existing AI systems, including the most complex and skilled ones. ANI is designed to execute specific tasks independently by imitating human characteristics. These machines have a narrow range of competencies as they can only do what they are programmed to do. Machine learning, which has two parts, shallow learning and deep learning, can enhance the design of buildings. For example, WeWork uses technology to evaluate and estimate the frequency of use for meeting rooms to enhance their design before construction begins. IBM's Watson, which falls under Narrow Artificial Intelligence, combines AI with sophisticated analytical software to create optimal performance as a "question answering" system. (Burns, 2023). Watson can also assist organizations in estimating future outcomes, generating suitable methods to encounter complicated processes, optimizing labor time, and improving the level of construction efficiency.

For the second type of AI called Artificial General Intelligence (AGI), which is also known as Strong AI. AGI has the ability to initiate human behaviour and is considered an AI agent that can think, observe, understand, and imitate human characteristics. These systems can independently develop numerous abilities, connect between domains, and draw generalizations, significantly reducing the time required for training. AGI systems can mimic human capacity for many tasks, making them equally competent. One of the key features of AGI is its ability to independently develop numerous abilities, connect between domains, and draw generalizations. This allows AGI systems to learn from different types of data, including text, images, and video, and develop a deep understanding of how things work. AGI systems can also identify relationships between seemingly unrelated data and make predictions based on that understanding.

The third type of AI is the Artificial Superintelligence (ASI), which is the most advanced version of AI that has significantly higher memory, faster data

processing and analysis, and decision-making powers. ASI can not only replicate the complex intelligence of humans but can also be incredibly better at it. The development of AGI and ASI could lead to a situation called the revolution, which is a term that has gained popularity. The revolution can refer to the emergence of intelligent machines that could surpass human intelligence and ultimately replace humans in many areas. While the potential benefits of having such powerful tools are immense, there are also concerns that these tools could pose a threat to our existence or even our way of life.

2.1.2 Application of AI System in the Construction Industry in Malaysia

The article discusses how artificial intelligence is a system that can mimic human behaviour and improve decision-making by analysing previous project data. In the Malaysian construction industry, there are currently three types of AI systems, as identified by Schia et al (2019). The AI system includes Augmented Reality (AR), Building Information Modelling (BIM), and drones.

2.1.2.1 Augmented Reality (AR)

The technology of Augmented Reality (AR) is an AI system that enhances user experience by overlaying digital information onto real-world objects and locations. It differs from Virtual Reality (VR) which creates a completely digital or computer-generated environment. Although not as well-known as VR, AR is becoming increasingly popular in various industries, including construction. The field of construction technology has a multitude of promising use cases for AI, especially in the industry of architecture, education, as well as on-site engineering processes aimed at both professionals and students. (Behzadi, A. 2016).

Augmented Reality (AR) technology has been widely used in various industries, including construction. In the construction industry, AR has several common uses. AR is commonly used for planning and presentation. AR in construction can provide a better view of the details and components from the construction plan. By visualizing the working models, authorities involved can gain a better understanding of the project. With AR technology, virtual tours can also be

taken before the start of construction, allowing stakeholders to visualize the project and make necessary changes beforehand.

Secondly, AR is commonly applied for related authorities to keep track of the project information visually in real-time. This is due to AR's ability to combine documents and digital data, making it easier for contractors, engineers, and architects to monitor and track construction progress without the need for physical site visits. This saves time and resources while keeping everyone involved up to date with the project's progress.

Moreover, AR can also be used to simulate hazardous or complex tasks, providing a safer environment for workers. With AR, workers can visualize and practice the tasks before performing them on the actual site, reducing the risks of accidents and errors. This also allows for more efficient training for workers, leading to increased productivity.

Another application of AR in construction is quality assurance and control. AR technology can be used to overlay digital data on the physical construction site to ensure that the project is being built according to the specifications and standards set by the stakeholders. This can prevent errors and mistakes in construction and increase the quality of the final product.

2.1.2.2 Building Information Modelling (BIM)

Building Information Modelling (BIM) is one of the most advanced systems In Architect, Engineering, and Construction (AEC) field. BIM technology able to provide advance improvement for workers in AEC field workers in term of design& visualization, coordination & collaboration as well as construction management.

According to Zigurat (2023), BIM is used to create detailed 3D models of project designs including structural, architectural, mechanical as well as electrical components. Adopting BIM models, it able to assist construction engineers and architects to stimulate and visualise project performance as well as identifying possible issue that might occur. Not only that, BIM models are able to provide a preview of the project before the project is built.

Besides, BIM can be applied to increase the chance of collaboration and coordination among various stakeholders in construction projects. This is because BIM models are able to perform in real-time updating of the project which allow stakeholders to access into the same platform. From that, it able to prevent from the unnecessary conflict and error occurred. Not only that, BIM models able to schedule the project timeline, allocation of budget and resources so that the stakeholder can keep track the progress to make optimum decision for the project. With the capabilities of BIM models, it improves the teamwork among stakeholders by restructuring the traditional working habits which all stakeholders able to voice out their issue anytime via BIM technology as the stakeholder able to keep track the project performance in real time in accordance with Sampaio et al. (2022).

Furthermore, BIM models can also improve the performance in construction management includes cost estimation, quality control as well as planning& scheduling. BIM models can develop detailed construction timeline which allow stakeholder to manage and allocate the workforce, equipment, and resources wisely. With the BIM models, stakeholders able to figure out the potential issue by tracking the real time performance of the construction project. For instance, Vico Office Inc. is one of the BIM software developed by Vico software which the software able to provides function of scheduling, coordination as well as estimation which brings big improvement on the performance in construction management industry in accordance with Hergunsel (2011).

In shorts, BIM can be defined as one of the powerful AI systems to improve construction projects in different aspects.

2.1.2.3 Drone

Drone is one of the common AI systems which now is broadly used in the construction industry. Drones consist of powerful system able to enhance the performance of construction projects in different aspects. There are three mains' reasons of drone are widely used in the construction industry Malaysia including the use of site inspection and progress tracking; mapping and measurement as well as the safety and security issues.

First, the drone is widely used to conduct a site inspections and progress tracking before and during construction. By using drones, it is able to determine potential issue, keep track the progress of the construction projects as well as able to detect any changes in the site. As drone able to provide the real-time images and videos of construction site, it can have a clear vision for engineers, contractors, and architects to monitor the performance of the project and come out with solutions if any potential issue occurred (Ashour et al., 2016).

Secondly, drone is commonly applied in mapping and measurement as drone consists of the ability to gather accurate measurements and data on the construction sites such as distance, volume as well as elevation. In order to increase the accuracy, the drone's operator is required to seek the Ground Control Points (GCPs). When the operator gets the aerial images taken by drone, can be adjusted by using GCPs if any occurrence of unclear or distortions of the captured image are caused by drone's altitude or the camera lens etc (Nooralishahi et al., 2022). Hence, it helps to increase the accuracy of the entire construction plan and is able significantly lower the risk of errors during construction.

Lastly, drone able to ensure the safety and security of construction site by monitoring the condition of the construction site. drone can be used to estimate the construction areas which is hard to reach by labour such as roofs top, especially in high-rise projects. it is able to minimize the operational risk as the usage of drone able to acquire topographical site data without reaching on-site or in hard-to-reach areas such as rooftops, especially in high-rise project (McSteen, 2022). It able to ensure labour work in an easy and safe work environment.

2.2 Importance of Artificial Intelligence in the Construction Industry

The construction industry is gradually adopting Artificial Intelligence (AI) systems, and this fact has been acknowledged by various stakeholders, including contractors, developers, architects, among others. In the following sections, we will discuss how AI is enhancing the construction industry.

There is an increasing adoption of Artificial Intelligence (AI) in the construction sector, as it is recognized by various stakeholders such as contractors, developers, and architects. One of the most significant benefits of AI in construction is its ability to streamline the planning phase. Mordor Intelligence conducted a survey that revealed over 35% of construction industry workers are occupied with unproductive tasks related to project planning and design issues, such as paper-based communication, rework etc. To tackle this challenge, the development of AI automation solutions has begun, with the aim of streamlining the planning process by leveraging historical data to improve decision-making in similar scenarios in the future. Additionally, AI can analyse large datasets, evaluate numerous models generated by diverse teams, and identify the optimal design options. Therefore, AI has the potential to enhance the project design process.

In addition, the use of Artificial Intelligence can greatly improve the quality of construction management. By analysing and evaluating past construction projects, AI-based solutions can generate more advanced blueprints for designing and constructing projects. This, in turn, enhances various aspects of construction, including project planning, task management, and providing valuable insights to clients to prevent unnecessary issues that can cause delays or increase expenses. AI can also play a crucial role in detecting uncertainty and changes in the project and taking corrective action in the early stages to prevent errors from deviating too far from the original plan. This allows for corresponding adjustments to be made to the construction schedule, and for all relevant parties to be notified of changes and delays. Overall, the integration of AI can greatly enhance the construction process and improve project outcomes.

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from the original plan. This allows for corresponding adjustments to be made to the construction schedule, and for all relevant parties to be notified of changes and delays. In overall, the integration of AI can greatly enhance the construction process and improve project outcomes.

2.3 Main factor will impact when implementing AI system in the construction industry.

This section will be discussed the main factor which brings effects when implementing Artificial Intelligence (AI) system in the construction industry.

2.3.1 Productivity

According to author Schia et al. (2019), the implementation of Artificial Intelligence (AI) can significantly boost productivity in the construction industry. When utilized correctly, AI can identify potential budget overruns, safety hazards, and design flaws early on. By integrating AI with the security system on construction sites, companies can monitor the movement of equipment, materials, and workers and detect any harmful behaviour or incidents, alerting those in the vicinity. Additionally, autonomous machinery can take over repetitive tasks, freeing up workers to focus on more complex and manual tasks that increase productivity. For example, schematic design and 3D printing are being integrated into construction work, allowing contractors to fabricate components in the facility and transport them to the site with minimal labour assistance (Johansen, 2021). The AI-based project manager can track the progress of the construction project via their smartphone or smart device through the integrated security system. These technological advancements not only enhance efficiency but also decrease the chances of accidents and increase safety on construction sites.

2.3.2 Safety and Security

The second impact is the level of safety in the construction site. The construction sector is essential in building essential facilities like housing, infrastructure, and commercial buildings, but it is also known for being a high-risk

industry with workplace injuries and fatalities. According to the Occupational Safety and Health Administration (OSHA), approximately 20% of worker fatalities occur in the construction industry. Hence, it is critical to prioritize safety in construction, and AI has immense potential in improving safety. The risks and dangers involved in construction make it essential to prioritize safety. However, AI can aid in preventing accidents through the use of wearable and sensor-based technologies that monitor safety. These systems can identify hazards on the construction site and alert managers through warning notifications to alert the construction manager (Regona et al., 2022). By eliminating danger, AI not only cuts costs but also prioritizes worker safety and makes construction a more desirable field. Furthermore, AI and robotics can assist in reducing the risks associated with construction work by removing hazardous, physically demanding, and labour-intensive tasks, allowing workers to focus on more challenging tasks.

2.3.3 Cost

Apart from improving safety, Artificial Intelligence (AI) can also impact the overall cost of construction. Despite the high initial cost, AI can help manage long-term construction costs and reduce the likelihood of cost overruns. Resource management is an important area where AI can help. For example, Procore is an AI-powered resource management software that can handle the financial aspects of a construction project. By optimizing resource allocation and usage, construction firms can reduce costs and minimize waste, which can lead to improved profit margins. Also, large construction projects often generate a significant amount of waste, and AI can assist in reducing this waste by optimizing resource allocation and usage. This optimization can result in reduced costs and improved profit margins. Additionally, AI can help predict and manage construction schedules, which can reduce delays and ensure projects are completed on time and within budget. Hence, AI has the potential to significantly impact the cost of construction by enabling efficient resource management and reducing waste. With the help of AI, construction firms can reduce costs and improve profit margins, ultimately making the construction industry more cost-effective (Afzal et al., 2019).

In a previous study, it was found that implementing AI in the construction industry can have a significant impact on several factors, including cost, safety and security, and productivity. Alice's research suggests that AI software can reduce construction costs. Meanwhile, Schia et al (2019). found that AI can increase productivity by replacing manual labour with automated processes. Johansen's research indicates that AI can improve safety and security in the construction industry by reducing the need for human labour. However, these studies are focused mainly on foreign countries and lack information specific to Malaysia. Therefore, further research is needed to explore the impact of AI on the construction industry in Malaysia, specifically in terms of cost, safety and security, and productivity. By studying the impact of AI in the Malaysian context, we can gain a better understanding of how this technology can be effectively utilized to improve construction practices in the country.

2.4 Hypothesis development

H0: AI system will influence the cost in Malaysia construction industry.

H1: AI system will not influence the cost in Malaysia construction industry.

H0: AI system will influence the safety and security in Malaysia construction industry.

H1: AI system will not influence the safety and security in Malaysia construction industry.

H0: AI system will influence the productivity in Malaysia construction industry.

H1: AI system will not influence the productivity in Malaysia construction industry.

2.5 Review of Relevant Theoretical Framework of AI implementation in construction
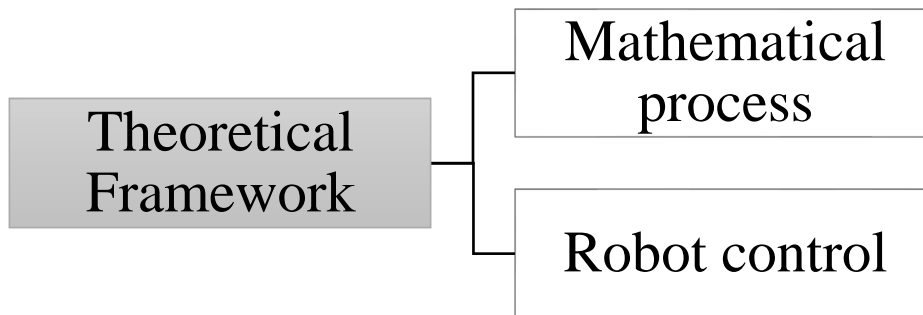
Figure 2.0 shows the theoretical framework

Figure 2.0 above shows the relevant theoretical framework of the Artificial Intelligence (AI) construction industry. The theoretical framework is developed by 3 main categories which include predictive modelling and simulation, robotic automation and control, natural language processing and cognitive computing.

First is the mathematical process which can create predictive modelling and simulation is the theory can link to the factors implementing AI in construction industry (Lawton et al., 2022). The relevant parties can adopt it in construction in order to make an optimum decision in the planning and design of the construction project. It can be used to identify potential issues or the area which requires improvement. By using the AI system to obtain data and generate predictive models which are able to improve productivity by skipping unnecessary procedures during construction process. For instance, the theory of machine learning algorithms nowadays can be used to estimate the ideal cost, time, and energy consumption to invest in the selected construction project (Abioye et al., 2021)

Besides, the theory of robot control which is utilize robotic automation and control broadly used in the construction industry to automate repetitive and workforce-intensive tasks (Bejczy & Tarn, 1986). There are some construction activities involved related to this theory such as 3D printing which able to minimize the risk of costly errors. Also, the robotic automation and control can be used enhance the efficiency of the construction project by minimizing the errors that caused by human. Meanwhile, it can reduce the safety issue of labour in the working site in accordance the research from Elattar (2008).

From the combination of mathematical process along with the robot control which adapted from authors of Bejczy & Tarn, 1986 and Lawton et al., 2022. The AI implementation have the significant impact to the construction industry Malaysia. The theory mentioned above would them develop a proposed conceptual framework which includes the Main factors that impact AI implementation in construction industry.

2.6 Proposed conceptual framework
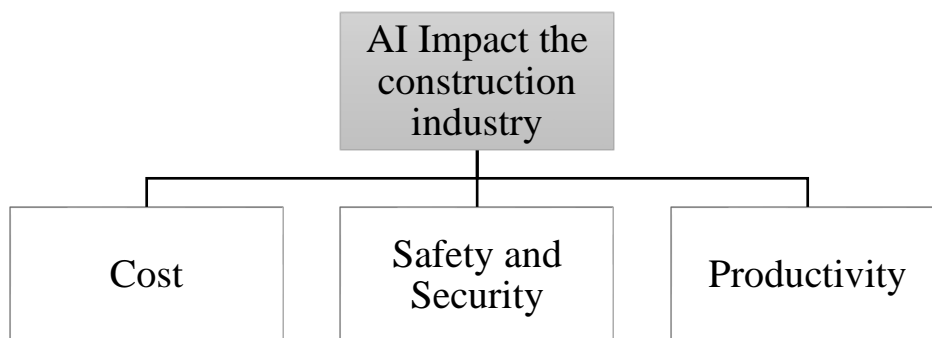
Figure 2.1 shows the relevant conceptual framework

The proposed conceptual framework presented pertains to a study that focuses on the construction industry and identifies cost, safety, and productivity as three crucial factors that impact the industry. The framework is based on previous research that acknowledges the importance of these factors. The study aims to analyse the impact of AI on the construction industry by examining its influence on these factors. The study considers cost as a significant factor that affects project cost and overall project value. Therefore, the research aims to investigate how AI can improve the quality of the construction industry in Malaysia by analysing its impact on productivity, safety, and cost, which are the independent variables.

2.7 Conclusion

In short, this chapter emphasizes the significance of Artificial Intelligence in both foreign countries and Malaysia which specifically in the construction industry. The article also describes the impact of Artificial Intelligence on the construction industry, based on previous studies and research that considers factors such as

productivity, cost, and safety. Additionally, the chapter formulates hypotheses that will be tested in Chapter 3 and outlines the data collection and processing methods that will be used to verify these hypotheses and achieve the research goals. The study design for data collection will also be discussed in more detail in the following chapter.

Chapter 3 Methodology

3.1 Introduction

In Chapter 3 will explain the methodology adapt in this research report for analyzing the main factors of Artificial Intelligence (AI) technology that brings impacts the constructions Malaysia, especially in Klang Valley area. The factors include cost issues, safety & security as well as productivity which are mentioned in Chapter 2. This part will bring up a few components including the research design, variable selection, questionnaire arrangement, method to analyze, target population and sampling framework.

3.2 Research Design

The research design also can be defined as a blueprint of the research question. It allows a researcher to get useful information from the respondents by focusing on the procedures of the research that are related to the research issues. There are two types of research design which includes quantitative research design and qualitative research design and both the research design have a slightly different procedure to conduct. Quantitative research design is more formal and has a systematic process and it analyzes using numerical data and it's usually adopted in research which needs to examine the relationships among variables. The qualitative research design is exploratory research that collects numerical data to provide insight into the issue and assist to create hypotheses for the quantitative research (Bodnar, 2015).

For this report on the research of the main factors that will impact when implementation of Artificial Intelligence (AI) system in the construction industry in Malaysia especially in Klang Valley area. A quantitative research design will be selected in this research report by collecting primary data from the respondents. There are five types of quantitative research designs which include experimental, Quasi- experimental, correlational, survey and descriptive research design. From these research designs, survey research design is selected for this study to collect numerical data. By using quantitative research design, it can perform more efficiently during the survey process as quantitative research design do not need to

conduct time- consuming process of creating open- ended responses and would be provided a set of answer in option form for respondents. Therefore, quantitative research design was chosen for this research report by examining the relationships among the variables that bring impacts when implementing AI system in construction industry in Klang Valley area.

Below researcher will be explained about the basic procedure for the factors that brings impact when implementing Artificial Intelligence in construction within Klang Valley. There are 5 steps in the entire data collection process.

Aim	Stage	Output
• Review relevant literature to develop theoretical framework for the impact of AI implementation in construction industry.	Stage 1 Literature Review	• The establishment of theoretical framework • Factors were identified.
• Determining the sample • Sampling procedure identifying a survey instrument conduct. • Pre-test for questionnaire	Stage 2 Questionnaire Designation	• Questionnaire being revised before the distribution
• Distribution of questionnaire to relevant respondents	Stage 3 Data collection	• Raw data gathered for further analysis stage
• Data screening • Perform SPSS using software.	Stage 4 Data Analysis	• Validity and reliability of measurement and structural model was achieved. • Hypotheses tested
• Result presentation and discussion	Stage 5 Findings& Conclusion	• Summarize findings. • Limitation and suggestion of the study

Table 3.0 Research Methodology Flowchart

First and foremost, the literature review is needed for the initial step of data collection. In this step, the researchers are required to review the relevant literature and to develop a theoretical framework for the impacts when implementing Artificial Intelligence (AI) in construction in Klang Valley area.

Second, the researchers have to identify the survey instrument by determining the sample and the sampling procedure. After that, the researchers have to identify which survey instrument they wanted to adopt there are two major types of survey instrument for this research report, the questionnaire will be adopted by distributing the questionnaire question to the target respondents.

Next is to identify the questionnaire designation, the researchers can start distributing the questionnaire by sending the link to Google form to collect data from the relevant respondents. For the questionnaire, researchers will priority send to the employees in the construction field that work in Klang Valley area.

After done the data collection step, the researchers are required to conduct the data analysis using the information given by relevant respondents. The researchers will perform SPSS using software, sorting out the useful data. By using the data selected and undergo the hypotheses test.

Lastly, conclude the findings using the data analysis result that was done in the previous step. Summarize the findings for a better understanding of the information that has been analyzed. Not only that, but the researchers also require to provide the limitation of the current study as well as the recommendation for the future study.

3.3 Data Collection Method

According to Simplilearn (2023), data collection is known as a process of assembly and evaluating useful data which is gotten from different sources in order to figure out the issue for the particular research topic. Data collection was to help researchers to get useful information from the target respondents. There are two types of data which includes primary data and secondary data. For this research topic that conducted by I will be using primary data instead of secondary data.

3.3.1 Primary data

Primary data known as the data collection process that receives data from the first- hand source (Costa, 2022). There are methods to collect the primary data which includes survey questionnaire, interviews observation as well as focus group. For this research study, researchers will use a survey questionnaire for the data collection. Therefore, the survey gathers primary data for the impacts when implementing Artificial Intelligence (AI) in a construction company in the Klang Valley area. The number of respondents would be determined by the number of companies replies.

3.3.2 Secondary data

Secondary data known as the research data that has been assembled by the previous researchers (Contributor, 2017). Basically, the researchers can get the secondary data from variety of sources includes websites, journal, article, government publications etc. using secondary data is more cost effective compared to primary data as the majority of secondary data have been create upon existing knowledge and expertise (Bhat, 2023). In the previous part, literature review technique was applied in this study as well. it can be used to identify the main impacts when implementing Artificial Intelligence system in the construction industry in Klang Valley area.

3.4 Sampling design

Sampling design is known as one of the important tools for researchers to collect data in a legal way. In the process of sampling design, the researchers require to determine the selection sample from the large population that gotten from the respondents. The objective to conduct a sampling design is to develop inference from the large population that collected in a number of small samples (Jawale, 2012).

3.4.1 Target population

Before distributing any questionnaire to the respondents and conducting the sampling process, identifying, and searching for the proper relevant target population is important for the entire research. In this survey, the respondents who work in the construction company are our target respondents and the survey location will focus on Klang Valley area which includes Kuala Lumpur and Selangor. Since there are a variety of construction which implemented different Artificial Intelligence (AI) system in their project, the questionnaire was designed for the individuals who works under construction industry with consists of at least 3 years involvement experience in AI implementation.

3.4.2 Sampling techniques

According to Fleetwood (2023), sampling is one of the important parts when conducting a research project. It is important for the researchers to choose the right technique to collect reliable and accurate data. There are two major types of sampling technique which includes probability sampling technique and non-probability sampling technique. For the probability sampling technique can be applied when the researchers randomly choose the population in the selection parameter. While the non-probability sampling technique can be applied when the researchers do not have a specific selection process. Both of the techniques have their own advantages and have been widely used by researchers so that they don't need to collect data from the entire population in order to get actionable insights.

For questionnaire survey will be using Cluster sampling which is one of the types of probability sampling. This is because the population of the studies is too large to be practically surveyed as a whole. Hence, cluster sampling is to select a certain amount of individual to represent for the entire population of the research. In this research, the only focus on the selected area is in Klang Valley area. The researcher emailed a few companies in order to get information of the population of employees in the company. The population would be set based on the company replies. After we collected the information of population employees in construction field. The research would adapt Cochran 1977 to calculate the ideal number of respondents. After that, the respondents are asked to share the survey to their

colleagues who are in construction field to complete get more responses which can help further data analysis in the next chapter. By using this way to conduct the survey will be more effective as the result will be more specific and able to provide insightful data (Fleetwood, 2023).

3.4.3 Sampling size

The number of respondents involved in a survey is refer to the sampling size calculated by researchers. Sample size known as the individuals involved in the research study to be the representative of the population when conducting the survey. The appropriate sample size is an important factor in further statistics analysis as the accurate sampling size can ensure the results are sufficient to represent the realities of the population in the research study (Kibuacha, 2022). Below the researcher will apply the formula of Cochran (1977) to determine the estimated sampling size in respect of the research. Since the population size as well as the proportion is unknown, the researcher would adopt the formula from Cochran (1977) as below:

$$n = \frac{p(1-p)z2}{e^2}$$

Where,

n = sample size
p = the population proportions (p=0.1)
e = acceptable sampling error (e = 0.05)
z = z value at reliability level or significance level.

Assuming *e*, acceptable sampling error in this research is 5%. Hence, the reliability level would be in 95%, the z-value from the Z-table shown 0.475

and the nearest z-score for 0.475 is 1.96.

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Source from (Khan,2019)

$$n = \frac{(1.96)^2}{4(0.05)^2}$$

=384.16

Said to be 384.

When the population size is small which also means the researcher can reduce the sample size. The given sample size contributes proportionately more information about a small population to represent a large population. In this research, the population size is assumed to be 300 from the result above. The sample size n can be figured out by using the equation below:

$$n = \frac{n}{1 + \frac{(n-1)}{N}}$$

$$= \frac{384}{1 + \frac{(384-1)}{300}}$$

= 169 respondents.

Hence, the sample size needed for this research is 169 respondents.

3.4.4 Sampling frame and sampling location

Sampling frame is a frame that collects data from which the list of items is drawn for the sample. It allows determining the probability selection (GROSSMANN, 2020). In this survey, the target respondents will be the employees in the construction industry who been participated in Artificial Intelligence (AI) system implementation. While the sampling location will be covered Klang Valley areas that have high level of innovation. Based on the Department of Statistics Malaysia (DOSM), Selangor achieve the highest value of construction work done, followed by the Federal Territories (Journal, 2022).

3.5 Research instrument

After gathering the data needed, researcher decides to use 5-points Likert scale as our research instrument. This is because the 5 points Likert scale allow the respondents to give the degree of acceptance instead of giving yes or no answer (Mcleod, 2008). From the 5- points Likert scale, the respondents can rate their level of agree regarding to the statement created. The rating level as below:

(1) Strongly disagree;

(2) Disagree;

(3) Neither agree nor disagree;

(4) Agree;

(5) Strongly agree.

3.6 Questionnaire design

After the researcher done deciding the sampling technique and calculated the target population. The researcher started to create a questionnaire for the relevant respondents. The survey will be done using Google Forms. The researcher will create the survey form and distribute it by sending the link or email to the relevant respondents. The respondents are required to fill up the questionnaire upon

their professional knowledge and own experience. The survey would estimate carry out for a month.

Section	Description
A	Demographic information
B	Artificial Intelligence involvement
C	Main factors: productivity, cost, safety & security

Table 3.1 shows the questionnaire design

Source: developed for the research

In the Section A of questionnaire mainly focus on the demographic information of the respondents. It consists of four questions in multiple choice and short essay form. The demographic information needed includes career positions, age, educational level as well as working experience. Based on the demographic information, it can be easy for a researcher to do an analysis of the relevant respondents based on their background regarding the main impact when implementing artificial technology in the construction industry. The demographic questions were created based on (Bhat, 2018).

In the Section B, the researcher will mainly focus on the basic understanding of the involvement of respondents regarding the implementation of Artificial Intelligence system. In this section would be provided three multiple choices questions.

In Section C, the researcher will mainly focus on the independent variables that have been researched by the researcher. In this section will be performed in 5-points Likert scale and the respondent were asked to rate the statement according to the level of agreement provided. Each independent variable would have three to four questions. The question in section C will focus on the independent variables including productivity, cost as well as safety& security. This section is the main part to analyze which is the main factor that brings impact when implement Artificial Intelligence (AI) system in construction industry.

3.7 Data Analysis

After gathering all the data from the responses from the survey questionnaire, the researchers are required to carry out the data analysis. They need to summarize the data collected and then interpret the analysis created by the researchers. in this data analysis process, the researchers would adopt the SPSS software because it is user-friendly and have a lower chance of mistake with the operation of SPSS (William, 2022). From that, the SPSS can help to simplify the complicated data to be viewed.

3.7.1 Descriptive analysis

The researchers are required to analyze types of data collected from the survey. Descriptive is one of them. When the researchers are done collecting the descriptive data, they will summarize it into descriptive statistics. The descriptive is important as it is a set data which represents the population in a certain industry. Basically, the descriptive data is the demographic profile of the target population. The descriptive data will be collected in Section A of the questionnaire which consists of four questions including position, age, educational level and working experience.

3.7.2 Scale Measurement- Reliability test

Besides, reliability tests as one of the parts of data analysis. The reliability test can be easy for researchers in identifying and minimizing the errors and variability in their study. This can be achieved by measuring the degree to which different methods, instruments, or raters produce the same results when used to measure the same situation. Cronbach's alpha will be used in the reliability test by taking the average of all possible reliability from the variance or covariance generated by the researchers. The benchmark value of Cronbach's Alpha is 0.7, whenever it is 0.7 or above indicates that the item is consistent and is reliable (Frost, 2022). Below is the standard of reliability test.

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

Table 3.2 shows the Cronbach's alpha standard

Source: Habidin, N.F., etc 2015

3.7.3 Content Analysis

Content Analysis is used in this research as well. Content analysis is a research method that involves systematically analysing and interpreting various forms of communication to identify patterns, themes, and messages within the data. Based on the research from Bengtsson, M. (2016), the content analysis is to organize and elicit meaning from the data collected and to draw realistic conclusions. The method is commonly used in social sciences, marketing, media studies, and other fields to understand the content of various texts and image. By using this analysis, the researchers can identify commonalities and trends that may be useful in understanding a particular phenomenon or issue.

3.7.4 Relative Important Index (RII)

Relative Importance Index is used to calculate for each of the variables according to their rank. According to Stevens (2022), RII is used to determine the important of each variable based on the frequency of occurring on the specific situations. The RII will be applied in the Section C of the questionnaire. Below is the formula of RII.

$$RII = \frac{\sum w}{(A \times N)} = \frac{5n^5 + 4n^4 + 3n^3 + 2n^2 + 1n^1}{5N}$$

RII = Relative Important Index

w = Weighting given each factor by the respondent. From range 1 to 5;

n^5 = Number of respondents for Strongly Agree;

n^4 = Number of respondents for Agree;

n^3 = Number of respondents for Slightly Agree;

n^2 = Number of respondents for Disagree;

n^1 = Number of respondents for Strongly Disagree;

A = Highest weight;

N = Total number of respondents.

Figure 3.0 shows the formula of Relative Important Index

3.8 Conclusion

From the researched done in this chapter is the methodology and it consists of six main parts which includes the research design, data collection method, sampling design, research instrument, questionnaire design as well as the data analysis method chosen. In the next chapter will discuss the results of the survey as well as the data analysis.

Chapter 4 Data Analysis

4.1 Introduction

In Chapter 4 will be covered data analysis which collected in the survey. The data will be analyzed in accordance with the survey result from the 169 respondents to make sure the result is analyzed accurately. There are four important parts in this section which includes the descriptive analysis, which is the demographic data, scale measurement which is the reliability test for the survey. The researcher chose to use Cronbach Alpha with SPSS software. Besides, this chapter includes Relative Important Index (RII) as well.

4.2 Demographic Information

4.2.1 Age
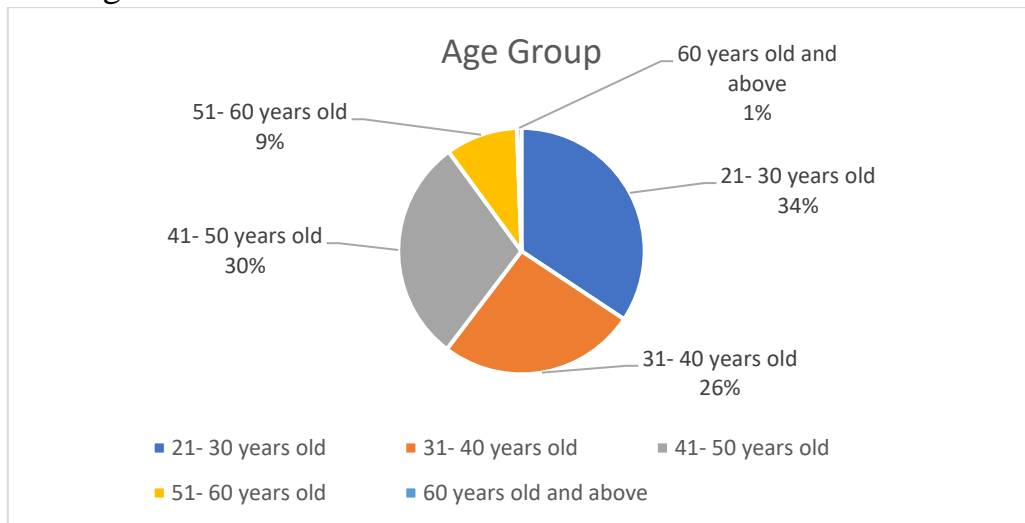
Figure 4.0 shows the pie chart of respondents' age

Position	N	%
21- 30 years old	58	34
31- 40 years old	44	26
41- 50 years old	50	30
51- 60 years old	16	9
60 years old and above	1	1

Table 4.0 shows the number and percentage of respondents' age

The pie chart above shows the age group of the respondents. The majority of the respondents in the age group of 21-30 years old which occupied 34%. Followed by the second highest age group of 41-50 years old with 30%. Next is 26% respondents which in the age between 31- 40 years old. There are only 9% of respondents in age group of 51-60 years old as well as 1% of respondents which is 60 years old and above.

4.2.2 Position
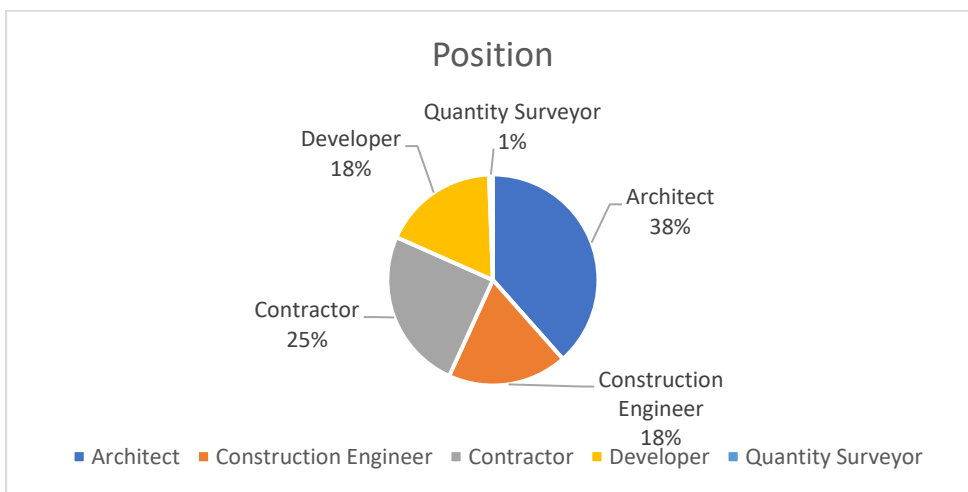
Figure 4.1 shows the pie chart of respondents' position

Position	N	%
Architect	65	38
Construction Engineer	31	18
Contractor	42	25
Developer	30	18
Quantity Surveyor	1	1

Table 4.1 shows the number and percentage of respondents' position

The result reflects in the portion of respondents that in their working position in working in construction company with Artificial Intelligence system. The majority of the respondents have positions of Architect by 38%. Followed by the second highest of the respondents are contractors who occupied the second highest by 25%. Besides, there are developers and construction engineers which

have the same portion with 18%. There are only 1% among the respondents having position quantity surveyor.

4.2.3 Educational Level
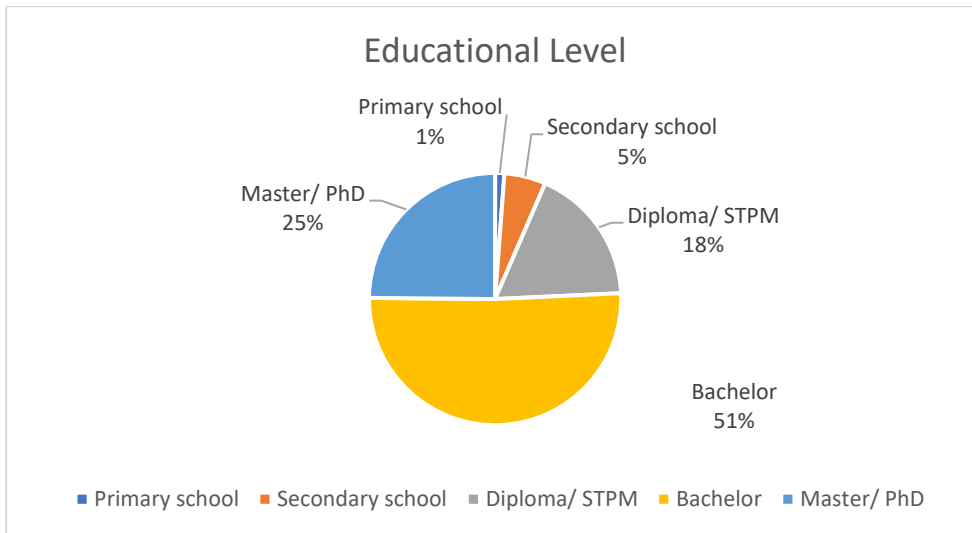
Figure 4.2 shows the pie chart of respondents' educational level

Educational Level	N	%
Primary school	2	1
Secondary school	9	5
Diploma/ STPM	30	18
Bachelor	86	51
Master/ PhD	42	25

Table 4.2 shows the number and percentage of respondents' educational level

Based on the result above shows the educational level of the respondents. More than half of the respondents have their highest educational level in Bachelor which occupied 51%. Besides, 25% of respondents graduated from Master/ PhD. Also, 18% of respondents received Diploma/STPM. In addition, 5% graduated from secondary school as well as 1% of respondents graduated from primary school.

4.3.4 Working experience
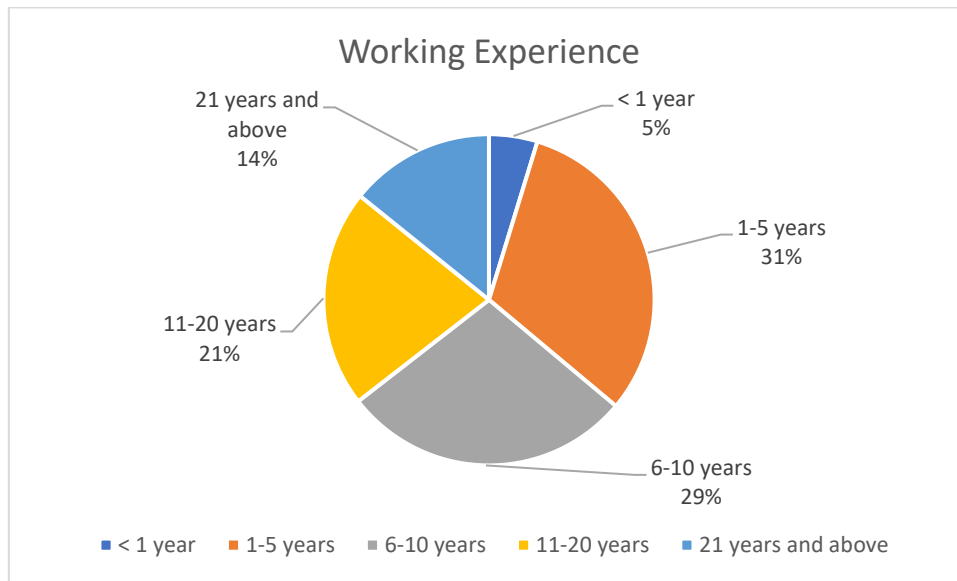
Figure 4.3 shows the pie chart of respondents' working experiences

Working experiences	N	%
< 1 year	8	5
1-5 years	53	31
6-10 years	48	29
11-20 years	36	21
21 years and above	24	14

Table 4.3 shows the number and percentage of respondents' working experiences

The pie chart above reflects the working experiences of the respondents. 31% of respondents had 1- 5 years of working experience which occupied 31% in total responses. Followed by the second highest which having 29% of respondents with 6-10 years of working experience. Moreover, respondents who had 11-20 years of working experience occupied 21% in total. In addition, there are 14% of respondents having working experiences which exceeding 21 years as well as there are only 5 % of respondents which is freshly graduated and new entrant to the construction industry which have no working experience in construction industry.

4.3.5 Do the AI system plays important role?
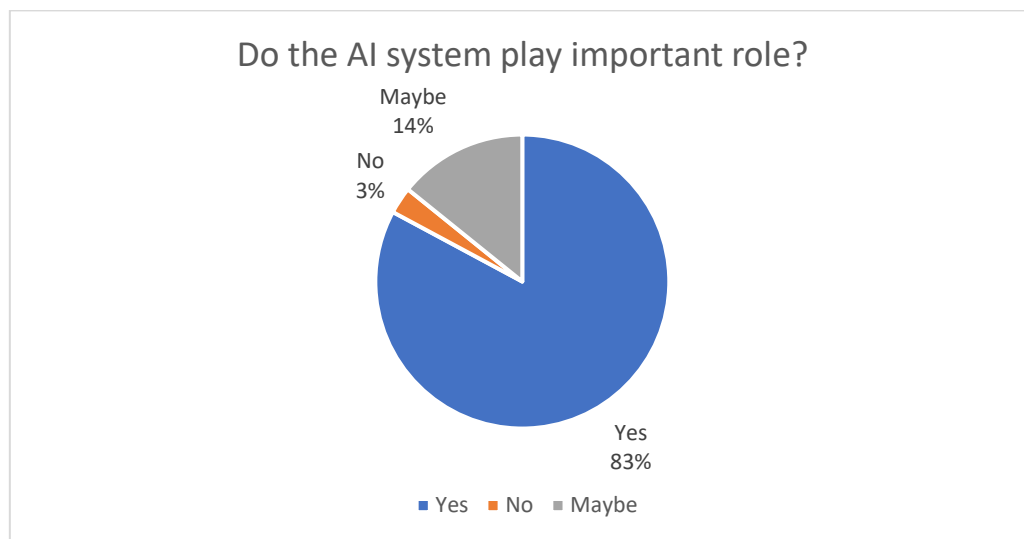
Figure 4.4 shows the level of agreement of respondents

	N	%
Yes	140	83
No	5	3
Maybe	24	14

Table 4.4 shows the number and percentages of respondents' level of agreement

In the pie chart above, it shows the clear illustration regarding the portion of responses towards the importance of Artificial Intelligence system in construction industry. The majority of the respondents, 83% agreed which the statement regarding the AI system playing an important role in construction industries. Besides, 14% of respondents have a neutral perspective regarding the AI system in construction industries. However, 3% of respondents disagree with the statement.

4.3.6 Is your company project involving AI system these few years?

Is your company project involving in AI system these few years?

Maybe 13%
No 9%
Yes 78%

■ Yes ■ No ■ Maybe
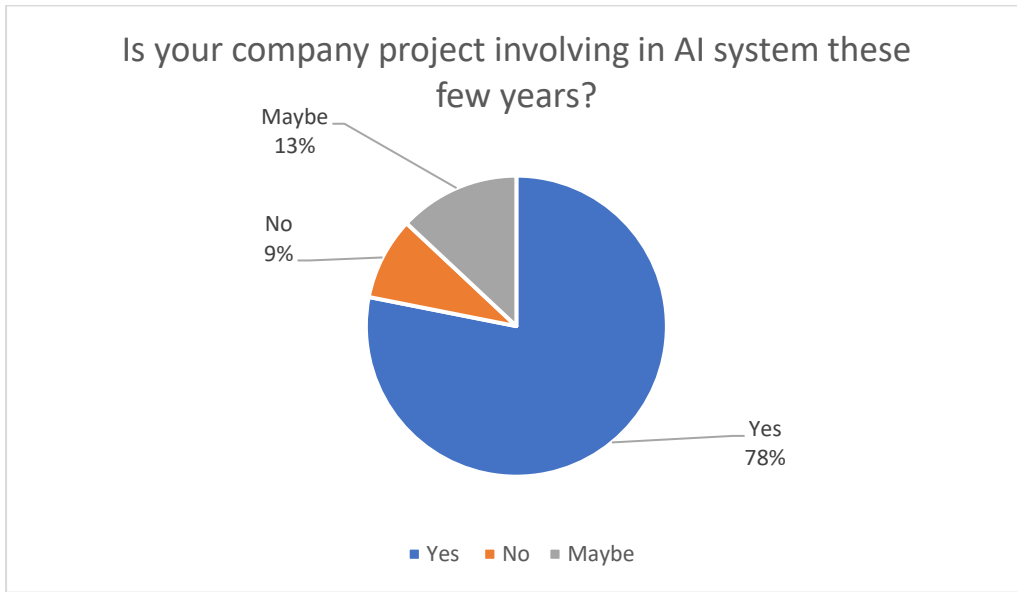
Figure 4.5 shows the level of agreement of respondents

	N	%
Yes	132	78
No	15	9
Maybe	22	13

Table 4.5 shows the number and percentages of respondents' level of agreement

Based on the pie charts reflects the results of the involvement of AI system in the company project. More than half of the respondents have been implementing AI systems in their company project in these few years. Besides, 13% of respondents consider the implementation of AI in their company projects. However, only 9% of respondents have not implemented AI system in their company project in these few years.

4.3 Scale Measurement- Cronbach's alpha

No	Factor	Cronbach's alpha	Mean	No. of item	No. of respondents	Level of reliable
1	Cost	0.835	3.511	3	30	Good
2	Safety & security	0.760	3.411	3	30	Acceptable
3	Productivity	0.896	3.258	4	30	Good
	Overall	0.714		10	90	Acceptable

Table 4.6 shows the result of Cronbach's alpha

(Source: Developed for the research, 2023)

For the scale measure, Cronbach's alpha has chosen in testing the reliability of the data collected. The researcher would conduct reliability test using SPSS software. In Cronbach's alpha, it can help to measure the internal consistency between the statement in the Likert scale. The standard Cronbach's alpha value is 0.7 and above. With the data collected, the researcher used the independent variables, and it obtained 0.835 in cost factor which indicates good value. Besides, the safety and security factor obtained 0.760 of acceptable Cronbach's alpha value. Last is the productivity factor obtained 0.896 which indicates good Cronbach's alpha value.

4.4 Relative Important Index (RII)

No	Question	RII	Rank	RII AVERAGE
a.	Does the cost factor bring impact when implementing Artificial Intelligence in construction Malaysia.			
	AI can reduce building costs by up to 20 percents.	0.778	3	
	AI can reduce the possibility of encounter overhead expenses.	0.818	1	0.798
	The return on investment of implementing AI technologies can cover up the cost of implementation in long term.	0.799	2	
b.	Does the safety and security factor bring impact when implementing Artificial Intelligence in construction Malaysia.			
	The high level of security system of a company is significant from prevent confidential information leaking out.	0.822	2	
	AI technologies implementation resulted in enhanced the work site safety.	0.831	1	0.825
	AI technologies can minimize the death rate of labour by using the monitoring system.	0.822	3	
c.	Does the productivity factor bring impact when implementing Artificial Intelligence in construction Malaysia.			
	The AI technologies can increase the efficiency of construction progress.	0.834	2	
	Practice project operation without human assistance would maximize the productivity of the project. (Eg: self-driving machinery)	0.798	4	
	High knowledge level of AI talents would significantly influence the productivity of the project. (Eg: different professional knowledge and working routine)	0.831	3	0.83
	AI technologies can keep track the construction progress to improve the productivity. (Eg: Smart devices)	0.854	1	

Cost factor	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Mean	RII	Rank
AI can reduce building costs by up to 20 percents.	2	7	29	101	30	3.89	0.778	3
AI can reduce the possibility of encounter overhead expenses.	1	5	28	79	56	4.09	0.818	1
The return on investment of implementing AI technologies can cover up the cost of implementation in long term.	1	9	23	93	43	3.99	0.799	2

Table 4.7 shows the RII result of cost factor

According to the table above, it showed that the statement of "AI can reduce the possibility of encounter overhead expenses." are having the highest RII value of 0.818. Most of the respondents are agree that cost factor bring impact when implementing Artificial Intelligence in construction industry.

Safety and security factor	Stongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Mean	RII	Rank
The high level of security system of a company is significant from prevent confidential information leaking out.	3	4	24	78	60	4.11	0.822	2
AI technologies implementation resulted in enhanced the work site safety.	0	6	22	81	60	4.15	0.831	1
AI technologies can minimize the death rate of labour by using the monitoring system.	1	5	23	85	55	4.11	0.822	3

Table 4.8 shows the RII result of safety and security factor

According to the table above, it showed that the statement of "AI technologies implementation resulted in enhanced the work site safety." are having the highest RII value of 0.831. Most of the respondents are agree that safety and security factor bring impact when implementing Artificial Intelligence in construction industry.

Productivity factor	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Mean	RII	Rank
The AI technologies can increase the efficiency of construction progress.	2	5	14	89	59	4.17	0.834	2
Practice project operation without human assistance would maximize the productivity of the project. (Eg: self-driving machinery)	0	9	28	88	44	3.99	0.798	4
High knowledge level of AI talents would significantly influence the productivity of the project. (Eg: different professional knowledge and working routine)	0	3	19	96	51	4.15	0.831	3
AI technologies can keep track the construction	0	2	17	83	67	4.27	0.854	1

progress to improve the productivity. (Eg: Smart devices)						 	

Table 4.9 shows the RII result of productivity factor

According to the table above, it showed that the statement of "AI technologies can keep track the construction progress to improve the productivity. (Eg: Smart devices)." are having the highest RII value of 0.854. Most of the respondents are agree that productivity factor bring impact when implementing Artificial Intelligence in construction industry.

No	Factor	RII	Rank
1	Cost	0.798	3
2	Safety and Security	0.825	2
3	Productivity	0.83	1

Table 4.10 shows the overall ranking of the main factors

From the Relative Important Index (RII) analysis, it contributes the ranking for each factor. According to the table above shows the analysis result of productivity factor have the highest RII value among these three factors which consists of 0.83. Second highest RII are belongs to Safety and security with the RII value of 0.825. Followed by the cost factor only consists of 0.798 of RII value.

Chapter 5 Discussion, Conclusion, and Implications.

This chapter are main to summarize the results and findings according to the initial objective of research. The researcher has conducted the research from findings on online from journal and article to gain the information from different construction company regarding the implementation of the Artificial Intelligence. In addition, the research conducted survey to get the current information as well. After the data been completely collected, the researcher undergoes the data analysis and finally get the results for the research. With the result from the data collected, the researcher would summarize with the statistical analysis. Besides, this chapter discussed the implication of the study and limitation encountered by researcher along with the recommendation for future research.

5.1 Summary of the statistical analysis

this section covered the summary of descriptive analysis for demographic profile, scale measurement as well as relative important index (RII) analysis.

5.1.1 Descriptive analysis

Demographic profile in the questionnaire is used to analyse the respondents' age group, position of their occupation, educational level, working experience as well as their AI adoption. The summary of section A, the demographic information shows most of the respondents are in the age group of 21- 30 years old which occupied 34%. From the result, the architect holds largest number among the responses. There are over half of the responses from respondents are bachelor's holder which had done Degree in related field. Moreover, majority of respondents who owned 1- 5 years of working experience. Besides, In the summary of section B regarding the Artificial Intelligence adoption, majority of the respondents up to 83% agreed that AI system play important in the construction industry and there are 78% of the respondents are implementing AI in their company project in these recent years.

5.1.2 Inferential Analysis Summary: Relative Important Index (RII)

No	Subfactor	Factor	RII	Rank
1	AI can reduce the possibility of encounter overhead expenses.	Cost	0.818	3
2	AI technologies implementation resulted in enhanced the work site safety.	Safety and security	0.831	2
3	AI technologies can keep track the construction progress to improve the productivity. (Eg: Smart devices)	Productivity	0.854	1

Table 5.0 shows the summary of RII result of main factors.

In section C, the researcher has generated and contributed the result according to them respectively by using the Relative Important Index (RII). The researcher has generated the ranking for each independent variable. Rank 1 with the RII value of 0.854 among the independent variables is the productivity with the statement of "AI technologies such as Smart Device can keep track the construction progress to improve the productivity.". Followed by the Rank 2 with the RII value of 0.831 from safety and security factor along with the statement of "AI technologies implementation resulted in enhanced the work site safety." Last is the cost factor with the lowest RII value among these three factors. The RII value is only 0.818 with the statement of "AI can reduce the possibility of encounter overhead expenses."

5.2 Discussion of Major Findings

5.2.1 Achieve objective 1

1. To identify the main factor that will bring impacts of implementing AI system in Klang Valley construction industry.

Table below shows the impacts of implementation of AI system in construction industry.

No	Factor	Author (s)
1.	Cost	Afzal, F., Yunfei, S., Nazir, M., & Bhatti, S. M. (2019).
2.	Safety and Security	Regona, M., Yigitcanlar, T., Xia, B., & Li, R. Y. M. (2022).
3.	Productivity	Johansen, A. (2021), Schia, M.H., Trollsås, B.C., Fyhn, H., and Lædre, O. (2019)

Table 5.1 shows the author(s) of the main factors research using content analysis.

(Source: Developed for research, 2023)

Based on the summary of statistical analysis, there are three factors found in the research which will bring impact in implementing Artificial Intelligence in Klang Valley construction industry including cost factor, safety, and security factor as well as productivity factor. There are few statements provided in cost factors and it was supported by Afzal, F., Yunfei, S., Nazir, M., & Bhatti, S. M. (2019).

The first statement mentioned the artificial intelligence system can save the building cost by up to 20%. This is because the AI system such as Building Information Modelling able to provide the clear analysis regarding in resources usage, duration required which can ensure the resources can fully utilized and minimize the wastage as well as when the construction able to complete on time or even in shorter. Besides, AI can reduce the possibility of encounter overhead expenses by developing clear analysis based on historical data. Last is the return on

investment of implementing AI technologies can cover up the cost of implementation in long term. For instance, AI technologies can replace human to generate more effective construction works instead of adopting traditional method which may causes human error and high expenditure in long term.

Second factor which supported by Regona (2022) which the three statements above. The statement mentioned the high level of security system of a company is significant from prevent confidential information leaking out. This is because the information of the project is strictly prohibited from unauthorize person. Once the confidential information of project leaked out would cause unnecessary issue such as involve in a law sue. Besides. The second statement of safety and security mentioned that AI technologies implementation resulted in enhanced the work site safety. For example, the work site safety is guaranteed as AI system able to replace human workforce with robotic automation to conduct hazardous task. The last statement mentioned the AI technologies can minimize the death rate of labour by using the monitoring system. It can be applied in the hard-reach area such as the roof of high-rise buildings, drone play important role which it can be simple to reach even able to record for the further use.

Third factor the researcher found is the productivity which my impact the AI implementation in construction industry as well. The statements were supported by author Johansen (2021). The first statement mentioned the AI technologies can increase the efficiency of construction progress. This is because the BIM technologies able to develop and project timeline for the construction with the duration required of each construction work task. It is helpful for the labour to know the task required to conduct in specific period to prevent the work task missing out. Second statement mentioned that the practice project operation without human assistance such as self-driving machinery would maximize the productivity of the project. As on the construction site, soil can be excavated and graded using autonomous construction vehicles like dozers, excavators, load-carriers, and haul trucks. However, it can be controlled and managed by a single operator to keep an eye on multiple autonomous machines operating at once which able to achieve effectiveness of the construction project. For the third statements mentioned the high knowledge level of AI talents would significantly influence the productivity of the project. For example, different expert would have different knowledge by

applying different method. Based on their past experience and apply with the suitable method accordingly. For the last statement of productivity factor mentioned AI technologies such as smart device can keep track the construction progress to improve the productivity. The data collected from smart device such as sensors and cameras can then be analysed by AI algorithms to provide real-time insights into the progress of the construction project. For example, machine learning algorithms can be used to predict when certain tasks will be completed based on historical data and weather conditions. This information can then be used to adjust the construction schedule, allocate resources more effectively, and identify potential delays or issues before the issue become serious.

Ultimately, Objective 1 has been achieved which the researcher identified the productivity as a main factor which cause the main impact toward the AI implementation in construction industry Malaysia.

5.2.2 Achieve Objective 2

2. To evaluate the most main factor will bring impacts to improve AI system in Klang Valley construction industry.

No	Factor	RII	Rank
1	Cost	0.798	3
2	Safety and Security	0.825	2
3	Productivity	0.83	1

Table 5.2 shows the ranking of main factors from RII result

The results of productivity factor have been generated from the responses from respondents who are currently employed in construction companies which have implement AI system in their company project. By looking at the ranking, the RII value of the productivity factor is at 0.83 which is the highest between these three factors includes cost and safety and security factor. The highest RII values indicates the impact is very serious to be considered when implementing AI in the construction project.

For the second highest of the factor which bring impact to improving AI system in construction industry is the safety and security factor with the RII value of 0.825. This indicates that the safety and security factor is important for the construction firm and employees as well. The statement of AI technologies implementation resulted in enhanced the work site safety obtained Rank 1 with the RII value of 0.831. Besides, the statement regarding the high level of security system of a company is significant from prevent confidential information leaking out obtained Rank 2 with the RII value of 0.822 which indicate that the AI is crucial for construction firm to protect the project information and they are aware with the issue as well.

With the result obtained, productivity can be known is one of the important factors that majority of construction firm and employees are concerned about. In accordance with McKinsey, productivity enhancement of up to 50% are possible with the implementation of Artificial Intelligence system. This could significantly result in cost savings as construction project completed on scheduled time can avoid the additional labour costs and avoid fines imposed by Construction Industry Development Board Malaysia (CIDB). In short, the Objective 2 has achieved by evaluated the productivity as the main factor to bring impact to improve AI system in Klang Valley construction industry.

5.3 Implication of the study

A has the potential to transform the construction industry, making it safer, more efficient, and more sustainable. Researchers in the field of construction can explore and experiment with various AI applications and techniques to improve the industry. This implication of study is benefits for all the construction firms and employees in construction industry includes architect, contractor, developer, construction engineer etc. From the findings and result obtained by the researchers, the construction firm able to put more attention in the productivity issue when they decided to implement Artificial Intelligence in their company project as nowadays there are more and more building development in Malaysia. Throughout the study, the research able to help the construction firm as well as the employees in related field more understand the importance and identify which factor might cause the big

impacts toward the AI implementation in their company construction project. By referring to this study, the construction firms, and employees in the related field able to improve their productivity and help to improve the growth rate of building development in Malaysia. Ultimately, it helps to stimulate the economic in Malaysia toward the brilliant future.

5.4 Limitation of the study

The limitation of the study that encountered by researcher was the limited source to obtain data through online as there are only small numbers of author which conduct the study specifically on Artificial Intelligence in Construction industry Malaysia. Besides, the research only targeted to the construction company in Klang Valley area, it cannot represent for the whole country because the demographic from other states might be different. The issues regarding the AI implementation in construction industry in other states might be different compared to Klang Valley area. For example, for some of the sub- urban areas with low population and do not have much high-rise buildings development as sub urban area got better land size while Klang Valley having limited size with huge population in the city. Therefore, Klang Valley having way more building development compared to sub- urban area, the responses from the respondents in different state would be different as well.

5.5 Recommendation

Based on the limitations mentioned above, there are some recommendations which can help future researchers for the future study. The research can be targeted for other states to gain different demographic information based on the current situation of the states such as Penang Island as the states currently undergo the reclamation and have the huge opportunity for the development which demand for the AI implementation on it project.

Besides, due to there are only fewer researcher conducted only. Researchers in the field of construction are encouraged to explore and experiment with various Artificial Intelligence systems and techniques to improve the industry. to provide useful information for public which can stimulate the development as well as economic of Malaysia toward brilliant way.

5.6 Conclusions

Throughout the entire study from Chapter 1 to Chapter 5. From developing problem statement regarding factors which bring impact for AI implementation in construction industry. The researcher identified three factors that bring impact which includes cost factor, safety, and security factor as well as the productivity factor. Besides, the researcher conducted surveys to collect data from the construction firm and employees in related fields. With the data collected, the researcher conducts descriptive analysis, reliability test as well as the Relative Important Index (IRR). Finally, the main impact has been identified and evaluated. However, there are some limitations when conducting research, the recommendation for future study is provided to overcome the limitation encountered by current research. In addition, the research contributes important information for the public, especially in the construction industry.

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Appendixes

Questionnaire Sample

FACULTY OF ACCOUNTANCY AND MANAGEMENT
DEPARTMENT OF BUILDING AND PROPERTY MANAGEMENT
FINAL YEAR PROJECT

SURVEY QUESTIONNAIRE

IMPACT OF ARTIFICIAL INTELLIGENCE (AI) SYSTEM IMPLEMENTATION IN
THE CONSTRUCTION INDUSTRY: CASE STUDY OF KLANG VALLEY

Dear Respondents,

I am Chan Huey Min, a final year student pursuing Bachelor of Building and Property Management in Universiti Tunku Abdul Rahman (UTAR). I am currently conducting a research project with the topic of " The Impact of implementing Artificial Intelligence in Construction Industry Malaysia".

You are invited to participate in this research by filling in this questionnaire. This questionnaire aims to investigate the level of acceptance the statement regarding the impact of AI implementation in Malaysia.

Your cooperation and honest response to complete this questionnaire is highly appreciated. Your response will be kept confidential, and only the statistics report extracted from all questionnaires collected will be disclosed.

For any suggestions or inquires related to this survey, please contact me at

hueymin409@1utar.my or +6018-4604098. Thank you.

1.   Acknowledgement of Notice *

Mark only one oval.

◯ I have been notied and that I hereby understood, consented and agreed per UTAR above notice.

Section A Demographic of Respondents

Instruction:
Please tick (/) all the answer.

Please select only OONNEE of your answer.

2.   Position *

Mark only one oval.

- ( ) Architect
- ( ) Construction Engineer
- ( ) Contractor
- ( ) Developer

3.   Age *

Mark only one oval.

- ( ) 21- 30 years old
- ( ) 31- 40 years old
- ( ) 41- 50 years old
- ( ) 51- 60 years old
- ( ) 60 years old and above

4.   Your highest achievement of educational level? *

Mark only one oval.

- ( ) Primary school
- ( ) Secondary school
- ( ) Diploma/ STPM
- ( ) Bachelor
- ( ) Master/ PhD
- ( ) Other: _____

5.   How long is your working experience/ *

Mark only one oval.

( ) No experience

( ) 1-5 years

( ) 6-10 years

( ) 11-20 years

( ) 21 years and above
      Section B Artificial Intelligence technologies adoption

Instruction:
Please tick (/) all the answer.

Please select only OONNEE of your answer.

6.   Do the AI technologies play important role in your company construction
      project? *

Mark only one oval.

( ) Yes

( ) No

( ) Maybe

7.   Is your company project involving in AI technologies these few years? *

Mark only one oval.

( ) Yes

( ) No

( ) Maybe

Section C: Does the cost factor brings impact when implementing Artificial
Intelligence in construction Malaysia.

Please indicate how strongly you agree or disagree with the
statements stated below by selecting from 1- 5 which represents:

1-   Strongly Disagree

2-   Disagree

3-   Neither agree nor disagree

4-   Agree

5-   Strongly Agree

8.   AI can reduce building costs by up to 20 percents. *

Mark only one oval.

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

9.   AI can reduce the possibility of encounter overhead expenses. *

Mark only one oval.

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

10.   The return on investment of implementing AI technologies can cover up the * cost of implementation in long term.

Mark only one oval.

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

Section C: Does the Safety and Security factor brings impact when implementing Artificial Intelligence in construction Malaysia.

Please indicate how strongly you agree or disagree with the statements stated below by selecting from 1- 5 which represents:

1-   Strongly Disagree

2-   Disagree

3-   Neither agree nor disagree

4-   Agree

5-   Strongly Agree

11.   The high level of security system of a company is significant from prevent
     * confidential information leaking out.

Mark only one oval.

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

12.   AI technologies implementation resulted in enhanced the work site safety. *

Mark only one oval.

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

13.   AI technologies can minimize the death rate of labour by using the
monitoring   * system.

Mark only one oval.

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

Section C: Does the productivity factor brings impact when implementing
Artificial Intelligence in construction Malaysia.

Please indicate how strongly you agree or disagree with the
statements stated below by selecting from 1- 5 which represents:

1- Strongly Disagree

2- Disagree

3- Neither agree nor disagree

4- Agree

5- Strongly Agree

14. The AI technologies can increase the efficiency of construction progress. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

15. Practice project operation without human assistance would maximize the
*
productivity of the project. (Eg: self-driving

machinery) *Mark only one oval.*

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

16. High knowledge level of AI talents would significantly influence the

productivity * of the project. (Example: different professional knowledge

and working routine) *Mark only one oval.*

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

17. AI technologies can keep track the construction progress to improve the * productivity. (Eg: Smart devices) *Mark only one oval.*

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