ORGANIZATIONAL READINESS FOR ARTIFICIAL INTELLIGENCE(AI) ADOPTION IN PROJECT RISK MANAGEMENT OF MALAYSIAN CONSTRUCTION INDUSTRY

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ORIGINAL LITERARY WORK DECLARATION

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Organizational Readiness for Artificial Intelligence (AI) Adoption in Project Risk Management of Malaysian Construction Industry

ABSTRACT

In this era of technology advancement, IT technologies have been developed with a fast-moving pace and there is no exceptional case in Malaysian construction industry which associates with poor project risk management. Digital transformation has been a topic to be discussed among the construction practitioners to incorporate digital tools for organization project risk management and ultimately to move forward IR4.0. The arising Artificial Intelligence (AI) technologies has been prospected as the solution to answer the demand from the industry. However, numerous research found that level of awareness of Malaysian construction industry is at a low level and readiness of organization towards AI adoption remains unknown. This research study is aimed to investigate on the status of organizational readiness towards AI adoption in project risk management of Malaysian construction industry. Quantitative research methodology has been adopted to accomplish the intention and a questionnaire survey was conducted. Total of two hundred and fourteen (214) CIDB registered G7 construction organizations have participated in the questionnaire survey. A theoretical framework with the inclusive of fifteen (15) key factors that influence the organizational readiness has been developed and validated to be applicable to the study. The study has discovered that Malaysian construction industry is at the level of "quite ready" for AI adoption in project risk management with CRI value of 62%. Output of this study is likely to be referred for providing insightful information for Malaysian construction industry to move on AI adoption.

Keywords: Artificial Intelligence, Organizational Readiness, Project Risk Management, Malaysian Construction Industry

Ketersediaan Organisasi Atas Penerimaan Teknologi Kecerdasan Buatan Dalam Pengurusan Risiko Project Industri Pembinaan Malaysia

ABSTRAK

Dalam era kemajuan teknologi, teknologi IT telah dibangunkan dengan kadar yang pesat dan industri pembinaan Malaysia tidak terkecuali dalam menerima kesan kemajuan ini yang mana industr pembinaan di Malaysia diketahui sering dikaitkan dengan pengurusan risiko projek yang lemah. Transformasi digital telah menjadi topik perbincangan di kalangan pengamal pembinaan untuk menggabungkan peralatan digital untuk pengurusan risiko projek organisasi dan bergerak ke hadapan dalam bidang berkaitan IR4.0. Teknologi kecerdasan buatan yang terkini dicadangkan sebagai penyelesaian untuk mengatasi tuntutan permintaan daripada industri dalam pengurusan risiko ini. Walau bagaimanapun, banyak penyelidikan mendapati bahawa tahap kesedaran industri pembinaan Malaysia berada pada tahap yang rendah dan kesediaan organisasi untuk beralih ke arah penerimaan teknologi kecerdasan buatan ini masih tidak diketahui. Kajian penyelidikan ini bertujuan untuk menyiasat status ketersediaan organisasi ke arah penerimaan teknologi kecerdasan buatan dalam pengurusan risiko projek industri pembinaan Malaysia. Metodologi penyelidikan kuantitatif telah digunakan untuk mencapai hasrat yang diinginkan dan tinjauan soal selidik telah dijalankan. Sejumlah dua ratus empat belas (214) organisasi pembinaan kelas G7 yang berdaftar dengan pihak CIDB telah mengambil bahagian dalam kaji selidik soal selidik tersebut. Rangka penyelidikan bersama lima belas (15) faktor utama yang mempengaruhi ketersediaan organisasi telah dibangunkan dan disahkan untuk digunakan dalam kajian ini. Hasil kajian ini mendapati bahawa industri pembinaan Malaysia adalah berada di peringkat "cukup bersedia" untuk penggunaan teknologi kecerdasan buatan dalam pengurusan risiko projek

dengan nilai CRI sebanyak 62%. Output kajian ini boleh dirujuk oleh industri pembinaan Malaysia sebagai maklumat yang bernas atas penerimaan teknologi kecerdasan buatan.

Kata kunci: Teknologi Kecerdasan Buatan, Kesediaan Organisasi, Pengurusan Risiko Projek, Industri Pembinaan Malaysia

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CHAPTER 1: INTRODUCTION

1.1 Chapter Introduction

This chapter included the research background and research gap discovered that initiated the research study. Research aim, objectives, research questions, and research methodology have been established following a detailed scope of study. Besides, the significance of this research study has been identified. Last but not least, the structure of the thesis has been presented with brief explanation on each content chapter.

1.2 Research Background

Construction projects are oftentimes associated with schedule delays, cost overrun, and poor quality that are ultimately related to the risks of a project (Taofeeq, Adeleke & Hassan, 2019). This is exceedingly thanks to the construction projects for being overly complex and unpredictable that the conditions of the project may change at any point of time (Ansah, Sorooshian, Mustafa & Duvvuru, 2016). In addition to that, the level of risk of a construction project during the project execution stage is comparatively higher than projects from the other economic sectors (Sathishkumar, Raghunath & Suguna, 2015). Thus, the project risk management which involved the process of risks identification, prediction, implementing, and monitoring of risks in accordance to PMI (2017) is worth noted as one of the most crucial project scopes in a construction project (Adeleke, Bahaudin, Kamaruddeen, Bamgbade, Salimon, Khan & Sorooshian, 2018). Researchers realized that the effort of improving the contemporary circumstances is crucial hence studies have been carried out within the context of project risk management.

With reference and response to the Fourth Industrial Revolution, the method of Artificial

Intelligence (AI) has begun to emerge in the eyes of researchers and numbers of researchers have started to look into the potential adoption of AI in the construction industry, priority to project risk management. To be in line with the Fourth Industrial Revolution, the Malaysian government has come out with a five-year strategic plan to set a target for the Malaysian construction industry to adopt AI within the near five years' time (year 2021–2025). Based on Norvig and Russell (2020), AI is defined as the machines that are programmed to think like humans with simulation of human intelligence. The term may also be introduced to any machine that portraits characteristics or behaviors correlated with a human intelligence such as learning and problem-solving. AI methods are seen as a way of innovation for business and not a new product, which was introduced in the 20th century (Shaughnessy, 2017).

There are numbers of AI models developed with the purpose of providing better solutions for project risk management in the construction industry such as Object-Oriented Evolutionary Fuzzy Neural Inference System, Integrated Prediction Model (IPM), Neural Network Model, Machine learning model with Artificial Neural Network (ANN), and Integrative Random Forest classifier with Genetic Algorithm optimization (RF-GA) (Cheng & Ko, 2003; Arditi & Pulket, 2010; Yousefi, Yakhchali, Khanzadi, Mehrabanfar & Saparauskas, 2016; Muizz, Rosli & Sunday, 2020; Zaher, Zainab, Salih & Nadhir, 2020). The potential uses of the available AI related technologies are summarized in Table 2.

Other than that, DePietro, Wiarda and Fleischer (1990) and Roger (1995) had initiated the study of organizational readiness towards innovation adoption in terms of three aspects, namely technological, organizational, and environmental, which as known as the TOE framework. The influencing factors under the TOE framework was identified under

the three major aspects. The TOE framework was then further expanded and improved in the study by Pumplun, Tauchert and Heidt (2019) with a more detailed consideration of the three aspects from the viewpoint of organizational. In addition to that, Hatmoko, Kistiani and Khasani (2019) argued that the concern of magnifying the people and management factors shall be raised and taken into more deepen consideration in a framework for the study of organizational readiness towards a new digital technology adoption. With the comparison of the three conceptual models, the author has developed a theoretical framework with the consideration of people, technological, organizational, and environmental as the main elements.

1.3 Problem Statement

From the literature reviews, the potential uses of AI technologies for the construction industry particularly for project risk management are frequently studied, thus AI related technologies that interestingly integrate the use of algorithms into traditional ways of project risk management are expected to be the future promising application for construction technology and closes the gap of technology existing in the construction industry (Blanco, Fuchs, Parsons & Ribeirinho, 2018). However, Schia, Trollsås, Fyhn and Lædre (2019) argued that the construction industry nowadays is still holding the thoughts of believing in individual expertise rather than results from empirics that AI offers. In addition to that, Kentouris (2017) stated that the level of awareness of the contemporary AI related technologies from the construction project practitioners was at a low level in the global context as most of the construction practitioners were demonstrating least knowledge about AI and majority neither practice nor use AI in their project risk management.

According to CIDB (2020), Malaysia has ranked 33rd out of 63 countries in the World Digital Competitiveness Ranking 2019 for its information technology (IT) integration under the readiness factor, 31st out of 140 countries in the global competitiveness for adoption of ICT, and 33rd out of 129 countries in terms of Global Innovation Index (GII) under category of ICT technologies. However, as shown in Figure 1.1, it was unfortunate that Malaysia ranked 26th out of 30 countries in the overall ranking for 63 economies including the construction industry for digital competitiveness. In addition to that, based on statistics from BIGIT (2020), Malaysian construction industries' level of maturity of AI which measured in terms of people, AI usage, AI solutions, data variety, and competitor comparison was at an infancy level. From a study by Basaif, Alashwal, Mohd-Rahim, Abd Karim and Loo (2020), it was concluded that the awareness level among the Malaysian construction industry for AI related technologies was relatively low. Not to mention, CIDB (2020) claimed that the Malaysian construction industry still is way behind other industries that have experienced digital transformation and massive advancement over the past few decades, which was believed due to the reluctance of the Malaysian construction industry practitioners towards the adoption of modern technologies and innovations.

Digital shift is ongoing and the Malaysian construction companies shall be ready to keep up the pace of transformation conspicuously for AI adoption in project risk management of construction projects which is evidently shown as an improvement and solution to most of the construction project issues. Nevertheless, from the literature reviews, it significantly shows that there is limited research focus on the influencing factors of AI adoption in the context of organization. Thus, the circumstances urge the needs for a research study to determine the status of organizational readiness of Malaysian construction companies towards the adoption of AI in project risk management with

regards to the relevant influential factors.

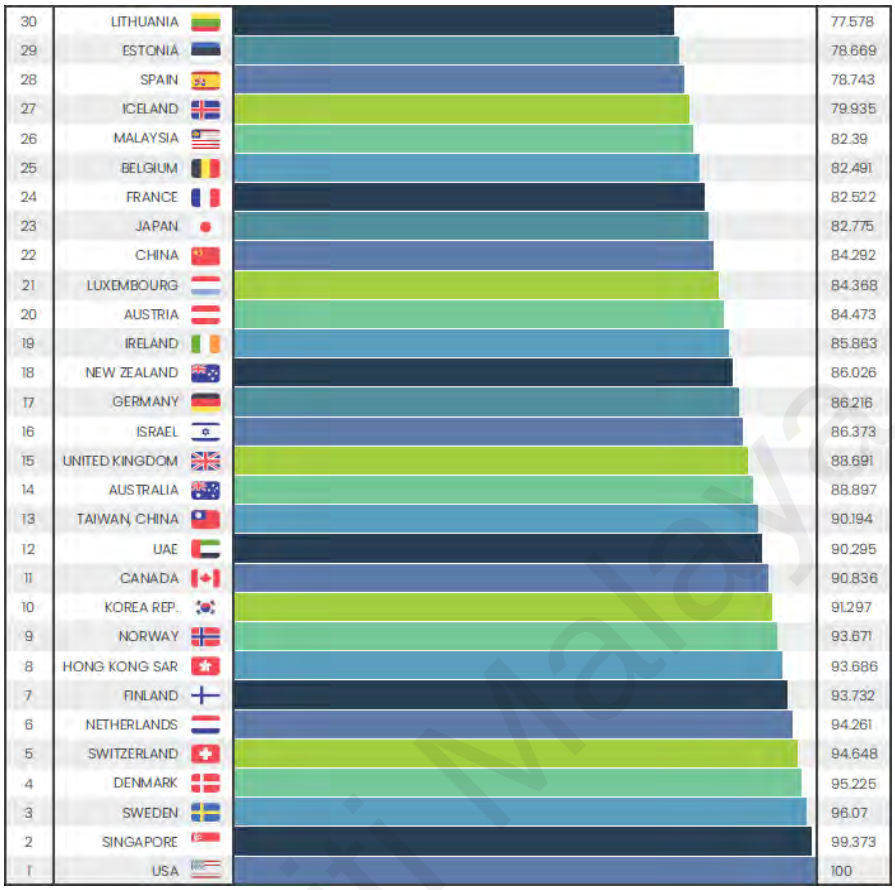

Figure 1.1: Digital Competitiveness Ranking (Source: CIDB, 2020)

1.4 Research Aim

The aim of this study is to investigate the organizational readiness of Malaysian construction companies towards AI adoption in project risk management.

1.5 Research Objectives

This aim is achievable by the following objectives:

1. To identify the AI related technologies used in project risk management.
2. To determine the key factors that influence the organizational readiness of Malaysian construction companies for AI adoption in project risk management.

3. To establish the status of organizational maturity level of Malaysian construction companies towards AI adoption in project risk management.

1.6 Research Questions

The research questions and the associated research objectives are shown in Table 1.1.

Table 1.1: Research questions (Source: Author derived)

Research Objectives	Research Questions
RO1: To identify the AI related technologies used in project risk management.	• What are the available AI related technologies for project risk management in the market? • What is the purpose for the available AI related technologies being used?
RO2: To determine the key factors that influence the organizational readiness of Malaysian construction companies for AI adoption in project risk management.	• What are the key influencing factors for organizational readiness towards AI adoption? • How are the influencing factor impacting the organizational readiness?
RO3: To establish the status of organizational maturity level of Malaysian construction companies towards AI adoption in project risk management.	• What is the status of maturity level of Malaysian construction companies towards AI adoption in project risk management? • Why are the maturity level results as such?

1.7 Research Methodology

This research study is designed to be an exploratory with the aim to investigate the organizational readiness of Malaysian construction companies towards AI adoption in project risk management with a quantitative research approach. The research is started off with a thorough literature review in order to determine the research gap from the landscape of project risk management. The research is then be designed with five key

processes including establishing awareness of the problem, identifying key influencing factors of organizational readiness towards AI related technologies adoption, development of theoretical framework from the comparison of conceptual frames of previous studies, primary data collection from the construction industry practitioners and establishment status of organizational maturity level towards implementation of AI related technologies for the purpose of determining the organizational readiness of Malaysian construction companies.

This study adopts the technique of questionnaire survey for data collection. Questions for questionnaire survey will be designed based on the available AI technologies related to project risk management and theoretical framework developed from the literature reviews in the format of structured closed-format questions. Pilot survey will first be conducted and validation of the questions have to be granted by the experts from construction industry prior to the distribution of questionnaire survey with the sample size as determined from the size of population.

After the data collection, the data shall be analyzed by using mean important scores (MIS). The relevancy of the AI related technologies will be resulted and the significant of the AI related technologies and the key influencing factors shall then be identified in order to achieve the research objective 1 and 2. Other than that, mean readiness score (MRS) for obtained value for each influencing factors and company readiness index (CRI) can then be calculated. Gap analysis will be carried out in order to determine the status of organizational readiness towards the AI adoption in Malaysian construction industry for accomplishing the research objective 3.

1.8 Scope of Research

This research study focuses on identifying the potential use of AI related technologies in project risk management and determine the key influencing factors for organizational readiness towards the adoption of AI related technologies. The status for organizational readiness for AI adoption in project risk management will be assessed and investigated with the consideration of people, technological, organizational, and environmental factors. The research study will be limited to only Grade 7 registered construction companies in Malaysia.

1.9 Significance of Study

The status of organizational readiness of AI adoption in project risk management for Malaysian construction industry provides an insight of how ready the Malaysian construction industry is positive towards the adoption of the AI related technologies which believe is a huge step forward to the future of the industry. Construction industry practitioners can learn on the key influencing factors for the adoption of the innovation and have a clear direction on what needs to be improved from the context of organizational for the preparation of AI adoption in their company from this research study. Conceptual framework of organizational readiness for AI adoption is developed from this study and can be referred by researchers to assess organization readiness for AI adoption in other countries to contribute towards the body of knowledge.

1.10 Structure of Thesis

The structure of the thesis is guided by the research process and arranged as illustrated in Figure 1.2. Brief description of each chapter from the thesis is discussed as follows.

1.10.1 Chapter 1 - Introduction

The first chapter of the thesis will provide a brief research background describing the landscape of the field of study as well as mentioning the gap of research that has been identified by the author. Aim and objectives of the study will be clearly stated in this chapter. The scope of research will be determined and a summary of research methodology will be included to explain the research mechanism for the study. Structure of the thesis will be outlined in this chapter too.

1.10.2 Chapter 2 - Research Methodology

In this chapter, the research design will be explained with a detailed description of the research processes as well as the approach utilized for the research study. Research techniques on data collection and analysis will be mentioned in this chapter.

1.10.3 Chapter 3 - Literature Review

This chapter will contain the landscape of project risk management and the motives of AI adoption in the construction industry. The potential AI related technologies from previous studies will be listed and discussed on the practicality and achievement from the AI related technologies. Then, the key factors of influencing organizational readiness for adoption of new innovations including AI will be discussed in detail in this chapter.

1.10.4 Chapter 4 - Results and Findings

This chapter will demonstrate the processes for data collection from questionnaire preparation to the actual data collection. The results from the questionnaire survey will then be presented in this chapter. The data is further analyzed in this chapter. The status of

organizational readiness for AI adoption in project risk management of Malaysian construction industry will be investigated and established in this chapter.

1.10.5 Chapter 5 – Findings and Discussion

This chapter will discuss the results that are output from the data analysis. The results will be compared and contrasted with relevant previous studies as outlined from literature reviews. Findings from the study will be discussed for the impact of the findings towards the organizational readiness for AI adoption in project risk management of Malaysian construction industry. Status of organizational readiness that output from data analysis will be further discussed to provide insightful values to the study.

1.10.6 Chapter 6 - Conclusion

This chapter will be the conclusion of the study with the reporting on the fulfilment of research objectives followed by the contribution of the study towards the body of knowledge. Limitation of the study will be identified and recommendations for future research will be stated.

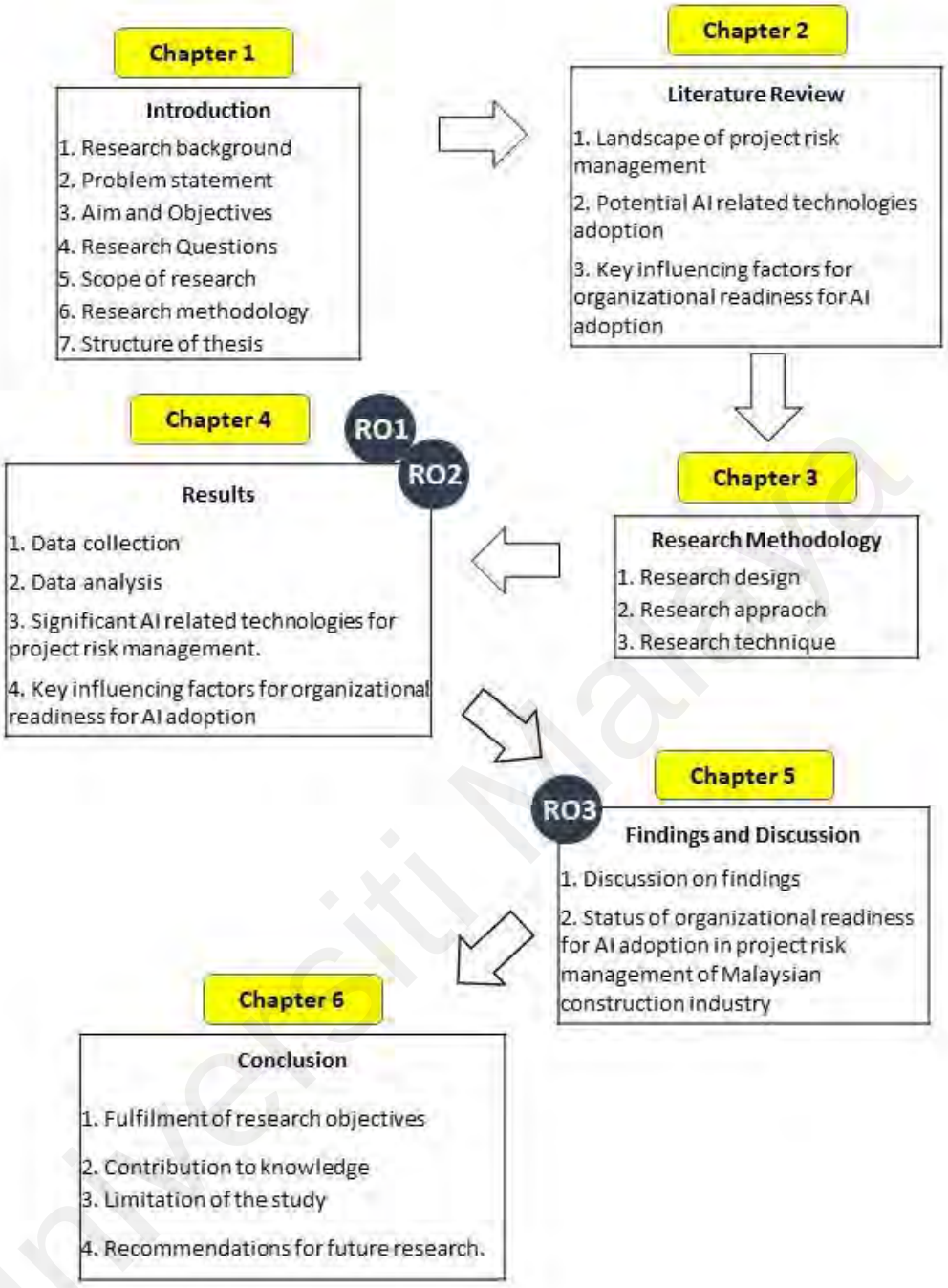

Figure 1.2: Relationships between thesis chapters and research objectives (Source: Author derived)

1.11 Chapter Summary

This chapter provides an overview of the research study and presents the motives for initiating this study. The chapter clearly stated the aim, objectives and research questions

associated of the research study. A brief elaboration on the strategies in order to bridge the gap of knowledge identified and scopes of the research has been included. Moreover, the significance that is expected from the study was presented. To accomplish the research objectives, the previous studies and literatures have been critically reviewed and discussed in the next chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 Chapter Introduction

This chapter includes the definitions of the important elements of this study such as project risk management, AI, and organizational readiness to provide a key definition and scope of this research study. It also provides an overview on the landscape of the Malaysian construction industry under digital transformation particularly on the AI technologies adoption. The potential of AI technologies available from several research studies will be discussed and key influencing factors of organizational readiness for an innovation adoption that revealed from literature searches. Finally, this chapter explains the gap of research that has been identified from the literature review, the need of this research study to bridge the gap of knowledge, and synthesis a theoretical framework to be included in this research study.

2.2 Key Definition

2.2.1 Project Risk Management

According to the Project Management Body of Knowledge (PMBoK), project risk management is defined as the process of making known how to conduct risk management activities of a project. The processes involved are identifying risk, performing qualitative and quantitative risk analysis, plan risk responses, implement risk responses and monitor risks (PMI, 2017).

2.2.2 Artificial Intelligence (AI)

AI is defined as the ability of a machine to mimic intelligent human behavior, thus seeking to use human-inspired algorithms for approximating conventionally challenging

problems (Salehi and Burgueño 2018). Ellilot and Andrews (2017) defined AI as machine with intelligence with not only limited to mankind intelligence but also with the fundamental of high technologies such as deep learning, big data, processing of natural language, and machine learning.

2.2.3 Organizational Readiness

With reference to Weiner, Amick and Lee (2008), organizational readiness was defined as the degree of which the members of organization are ready to accept changes mentally and in terms of behaviour. Holt, Armenakis and Field (2007) argued that the organizational is related to the level of belief that an organization is able to adopt change which is certainly required and beneficial as well as existence of leaders from the organization who willing to commit for change. Lokuge, Sedera, Grover, and Xu (2019) defined organizational readiness as organizational member's commitment to change and being ready for innovation implementations.

2.2.4 Key Definition Adopted in this Research

Considering all the definitions stated and with reference to the research study, the organizational readiness towards AI adoption in project risk management shall be understood as the extend of which the organization is prepared and capable of adopting a machine with mimic of mankind intelligence for risk identification, risk analysis, and decision making with regards to risk in construction projects.

2.3 Research Background

Construction industry is viewed as one of the essential industries and acts as an important pillar towards the economic growth in Malaysia. According to CIDB (2020), the

Malaysian construction industry has contributed 4.5% of the national Gross Domestic Product (GDP) in the fourth quarter of year 2019. However, despite being one of the main players in Malaysia economy, majority of the construction projects are frequently experiencing occurrence of delay in schedule, overrun in cost, and low level of product or service quality which very much correlated to the mishandling of project risks as a result of the nature of construction projects for being excessively complex and unpredictable (Taofeeq, Adeleke and Hassan, 2019; Ansah et al., 2016). Condition and environment of the construction projects may change at any point of time especially during the implementation stage of the project. Thus, the project risk management which involved the process of risks identification, prediction, implementing, and monitoring of risks in accordance with PMI (2017) is worth noted as one of the most crucial project scopes in a construction project (Adeleke, et al, 2018).

Throughout the years, there are multitudes of tools and techniques being introduced to assist on the project risk management processes to minimize the chance of negative results from project time, cost, and quality. Tools and techniques such as Monte Carlo analysis, sensitivity analysis, decision tree analysis, influence diagrams, SWOT(strengths, weaknesses, opportunities, and threats) analysis, PESTLE (political, economic, social, technological, legal, and environmental) framework, TECOP (technical, environmental, commercial, operational, and political) framework, and VUCA (volatility, uncertainty, complexity, and ambiguity) framework are commonly been implemented in the risk identification, analysis and decision making processes (PMI, 2017). However, judged by the results from years of failure attempts, these tools and techniques are seeming ineffective mainly due to the limited consideration of data and human errors. Schia et al (2019) stated that algorithms with the usage of data from past projects and inputs from humans are likely to be the answers to current situations by generating possible

alternatives way for project deliverance and more accurate predictions on cost and schedule, thus the project risks are possible to be kept at minimum.

Based on Harty, Kouider and Paterson (2015), the digital transformation is happening in the construction industry with a rapid advancement in present-time. To keep up with the fast-paced world of digital transformation, the Malaysian government has come out with Construction 4.0, which is a five-year strategic plan in line with Industrial Revolution 4.0 for the forward direction of Malaysian construction industry (CIDB, 2020). The Construction 4.0 included the target duration for Malaysian construction industry to adopt the contemporary emerging technologies from the digital world that have been categorised into short-term (less than 1 year), medium-term (less than 3 years), and long-term (less than 5 years) as shown in Table 2.1.

Table 2.1: CIDB 5-year target plan for emerging technologies adoption (Source: CIDB, 2020)

Categories	Targeted Duration	Technologies
Short Term	Less than 1 year	Prefabrication & Modular Construction
		Building Information Modeling (BIM)
		Autonomous Construction
		Augmented Reality & Virtualisation
		Cloud and Realtime Collaboration
		3D Scanning and Photogrammetry
Medium Term	Less than 3 years	Big Data and Predictive Analytic
		Internet of Things
Long Term	Less than 5 Years	3D Printing & Additive Manufacturing
		Advanced Building Materials
		Blockchain
		Artificial Intelligence

As indicated in Table 2.1, the Malaysian government realized the potential of adoption of AI in the construction industry in the near future of less than five years. Blanco et al. (2018) also mentioned that AI is capable of providing assistance to the construction

industry to get better of the challenges the construction industry is facing currently by reducing the risks from the perspective of schedule, cost, and safety of a project. In addition to that, AI prevailed its advantage of being quick responsive and accurate in predictions under a complex circumstance which believed have overpass capability of a human in some situations as humans are comparatively less capable than AI with regards to data, information, and knowledge analysis (Abbass, 2019; Carpenter, Liu, Cao & Yao, 2018). Other than that, Bolton (2018) argued that the end-users of AI could experience improvements in their tasks with the output from the data that provided by AI which led to positive impacts such as reduction in human error and significant increase in efficiency of service deliverance. Nonetheless, Schia et al. (2019) claimed that the construction industry is still in the midst of feeling more comfortable with the industry expertise over a set of empirics. In addition to that, Kentouris (2017) and Basaif et al. (2020) also stated that the level of awareness of the contemporary AI related technologies from the construction project practitioners was at a low level in Malaysian construction industry or even at the global scale as most of the construction practitioners were demonstrating least knowledge about AI and majority neither practice nor use AI in their project risk management.

2.4 AI related technologies for Project Risk Management.

With the motive of Industrial Revolution 4.0, AI related technologies have been widely adopted in many different kinds of industries for operation and management performance improvement (Brunette, Flemmer & Flemmer, 2009). To provide an answer to the construction industry practitioners for better risk management in the projects, researchers have put efforts into developing AI models that suit the industry. There are several AI related models that have been proven to be practical and useful in dealing with the uncertain and complex circumstances of construction projects, particularly in the context

of project risk management.

Among the AI related models, Cheng and Ko (2003) had come out with an AI model with the integration of three techniques related to AI, which are Fuzzy logic (FL), Neural network (NN), and genetic algorithms (GA). FL is commonly used as one of the techniques to develop AI models for its ability to simulate the process of decision-making from humans at a high level as well as output a rational decision under an uncertain and imprecise environment. NNs has been designed to solve problems with poor definition and structured scope of work by using an appropriate network topology. However, NN was discovered to have difficulty in selecting appropriate parameters and functional structure in its learning of different tasks. GA is a stochastic searching process that was introduced with the purpose of imitating the natural process of evolution. Mechanism of the nature of selection and genetics is referred to in GA and it is claimed to be more flexible for implementation to specific problems. As to address the shortcomings of FL, NN, and GA, Cheng and Ko (2003) proposed the combination of these three AI related techniques with an approach of object-oriented. An object-oriented approach by means to conceptualize every physical and conceptual item as the object, with that, the object-oriented system is able to collect interactions between objects and bring it together for completing certain tasks. The AI model was named as Object-Oriented Evolutionary Fuzzy Neural Inference System (OO-EFNIS). The OO-EFNIS was developed to lessen the impact of poor project risk control by solving the risk of containing weak structured, complicated, undetermined, nonlinear, and ambiguous information problems in construction management. The OO-EFNIS was validated to be able to perform accurate predictions and produce alternatives for problems in a shorter period of time. It was proven to have a 89% accuracy of cost prediction in an optimal case.

Besides, Arditi and Pulket (2010) had conducted research to establish an integrated prediction model (IPM) for predicting the outcome of construction litigation. The model aimed to provide a clear picture of contractual responsibilities of all project stakeholders and to avoid the risk in wastage of cash flow, time, and aggravation on unnecessary case of misconduct. IPM consists of four major components, which are data collection, attribute selection, prediction, and assessment. WESTLAW, an online database system was adopted as the source of data for IPM. In the process of data collection, all data will be filtered to prevent usage of inconsistent and incomplete data. Elimination of inefficacious attributes will then be conducted in the attribute selection process with the aids of Correlation-Based Feature Subset Evaluator, Information Gain Attribute Evaluator, and Consistency Subset Evaluator. For the prediction process, baseclassifiers such as Decision Tree Learner, Repeated Incremental Pruning, and Metalearners were enhanced with error reduction techniques and were employed to complete the system. The prediction was then assessed in terms of prediction accuracy, speed, and robustness. IPM has demonstrated its ability to make precise predictions from unstructured and inconsistent data and has been proven to own a prediction rate of 91.15% in the outcome prediction.

Moreover, an artificial neural network (ANN), one of the AI related models was invented in a research project by Yousefi, Yakhchali, Khanzadi and Mehrabanfar (2016). ANNs are an innovative technology for information processing that mimic brains as well as the natural nervous system of humans. The ANNs are capable of learning from experience, deduce alternatives for problem solving with the exclusion of data that consist of characteristics from irrelevant input with the components of neurons and synaptic transmissions. The ANN model was invented to serve the purpose of predicting probable claims of cost and time in order to prevent the risk of cash flow issues in a construction

project. Cost claim index (CCI) and time claim index (TCI) were employed to provide an all-inclusive and decipherable indication of the construction projects in terms of claims that can be achieved. The research project had concluded with 0.2% errors from the ANN model from its performance in time and cost claims prediction and resulted in 97.6% and 99% accuracy in terms of CCI and TCI respectively. The model is significant for the construction industry practitioners able to prevail in improvement on their claim management and avoid the risk of poor cash flow management which hinders the project success.

Other than that, Muizz et al. (2020) carried out research on comparison of AI related technologies of K-Nearest Neighbors (KNN), Artificial Neural Network (ANN), and Support Vector Machines for their performance in delay risk assessment with regards to tall building projects. According to Yu, Guan, Yang and Yao (2016), and Wauters and Vanhoucke (2017), KNN is a method of identifying the closest related outcome of an input data point with the usage of historical data. ANNs which have been commonly used for being an intimation of mankind biological neural networks behaviors are indicated as iterative systems if representing interrelationship of data arranged in a network with multi layers. ANNs are capable of indicating and simulating the complex non-linear relationships between data with the use of computations in the form of multiple parallel. SVM is indeed a combination of linear modeling and learning from instances. It is widely used as a technique for problems classification and regression with structural risk minimization and statistical learning theory as its theoretical basis. SVM is capable of transforming the input data into a feature space with high dimensions where the process of linear classification is conducted and enables the complex relationships between predictors and outcomes can be handled well. The study from Muizz et al. (2020) concluded that the AI related models outperformed the traditional ways of performing

risk assessment for project delays with an accuracy of all above 75%. The ANNs with classification accuracy of 93.75% was mentioned as the most reliable AI model in the context of delay risk assessment.

Lastly, Zaher et al. (2020) have also attempted to solve the issue of poor prediction of problems that are associated with project delays with the development of a hybrid AI model. The hybrid AI model was named integrative Random Forest (RF) classifier with optimization of Genetic Algorithm (RF-GA). The RF model was based on the integration of decision tree classifiers and algorithms that exhibited feasibility and reliability in the process of predictions. With the combination with GA, several parameters from RF were able to be optimized for better accuracy in random variables classification. GA was proven to be a dependable technique in complicated systems optimization regards with natural selection and have been commonly used in project scheduling, optimization of resources, time and cost optimization and dispute classification for the sake of better project risk management. The hybrid RF-GA model was shown to be reliable on prediction of time performance in construction projects under a dynamic circumstance with a level of accuracy of 96.43% and classification error 3.57%.

The summary of contemporary AI related technologies for project risk management is shown in Table 2.2.

Table 2.2: Summary of AI related technologies for project risk management (Source: Author derived)

Authors	AI Model	Uses
Kezner (2003)	PERT diagram with Fuzzy variables	Planning, scheduling, and controlling for project risks

Table 2.2, continued: Summary of AI related technologies for project risk management (Source: Author derived)

Authors	AI Model	Uses
Cheng and Ko (2003)	Object-Oriented Evolutionary Fuzzy Neural Inference System	To solve ill-structured, complex, uncertain, nonlinear, and incomplete information problems in construction management
Arditi and Pulket (2010)	Integrated Prediction Model (IPM)	Predict outcome of construction litigation
Yousefi et al. (2016)	Neural Network Model	Predict time and cost claim
Muizz et al. (2020)	Machine learning model with Aritificial Neural Network (ANN)	Predict risk of delay
Zaher et al. (2020)	Integrative Random Forest classifier with Genetic Algorithm optimization (RF-GA)	Project delay problem prediction

2.5 Key influencing factors of organizational readiness for technology adoption

From the literature reviews, several researches have been conducted with the aim to study readiness on adoption of technologies from the perspective of organization. In 1990, DePietro et al. (1990) developed a framework to assess the organizational readiness towards technology implementation in terms of three major elements, which are technological, organizational, and environmental (TOE), it was further extended by using the theory of innovation diffusion by Rogers (1995) as stated in a study by Zhu and Kraemer (2005). The TOE framework provides a point of initiation for the study on

technology innovations and a generic theory for diffusion into organization. The TOE framework was tested in the field of information and communication technology as well as other industries and proven to be suitable for looking into adoption of innovations at the level of organization (Aboelmaged, 2014).

In the context of technology, the availability of internal technology infrastructure and external technologies that exist in the market is concerned. Influencing factors such as relative advantage, which indicates the extent to which an innovation is comparatively greater than the former solutions from organizational perception, and compatibility, which represents the degree to which the proposed technology complement with the needs of the expected adopter in the organization level.

According to Alsheibani, Cheung and Messom (2018), the availability of the required organizational resources in order for implementation of new innovations is crucial. Thus, the organizational readiness shall be viewed from the organizational influencing factors including top management support, organizational size, and resources. These factors shall be taken into consideration to picture the ability of an organization to implement a new innovation. Managerial support can be clearly represented from the supportiveness of top management in establishing strategic plans towards the technology's implementation. DePietro et al. (1990) claimed that organizational size contributes to the amount of financial and technical resources shall be taken into consideration to determine the readiness of new innovation adoption. Iacovou, Benbasat and Dexter (1995) also claimed that organizational resources such as employees and technologies play a critical role in adoption of new technologies as adequate skill level and methodologies for adoption have positive impact towards organizational readiness for new technologies.

Under the context of environmental factors, competitive pressure and government

regulation are believed to be the key influencing factors for an organization to be prepared in the adoption of new technologies as organizations are likely to plan for forward actions with reference to external environmental conditions (Alsheibani et al., 2018). Competitive pressure from the competitor company and its intensity is a driver and motive for an organization to adopt new innovations in order to keep the organization in a better market position. Alsheibani et al., 2018) argued that Government regulations which refer to the encouragement from government regulating bodies in the adoption of new technology are said to affect the new technology implementation in a positive and negative way.

The advanced TOE framework from DePietro et al. (1990) and Rogers (1995) is illustrated in Figure 2.1.

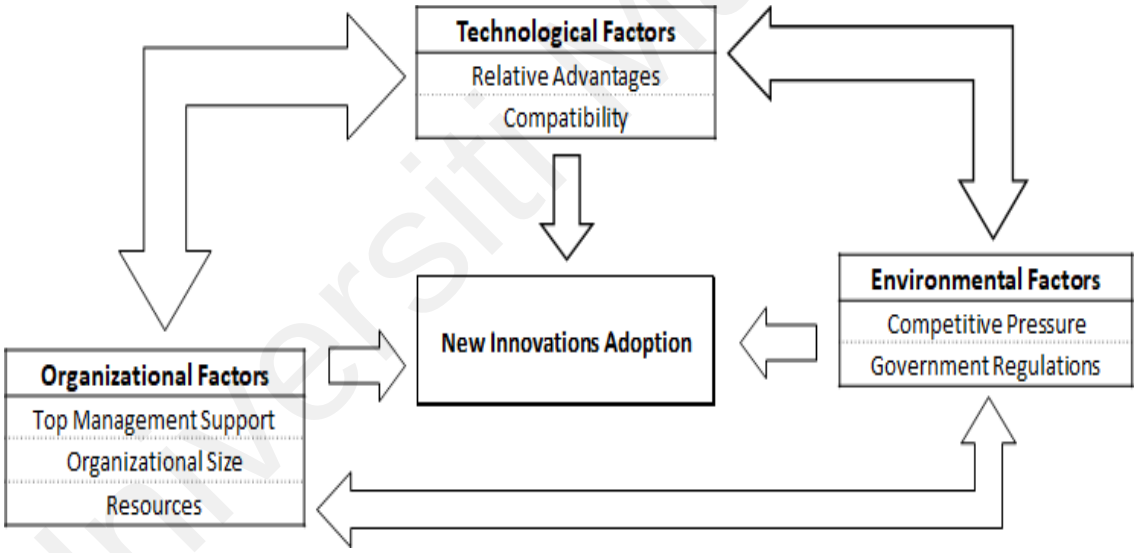

Figure 2.1: TOE framework for new innovations adoption (Source: DePietro et al., 1990 & Rogers, 1995)

In 2019, Pumplun et al. (2019) had extended and deepened the TOE framework for studying organizational readiness towards AI adoption. The research study concluded that the TOE framework should be improved to suit the case of AI adoption as illustrated in Figure 2.2.

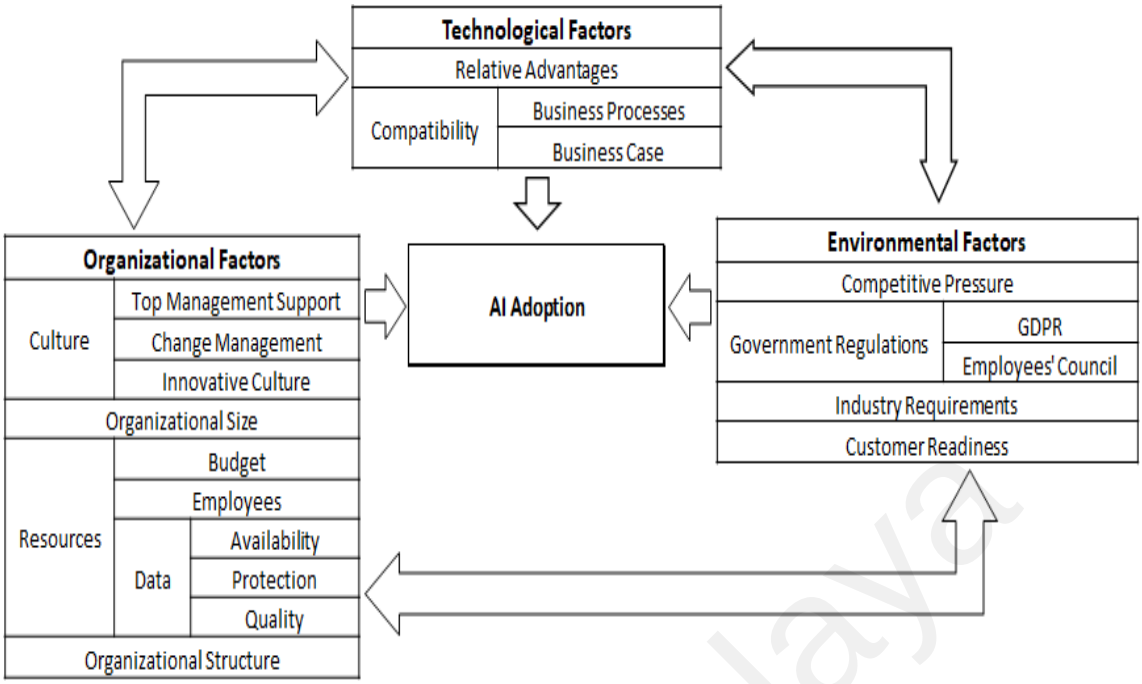

Figure 2.2: Extended TOE framework for AI adoption. (Source: Pumplun et al., 2019)

Under the context of technological factors, Pumplun et al. (2019) argued that the compatibility should be deepened into business processes, which measure the adaptiveness of companies towards the new requirements from the adoption of AI, and business cases, experts from the study pointed out that the new adoption of AI shall have a need or problem to serve to in order to be a tool for a clear purpose.

Other than that, for the influencing factors of organizational, organization culture has been taken into account for the adoption of is strongly dependent on not only the top management support but also the change management and innovative culture of an organization. Change management is defined as the willingness of the organization to accept the usage of new innovations as training for AI improvement will be conducted by the employees gradually. Only if high willingness of employees in an organization exists, the solutions output from the machines will be able to improve in terms of quality. Innovative culture that promotes the desire of implementing new technology is relatively

important as well as claimed from the study. Moreover, the resource element of the framework has been further extended into budget, employees, and data that are inclusive of data availability, protection, and quality. Besides focusing on the budget and employee resources of an organization, Pumplun et al. (2019) mentioned that organizational resources of data shall be brought into the picture of AI adoption as well. As data is crucial in training the AI related technologies, organizations shall be assessed on their readiness in terms of data availability within the organization, how well the data has been protected, and quality of the available data. Organizational structure is measured on the basis of capability of the existing structure to establish a new innovation which resulted from the study to be one of the influencing factors for organizational readiness.

Furthermore, under the category of environmental factors, government regulations were suggested to be looked into particularly on the General Data Protection Regulation (GDPR) as well as the employee's council as both of these government regulations might restraint the adoption of AI in an organization. In addition to that, industry requirements were taken into consideration as the adoption of new technologies may be hindered and affected by the external circumstances, specific laws and regulations, and the interaction between organizations and environment. In view of the correlation of customer readiness towards the organizational readiness for the adoption of AI technologies, Pumplun et al. (2019) concluded the need of looking into customers' ability and willingness to cope with new technologies.

With reference to Hatmoko, Kistiani and Khasani (2019), a framework has been developed to assess the company readiness towards a new digital technology particularly on Building Information Modelling (BIM) that consists of four major components, which are organizational process, management, people, and technology as demonstrated in

Figure 2.3.

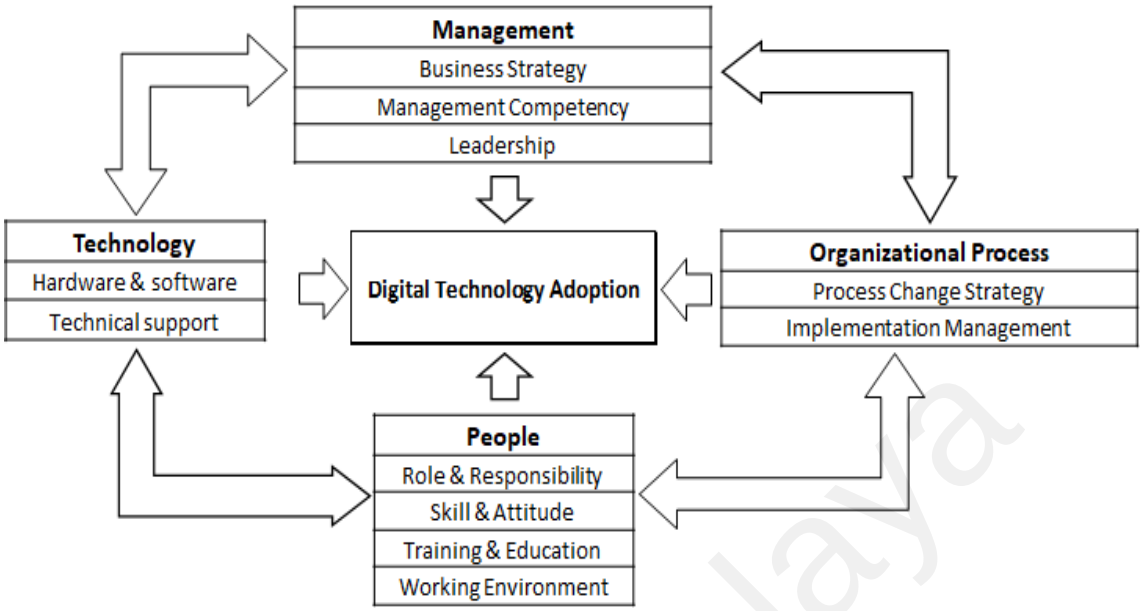

Figure 2.3: Framework for adoption of digital technologies (Source: Hatmoko et al., 2019)

As compared to the extended TOE framework from Pumplun et al. (2019), the framework demonstrated in the study from Hatmoko et al. (2019) has magnified the people-oriented factors and excluded the environmental factors from the assessment. Hatmoko et al. (2019) has extracted the element of people and management from the context of organizational and label them as stand-alone factors which indicate the importance of human factors for an organization to be ready for a new digital technology adoption. The concept was motivated by numbers of researchers who claimed that a new technology adoption requires people to be ready with their role and responsibility to be readjusted, new sets of skill and attitude to be established, training and education to be carried out and a conducive working environment which is associated with an innovative organizational culture (Eastman, Teicholz, Sacks, Liston & Handbook, 2008; Gu, Singh, Tsai, Taylor, London & Brankovic, 2008; Yusuf and Osman, 2008; Smith and Tardif, 2009; Zahrizan, Haron, Marshall-ponting & Abd, 2013; Harris, Haron & Hussain, 2014; Haron, 2013; Merschbrock and Munkvold, 2015; Adi, Harris, Irfan, Zulhanif & Afifuddin, 2016; Mohd, Latiffi, Fathi & Harun, 2017; Muhammad, Haron, Alias & Harun, 2017). Besides,

the management factors were mentioned by Hatmoko et al. (2019) as one of the significant influencing factors that are positive towards the organizational readiness towards adoption of new digital technologies. In order for the implementation of new digital technology, business strategy is essential to be in line with the initiatives to adopt new innovations, management competency level must be at the level of able to overcome and manage risks from the adoption process as well as at the adequate level of commitment and support towards the processes. With a similar approach from Pumplun et al. (2019) which indicated the need for top management support, study from Hatmoko et al. (2019) expressed that the concern on leadership shall be taken into consideration for organizations to adopt a new technology.

With reference to research by Lokuge et al. (2019), organizational readiness for a digital innovation is dependent on seven key factors as derived from the literatures which as shown in Figure 2.4. The theoretical framework developed from the study revealed similarity from the aspects of cultural, resource, strategic, and IT. It is worth to be noted that innovation valance which integrated from the valence of change concept represents the positivity of employees' attitude towards the adoption of a digital innovation is determined as one of the key drivers for an organization to be ready for a digital shift. Besides, Lokuge et al. (2019) opined that the organizational readiness towards an innovation is not only dependent on the acceptability of employees but also their ability to adapt a new skill set and attitude, which been termed as cognitive readiness from the research study. Other than that, organization is expected to look for support from wide range of external stakeholders including software and hardware vendors, customers, and consultants for the implementation of innovation, hence, the status of readiness for partnership with external stakeholders is relatively essential towards the organizational readiness for digital innovation and must be taken into account.

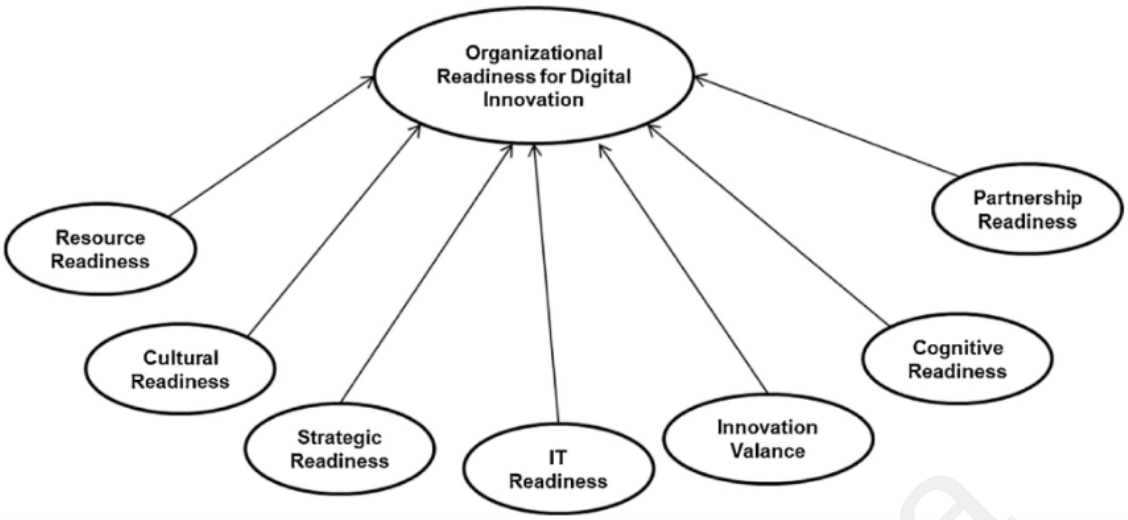

Figure 2.4: Framework for organizational readiness for digital innovation (Source: Lokuge et al., 2019)

2.6 Review on Previous Studies

From the literatures, it is undoubtedly that the AI technologies are definitely a promising tool to improve management performances and operation of projects in terms of project risk management under the motive of Industrial Revolution 4.0 (Brunette et al., 2009). To accommodate the arising interest from the industry, numerous AI technologies have been developed such as the Object-Oriented Evolutionary Fuzzy Neural Inference System, IPM, Neural Network Model, ANN, and RF-GA from the researchers all around the world which were evidently shown to have positive impacts in dealing with complex issues from project risk management (Cheng & Ko, 2003; Arditi & Pulket, 2010, Yousefi et al., 2016, Muzzi et al., 2020; Zaher et al., 2020). However, it was proven by a few researchers that the awareness level of construction project practitioners in Malaysia or even in a global context is relatively unsatisfying and statistics from professional institutions demonstrated that the Malaysian construction industry is still comparatively behind of other industries in terms of AI technologies adoption (Kentouris, 2017 & Basaif et al., 2020). Nevertheless, limited literatures have been established to discuss on the root causes of the current circumstance from the organizational point of view.

The author intended to investigate on the Malaysian construction industry contemporary state of affairs toward the adoption of AI technologies from the status of organizational readiness of Malaysian construction companies. Several research studies have been carried out to identify the factors that could be determinant towards an innovation adoption from the organizational perspective, the findings from the selected research studies are compared and presented in Table 2.3. Nonetheless, the influencing factors for organizational readiness towards an innovation particularly under the condition from the Malaysian construction industry are yet to be determined and might differ from the factors identified from studies of organizational readiness for digital innovation from other nation. Hence, the conceptual framework from DePietro et al. (1990) and Rogers (1995) with the governing factors from category of technological, organizational, and environmental (TOE) has been taken as the basis of the research study theoretical framework. The TOE model has been integrated and further developed with reference to the research findings from Pumplun et al. (2019), Hatmoko et al. (2019), and Lokuge et al. (2019) which indicate the need to appreciate people factors in determining an organizational readiness toward the adoption of digital innovation. The theoretical framework developed is presented in Figure 2.5 which inclusive of the key influencing factors of organizational readiness towards AI technologies adoption that taken into account from the available literatures. Moreover, the definitions of each factor are derived from the literatures as shown in Table 2.4.

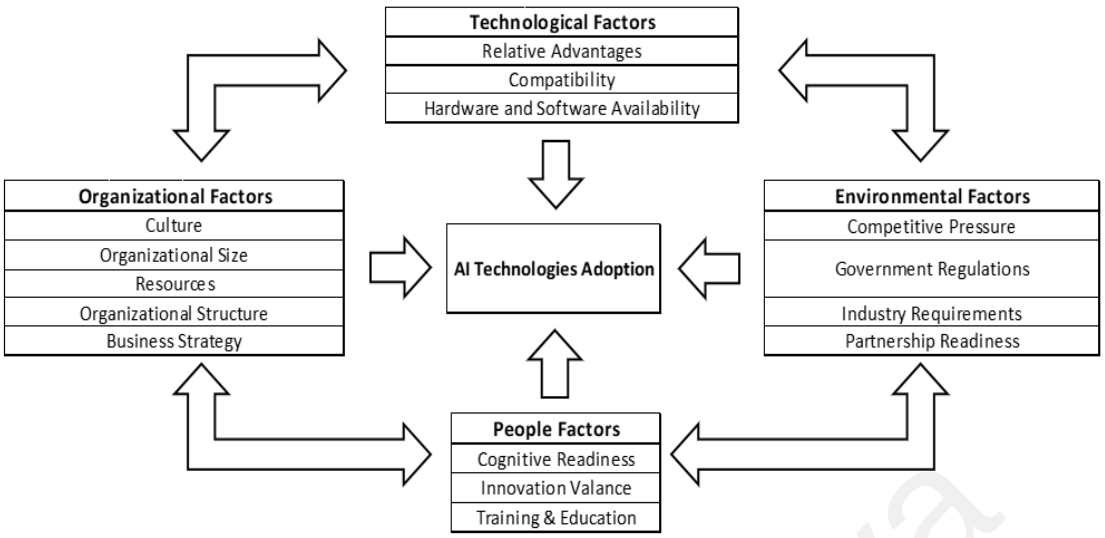

Figure 2.5: Theoretical framework for AI technologies adoption (Source: Author derived)

Table 2.3: Comparison of frameworks from literatures (Source: DePietro et al., 1990; Rogers, 1995; Pumplun et al., 2019; Hatmoko et al., 2019; Lokuge et al., 2019)

Elements	Factors	Subcategories	DePietro et al. (1990) and Rogers (1995)	Pumplun et al (2019)	Hatmoko et al. (2019)	Lokuge et al. (2019)
Organizational	Culture			/		/
		Top management support	/	/	/	
		Change Management		/	/	
		Innovative Culture		/		
	Organizational Size		/	/		
	Resources		/	/		/
		Budget		/		
		Employee		/		
		Data		/		
Technological	Relative Advantage		/	/		
	Compatibility		/	/		
		Business Processes		/		
		Business Case		/		
	Hardware & Software				/	/
	Technical support				/	/
Environmental	Competitive Pressure		/	/		
	Government Regulations		/	/		
		GDPR		/		
		Employees' Council		/		
	Industry Requirements			/		
	Customer Readiness			/		
	Partnership					/
Management	Business Strategy				/	/
	Management Competency				/	
	Leadership				/	
People	Role & Responsibility				/	
	Skill & Attitude				/	
	Training & Education				/	
	Working Environment				/	
	Innovation Valance					/
	Cognitive Readiness					/

Table 2.4: Definitions of key including factors (Source: Author derived)

ELEMENT	FACTORS	DEFINITIONS
Technology	Relative Advantages	Extend to which the AI technologies are comparatively greater than the traditional solutions from organization point of view.
	Compatibility	Degree to which the AI technologies meet the needs of the organization.
	Hardware and Software Availability	Availability of AI related hardware and software.
Organizational	Culture	Supportiveness of organization top management, willingness of the organization to accept the AI technologies adoption, and organization desire to implement AI technologies.
	Organizational Size	Scale of financial and technical resources of organization.
	Resources	Organization budget allocation and availability of quality data with secure data protection.
	Organizational Structure	Capability of organization structure to establish AI technologies.
	Business Strategy	Strategies in place to initiate AI adoption in organization.
Environmental	Competitive Pressure	Intensity of pressure from competitor organization.
	Government Regulations	Encouragement from government bodies in AI technologies adoption.
	Industry Requirements	Availability of specific law and regulations, and interaction between organizations.
	Partnership Readiness	Organization external stakeholder ability and willingness to cope with AI technologies.
People	Cognitive Readiness	Readiness of employee to be readjusted in their role and responsibility
	Innovation Valance	Degree of employee acceptance towards a new set of skill and attitude to be established.
	Training & Education	Availability of training and education for employee for AI technologies adoption.

2.7 Chapter Summary

The literature review is an important element of a research study to establish the present research gap from the field of study. From this chapter, the key definitions are established to suit the interest of this research study. The literature related are critically reviewed and the research gap has been identified which indicates the demand of this research study for bridging the gap of knowledge of AI technologies adoption from the organizational perspective. This chapter also elaborates the previous studies on the organizational readiness towards digital innovation and the key influencing factors are referred to develop the theoretical framework of this research study for achieving the research objectives. The next chapter will discuss on the research approach and the methodology set up for accomplishing the research study aim from the research objectives identified.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Chapter Introduction

This chapter discusses on the research approach that has been upheld in this research study from the elaboration of its philosophical worldview, research design, and research methods in detail. It also presents the strategic plan for this research study designed by the author to obtain the related data from primary and secondary sources for the purpose of reflecting the actual circumstances and also the research analysis designed to achieve the research objectives.

3.2 Research Approach

The study is an exploratory study that aims to investigate the organizational readiness of Malaysian construction companies towards AI adoption in project risk management. According to Creswell and Creswell (2018), for the purpose of exploring indeterminate problems in a distinct situation, exploratory research is conducted. In general, the exploratory study is carried out for a better understanding on the issues as limited research has been conducted in that particular field. This is in line with the motive of this study that limited previous research was found in the field.

Quantitative research approach is selected to achieve the research objectives guided by the research aim as the variables of organizational readiness are able to be quantified and primary data is expected to be gathered in a large amount. Quantitative research approach is commonly used as an investigation of phenomena in an empirical and systematic way by gathering quantifiable data and performing statistical, mathematical, or computational techniques. The basic linkage between observation from empirical viewpoint and quantitative connection expressed in a mathematical way is indicated with the estimated

quantities in a quantitative research approach (Basias and Pollalis, 2018). The exploratory quantitative research will be carried out by using questionnaire surveys for its advantage of convenience and quick to deal with large numbers of respondents located all over Malaysia.

Prior to the decision of the study being a quantitative research, three components have been taken into consideration in the process of selecting the suitable research approach, which are philosophical worldviews, research design as well as research methods (Creswell & Creswell, 2018). The relationship of the three components is as shown in Figure 3.1.

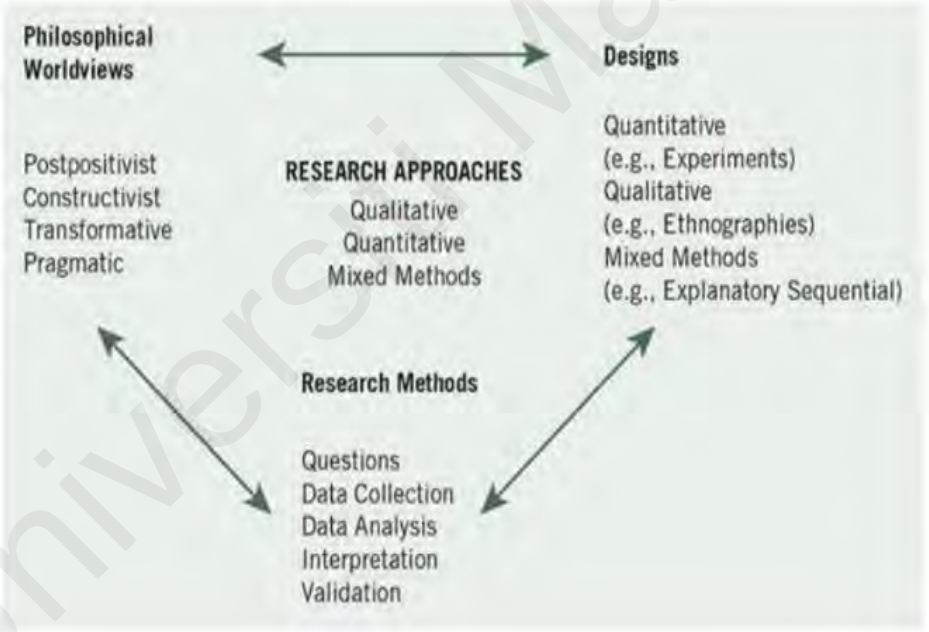

Figure 3.1: Interconnection of philosophical worldview, research designs and research methods (Source: Creswell & Creswell, 2018)

3.3 Philosophical Worldview

According to Slife and Williams (1995), there is in need to identify the philosophical worldview of the research study as it would influence the practice of the research and the approach of research. The philosophical worldviews are seen as the generic idea or

orientation of philosophic that a researcher wish to bring up from a study (Creswell & Creswell, 2018). There are four common types of philosophical worldviews from the literatures which presented in Table 3.1.

Table 3.1: Four types of worldviews (Source :Creswell & Creswell, 2018)

Worldviews	Characteristics	Key elements
Postpositivist Worldview	➢ Challenge the traditional belief of a knowledge. ➢ Philosophy of which causes result the outcomes or impacts. ➢ Knowledge is developed based on close observation and measurement of a reality.	✓ Determination ✓ Reductionism ✓ Empirical observation and measurement ✓ Theory verification
Constructivist Worldview	➢ Seek for understanding of the nature and environment of individuals' living and working from various subjective meanings. ➢ Address the complexity interaction processes among individuals and intent to develop a theory from the perception of others about the world.	✓ Understanding ✓ Multiple participant meanings ✓ Social and historical construction ✓ Theory generation
Transformative Worldview	➢ Hold an agenda of reform action that might result changes in participants' lives. ➢ Provides participants a voice to urge for a change and improve their lives.	✓ Political ✓ Power and justice oriented ✓ Collaborative ✓ Change-oriented
Pragmatic Worldview	➢ Understanding of problem instead of methods by using available approaches. ➢ Focus attention on research problem in social science and knowledge regarding the research problem is derived by using pluralistic approaches.	✓ Consequences of actions ✓ Problem centred. ✓ Pluralistic ✓ Real-world practice oriented

The study intends to identify the key factors that influence the organizational readiness of Malaysian construction companies for AI adoption in project risk management and the status of the companies towards the adoption which triggered by the low awareness level of construction practitioners regarding the topic of digital shift in Malaysia and in need of a framework to provide insight of the readiness of Malaysian construction companies towards the AI adoption in an empirical way. This is in line with the postpositivist worldview which the research study reflects the demand of identify and evaluate the determinant causes that affect the result with a scientific method. The knowledge developed from the study shall be established from precise observations and quantification of a phenomenal or behaviour of individuals and the theory shall be verified and refined for better understanding of a situation which being the organizational readiness of Malaysian construction companies for AI adoption in project risk management from the research study. Besides, the research study attempts to generate statements which are true and relevant to provide a clear perception towards the situation is aligned with the worldview of being positivism.

3.4 Research Design

In accordance with Creswell and Creswell (2018), research design is the type of exploration that provide a set of procedures with clear direction for a research study enclosed in research approach of quantitative, qualitative, and mixed methods. The common research designs within the three research approaches that have been discovered from literatures are as shown in Table 3.2.

Table 3.2: Type of research designs (Source: Creswell & Creswell, 2018)

Quantitative	Qualitative	Mixed Methods
• Experimental designs • Nonexperimental designs, such as surveys • Longitudinal designs	• Narrative research • Phenomenology • Grounded theory • Ethnographies • Case study	• Convergent • Explanatory sequential • Exploratory sequential • Complex designs with embedded core designs

To accomplish the research objectives, a nonexperimental research design is required and survey research shall be designed for the quantitative research study. With reference to Fowler (2008), a survey research is defined as of which tendencies, perspectives, or attitudes in accordance with a sample from population are presented in a descriptive numerical way. Structured interviews or questionnaires are used for the sake of data collection and to generalize the data of a population from a set of samples in a survey research.

3.4.1 Research Strategy

To accommodate the research design of survey research, the study has been strategized with research processes including establishing awareness of the problem, identifying key factors, developing theoretical framework, data collection, and establishing status of organizational maturity level as illustrated in Figure 3.2. The relationship between research process and research techniques is tabulated as displayed in Table 3.3.

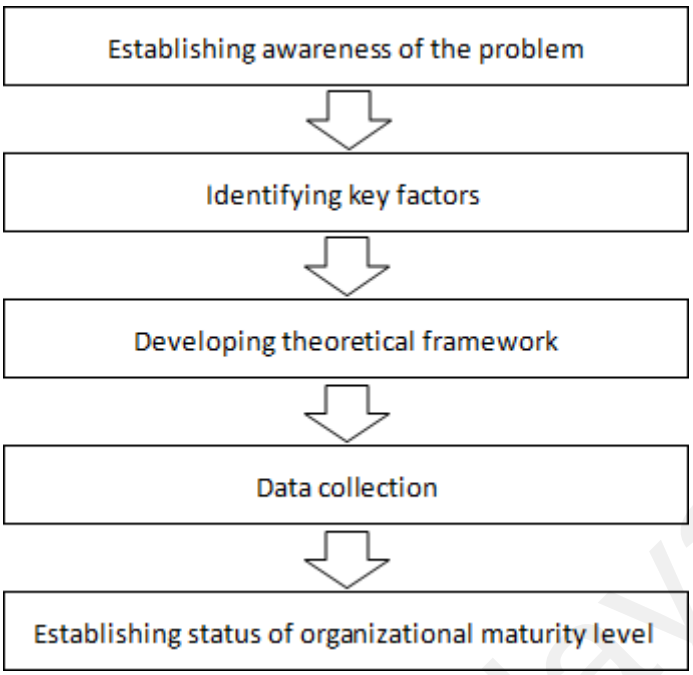

Figure 3.2: Research processes (Source: Author derived)

Table 3.3: The relationship between research process, research techniques and research objectives (Source: Author derived)

Process of Research	Techniques of Research	Related Research Objectives
Establishing awareness of the problem	Secondary data analysis	Research Objective 1
Identifying key factors	Questionnaire survey	Research Objective 2
Development of theoretical framework	Secondary data analysis	Research Objective 2
Data collection	Questionnaire survey	Research Objective 1,2, and 3
Establishing status of organizational maturity level	Questionnaire survey	Research Objective 3

3.4.1.1 Establishing awareness of the problem.

The research study is initiated with literature review of understanding the landscape of project risk management and AI related technologies. The gap of research is then identified from the literature reviews which indicates the need of this research study in order to investigate the organizational readiness towards adoption of AI in project risk management of Malaysian construction industry. The contemporary models of AI available for implementation in the field of project risk management that have been developed from several researches are identified at this stage.

3.4.1.2 Identifying key factors.

To be in line with the research objective 2, a thorough literature review has been done to identify the key factors that influencing the organizational readiness for AI adoption in project risk management of Malaysian construction companies. Several previous studies have been referred and the key influencing factors are recognized with the comparison of four conceptual frameworks from the studies.

3.4.1.3 Developing theoretical framework.

With the comparison of results from previous studies as shown in Table 3, the theoretical framework has been developed and illustrated in Figure 7. The theoretical framework is referred for the questionnaire design in the later stage of this study.

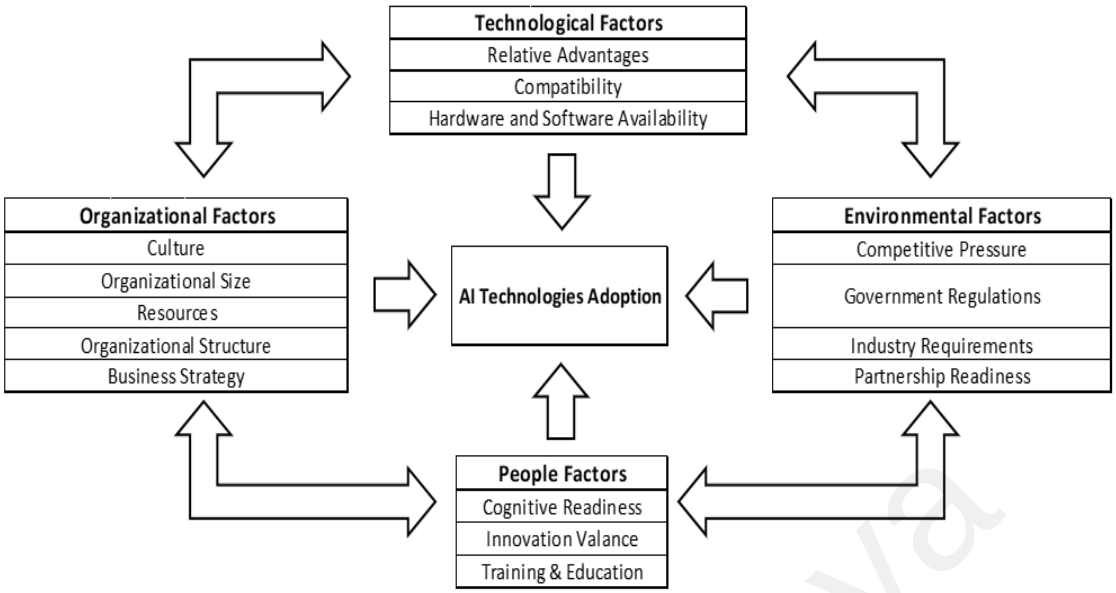

Figure 3.3: Theoretical framework for AI technology adoption (Source: Author derived)

3.4.1.3 Data Collection

The primary data for the study will be collected via questionnaires survey with the questionnaire designed and developed from the theoretical framework as shown in Figure 3.3. Prior to the questionnaire distribution, a pilot questionnaire survey will be conducted with the participation of construction project risk management experts. The pilot questionnaire survey will be done for the purpose of validating the appropriateness of the questions. The finalized version of questionnaires will then be sent to targeted respondents for field data collection.

3.4.1.4 Establishing status of organizational maturity level.

In this stage of research, the organizational maturity level is established from the data collected from questionnaire surveys. Primary data will be analyzed to identify the relevant AI technologies for project risk management discovered from the literatures and the key influencing factors for organizational readiness in AI adoption. The results from

data collection will then be further analyzed with the employment of company readiness index (CRI) and gap analysis. The organizational readiness for AI adoption in project risk management for Malaysian construction industry is then being investigated and concluded in this study.

3.5 Research Methods

The research method is formed from the deliberation of the form of data collection and technique for data analysis to be incorporated in the research study (Creswell & Creswell, 2018). To organize the research methods for this research study, it is essential to take into account of all possibilities as shown in Table. In view of the research objectives and intention of this research study, it is suitable to introduce the quantitative methods for observing the actual situation with predetermined questions. Numerical information is intended to be gathered and analysis or interpretation shall be based on statistic results.

3.5.1 Data Collection

To achieve the research objectives, the research study is initiated by doing literature review on the landscape of Malaysian construction industry particularly on the AI adoption in project risk management. Potential implementation of AI related technologies are being identified from the literature review and several key influencing factors towards organizational readiness for adoption of new technologies are explored.

Questionnaire survey which is one of the common research instruments or tools to be introduced in a quantitative research method is designed in this research study for primary data collection from the field. The questionnaire will be designed based on the list of available AI technologies discovered from the literatures and theoretical framework

developed as shown in Figure 3.3 for the purpose of gathering demographic, behavioral, and attitudinal data from the respondents. In addition to that, the structured questionnaire survey will consist of questions of closed format whereby the respondents have to choose from the given choices as it will provide convenience for respondents to participate in the questionnaire survey. Likert scale of scale 1-5 is likely to be employed in the questionnaire survey to guide the respondents for answering the closed-format questions with the extent of which they agree or disagree to the statements. Primary data is expected to be collected via online questionnaire and postal questionnaires.

Prior to the questionnaire survey being conducted, a pilot survey will be carried out with the involvement of two individual experts from Malaysian construction industry to validate the questions and format of questionnaire is suitable to be addressed to personnel from Malaysian construction industry. The pilot survey is distributed to the two experts with physical distribution and comments are made right after the distribution been received. The experts from Malaysian construction industry are defined to be more than twenty-year experience in the construction industry with experience on effective implementation of new innovation towards organizations from construction industry. Alteration of the questionnaires is anticipated for the production of final version questions. The questionnaires are commented and amended for questions to be more focus on organization in terms of demography as the unit of research is determined to be organization.

3.5.2 Sampling Method

The research study will be implementing the simple random sampling method in which elements from the population are randomly selected for sampling with an equal probability. This is to reduce the possibility of bias involved in the research study. A numbered list of population will be gathered from CIDB or total numbers of registered

construction companies in Malaysia and random numbers will be picked for sampling purposes. The study will be focusing on the G7 category of registered Malaysian construction companies which the characteristics of the construction companies are shown in Table 3.4. The G7 Malaysian construction company represents the contractor supplier of a construction project as contractors and suppliers are responsible for the execution of the project and likely to practice a complete project risk management system that the field of study that this study intended to explore on. The selection of only G7 Malaysian construction companies is due to construction companies with G7 grade are possibly to be more scaled and comprehensive in its system that become the primary target for the adoption of AI related technologies. Thus, the unit of analysis for this study is the managers of Malaysian construction companies under the G7 category. The sample size of the study is identified from the table of sample size by Sekaran (2003) as shown in Table 3.5. Based on CIDB (2020), the total number of grade G7 construction companies is 8,859 units hence the sample size of 368 units is required for the study.

The final version of the questionnaire survey will be sent to the randomly selected sample organizations via email, social applications (Whatsapp and LinkedIn), phone call, and physical distribution. List of contacts for questionnaire survey distribution purpose is obtained via CIDB official website with company contact no. included. Email addresses of the organizations will be searched via online search engine (Google) for email invitation motive. The survey will take place for 6 weeks and only valid responses will be taken into consideration into the data presentation and data analysis for further study.

Table 3.4: Categories of Malaysian construction companies (Source: CIDB, 2020)

Grade	Tender capacity, RM	Paid-up Capital, RM
G7	No Limit	750,000.00
G6	Not exceeding 10 million	500,000.00
G5	Not exceeding 5 million	250,000.00
G4	Not exceeding 3 million	150,000.00
G3	Not exceeding 1 million	50,000.00
G2	Not exceeding 500,000.00	25,000.00
G1	Not exceeding 200,000.00	5,000.00

Table 3.5: Sample size table (Source: Sekaran, 2003)

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

3.5.3 Data Analysis

The demographic of the respondents from the study will be displayed in the form of a pie chart and Microsoft Excel will be used to facilitate the data analysis procedures and data presentation. The Company Readiness Index (CRI) that was introduced in the study by Hatmoko et al. (2019) is referred to determine the status of organizational readiness for AI

adoption in project risk management for Malaysian construction companies. From the data collected, a mean important score (MIS) of each influencing factors will be calculated using Eq. 1 and the weight factors (WF) is able to be determined by employing Eq. 2. On top of that, relative important index (RII) is identified from Eq. 3 for ranking the factors in terms of importance, the method of analysis is found to be effective from research by Basaif et al. (2020). Then, the mean readiness score (MRS) is calculated from Eq.4 to determine the readiness score for each influencing factors and weighted scores (WS) is able to be outputted from Eq. 5 with reference to the calculated WF. Lastly, the CRI can be identified as calculated from Eq.6. Reliability coefficient (Cronbach's alphas) is employed to validate the reliability of the data from the questionnaire survey and result consistency. The MIS and MRS of each influencing factor will be plotted in a spider-web diagram. The parameters for analysis will be input to the Statistical Package for the Social Sciences (SPSS) to ease the analytic measures for the research study and the interpretation of data shall be presented as the output from the software. The relevancy of the available AI technologies and key influencing factors for organizational readiness will be identified.

Furthermore, gap analysis will be conducted to calculate the difference between MRS and MIS of all influencing factors and to determine the maturity level of each component that influences the organizational readiness. Thus, the status of organizational readiness of the Malaysian construction companies will be established in accordance to Table 3.6.

(Eq. 1) $$MIS = \frac{\sum_{i=1}^{n} Yi}{n}$$

(Eq. 2) $$WF = \frac{MIS}{\sum_{i=1}^{p} MIS} \times 100\%$$

(Eq. 3) $$RII = \sum W / (A*N)$$

(Eq. 4) $$MRS = \frac{\sum_{i=1}^{n} Xi}{n}$$

(Eq. 5) $$WS_i = WF_i \times MRS_i$$

(Eq. 6) $$CRI = \frac{\sum_{i=1}^{n} WSI}{5} \times 100\%$$

Table 3.6: Classification of organizational readiness from CRI (Source: Hatmoko et al., 2019)

CRI value	Mean Gap Interval	Readiness Status
0% - 34,99%	0.650-0.757	Not ready
35% - 50,99%	0.542-0.649	Less Ready
51% - 65,9%	0.433-0.541	Quite ready
66% - 80,99%	0.325-0.432	Ready
81% - 100%	0.216-0.324	Very Ready

3.6 Chapter Summary

In short, this chapter elaborates the research approach chosen for the research study which to meet the intended research objectives established. The research study has been chosen as a quantitative research study with the consideration of its philosophic worldview, research design, and research methods that been selected. A closed-end questionnaire will be established from the theoretical framework from the research study for the sake of data collection. To further analyze the primary data from the research study, a statistical analysis and gap analysis will be conducted to make known of the actual status of Malaysian construction companies towards the AI technologies adoption.

CHAPTER 4: RESULTS

4.1 Chapter Introduction

This chapter presents the primary data collected via the research methodology. Data collected from the questionnaire survey with compliance to the research procedures are presented in this chapter. Besides, this chapter is intended to present the results from data analysis from the methodology applied on the outcome of questionnaire survey. Reliability test of the study on the results obtained is shown in this chapter to justify the data to be relevant and reliable for contributing useful and accurate information to the study.

4.2 Data Collection

To obtain the primary data for achieving the research objectives, the study employed the quantitative research method for making use of questionnaire survey as the major research tool. The questionnaire survey was designed in a closed-end format and Likert scale was incorporated for respondents to answer the questions. A pilot survey was distributed to three industry experts for validating the suitability of the questionnaire. The final version of questionnaire was shared to 558 organizations via email, social applications (Whatsapp and LinkedIn), phone call, and physical distribution. The survey was taken place for a duration of 6 weeks and total of 214 representatives from the targeted organizations were consented in the study that made up the response rate of 38.4%. However, the valid responses of 214 units were less than the determined sample size of 368 units which achieved 58.2% of the intended study sample size.

The response rate of less than 50% is believed due to email invitations to the randomly selected sample organizations from the list have only reached to the general email of the

organizations but not the desired group of potential respondents. However, efforts have been made to approach potential respondent personally by phone call and physically for questionnaire survey distribution. The valid return questionnaire of 58.2% from the intended sample size is justifiable with the similar response rate on previous research by Hatmoko et al. (2019) on an assessment to company readiness towards BIM implementation in Indonesia as well as Basaif et al. (2020) on studying the awareness of AI application in construction projects. This also proves that the response rate of such is still able to yield reliable results to the study.

4.3 Data Presentation

4.3.1 Background of Respondent

As to ensure the respondents' attributes are in line with the targeted research population, information on background of respondents including personal and organization background has been obtained from the questionnaire survey.

4.3.1.1 Participant's Background

Pie chart from Figure 4.1 indicates the education background of the respondents, whereas 66.8% from the respondents are bachelor's degree holders and 19.6% from the total respondents are with master's degree. The result shows that majority of the participants are with high education level that reasonably proven the contexts of the questionnaire survey are well understood. Besides, 67.8% from the 214 respondents have worked with their current organization for more than 5 years while 31.3% of them have 1 to 4 years working experience with the organizations. The statistics justify the knowledge and familiarity of the respondents towards their organizations and able to output accurate results and reflects the actual circumstances of the organization status on all aspects from

the study. Other than that, job level of the participants is included in the questionnaire as to indicate the level of responsibility of the participants in the organization. Based on Figure 4.3, the result represents 46.7% of the respondents are at managerial level who are expected to be involved in organization strategic planning and majority (53.3%) from the survey respondents are at executive level in the organizations who are mostly involved in the operation of the organizations and direct impacted from the implementation of an innovation.

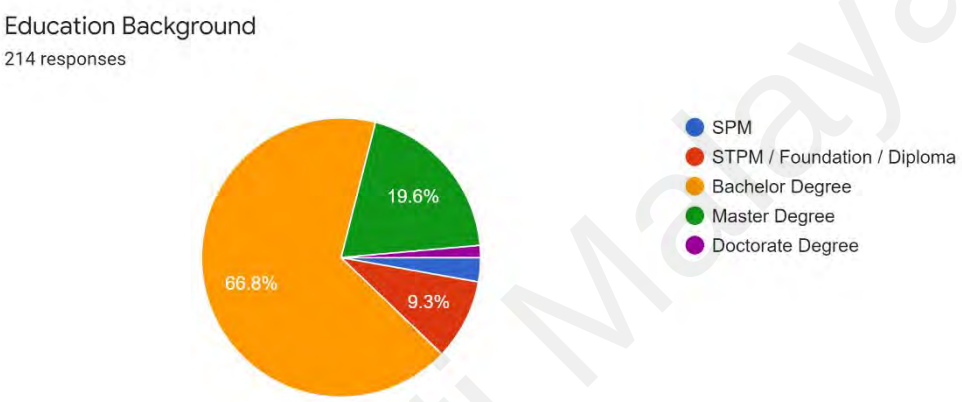

Figure 4.1: Respondent's education background (Source: Google Form)

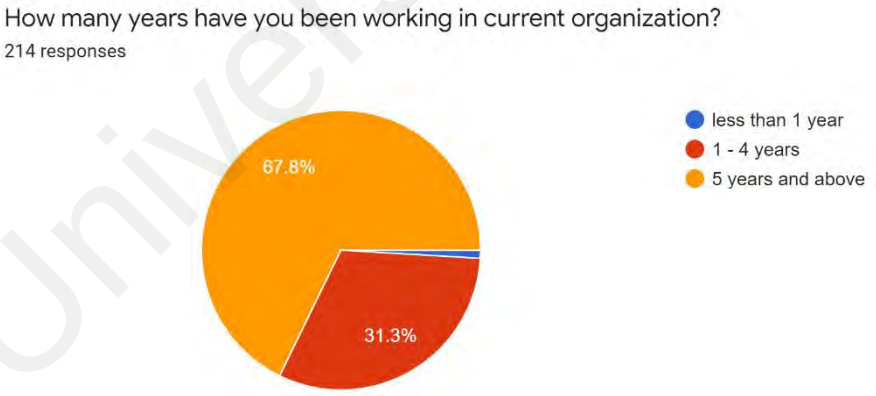

Figure 4.2: Respondent's year of experience in current organization (Source: Google Form)

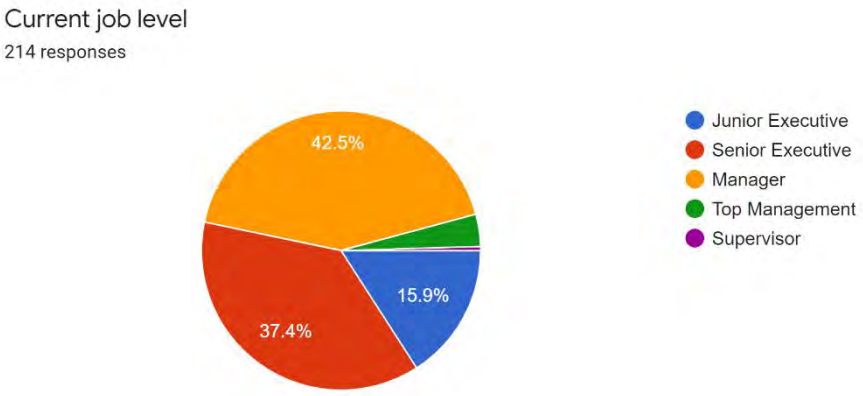

Figure 4.3: Respondent's job level (Source: Google Form)

4.3.1.2 Organization Background

As the study has been designed to be surveyed among organizations and the unit of analysis was set to be organizations, questions with relation to organization background are relatively important for the study. With reference to Figure 4.4, 94.9% participating organizations are from private sector and only minority of the organizations are government related corporates. Organization size is essential to provide information and insight on organization's scale of business and resources available. Figure 4.5 has illustrated the size of the organizations that participated in this study. Out of 214 responses, 162 organizations (75.7%) are at the scale of 201 employees and above, and 16.4% and 6.5% of the organizations are operating with 51-200 employees and 20-50 employees respectively which considerably at middle level of operation scale. It was found out that only minority (1.4%) of the organizations are at a small scale of operations with less than 20 employees.

Type of organization has been concerned as to have a clear understanding on the organization business nature. According to Figure 4.6, 92.1% of the respondents are from construction company of contractor role and 7.9% are organizations of supplier nature in

construction industry. Figure 4.7 shows that the valid responses to the questionnaire survey are from the Grade 7 CIDB registered construction company that further confirmed the intension of the study which was to focus on Grade 7 registered construction company as well.

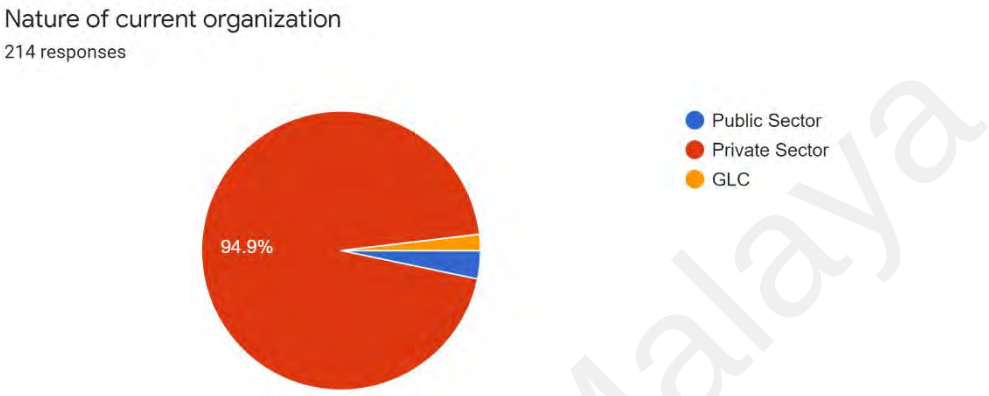

Figure 4.4: Nature of organizations (Source: Google Form)

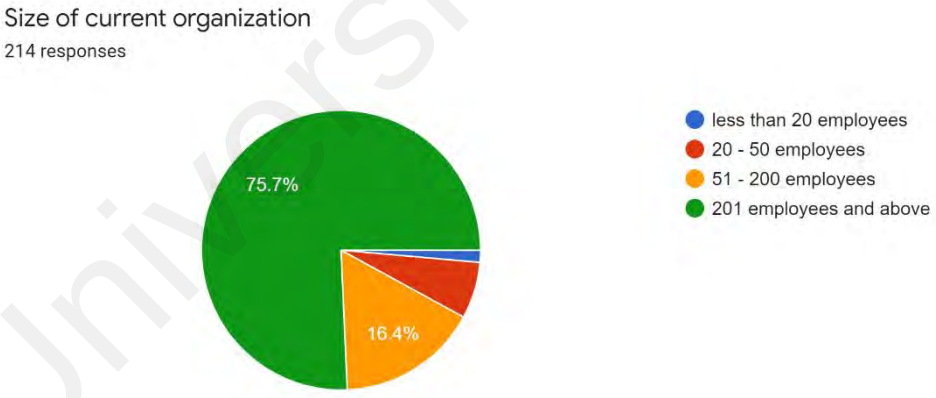

Figure 4.5: Size of organization (Source: Google Form)

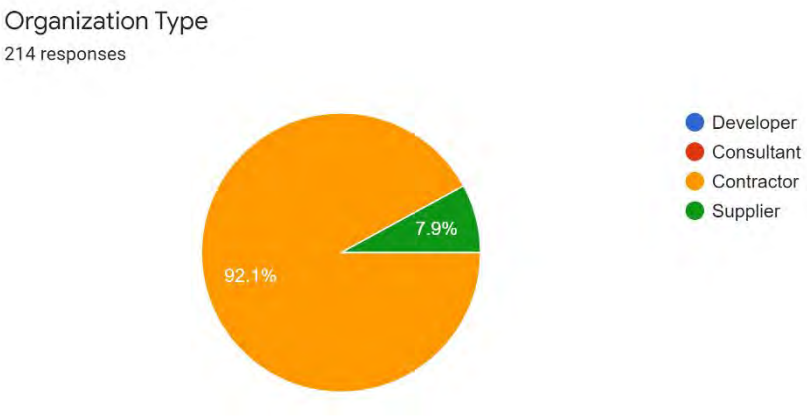

Figure 4.6: Type of organization (Source: Google Form)

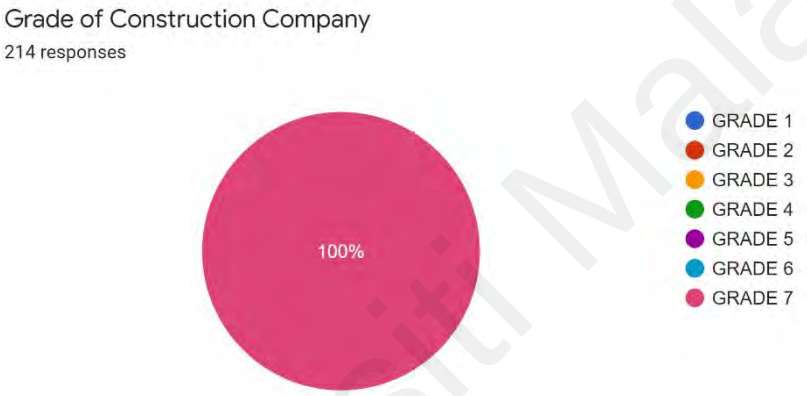

Figure 4.7: Grade of contractor (Source: Google Form)

4.3.2 Importance of Influencing Factors

In Section 2 of the questionnaire survey, the influencing factors as determined from the literature review have been listed and the respondents were asked to rate the importance for each of the factors towards organizational readiness of AI adoption in project risk management. Likert scale of 1 (not important) to 5 (very important) was available for the rating from the respondents' opinion. The ratings which were obtained from 214 valid responses for each influencing factors are presented in Table 4.1. The results from this section are vital to provide valuable data for studying on the relevancy of the influencing

factors which were captured from literatures and to determine the key influencing factors from the organizational point of view.

4.3.3 Readiness of Influencing Factors

To accomplish the research objectives of the study, the questionnaire survey is incorporated with questions that were intended to provide insightful data on how ready the organizations are for adopting AI in project risk management from the organizational perspectives. Series of statements are put forward with reference to the 15 influencing factors from the theoretical framework for the respondents to provide feedback according to their organizations in the form of Likert scale ranging from 1 (totally disagree) to 5 (totally agree). Results from the questionnaire survey has been tabulated in Table 4.2.

Table 4.1: Results of importance of influencing factors (Source: Author derived)

Influencing Factors		1 Not important	2 Least important	3 Neutral	4 Important	5 Very important
T01	Relative Advantages	0	0	55 (25.7%)	117 (54.7%)	42 (19.6%)
T02	Compatibility	0	0	35 (16.4%)	127 (59.3%)	52 (24.3%)
T03	Hardware and Software Availability	0	4 (1.9%)	30 (14.0%)	112 (52.3%)	68 (31.8%)
O01	Culture	0	3 (1.4%)	30 (14.0%)	119 (55.6%)	62 (29.0%)
O02	Organizational Size	0	4 (1.9%)	11 (5.1%)	106 (49.5%)	93 (43.5%)
O03	Resources	0	1 (0.5%)	19 (8.9%)	105 (49.1%)	89 (41.6%)
O04	Organizational Structure	0	7 (3.3%)	46 (21.5%)	131 (61.2%)	30 (14.0%)
O05	Business strategy	0	13 (6.1%)	41 (19.2%)	133 (62.1%)	27 (12.6%)
E01	Competitive Pressure	1 (0.5%)	27 (12.6%)	74 (34.6%)	83 (38.8%)	29 (13.6%)
E02	Government Regulations	0	0	45 (21.0%)	132 (61.7%)	37 (17.3%)
E03	Industry Requirements	1 (0.5%)	0	58 (27.1%)	132 (61.7%)	23 (10.7%)
E04	Partnership readiness	0	24 (11.2%)	61 (28.5%)	109 (50.9%)	20 (9.3%)
P01	Cognitive Readiness	1 (0.5%)	3 (1.4%)	74 (34.6%)	108 (50.5%)	28 (13.1%)
P02	Innovation Valance	0	1 (0.5%)	25 (11.7%)	133 (62.1%)	55 (25.7%)
P03	Training & Education	0	0	27 (12.6%)	124 (57.9%)	63 (29.4%)

Table 4.2: Results of readiness of influencing factors (Source: Author derived)

Influencing Factors	Statement	1 Totally Disagree	2 Disagree	3 Neutral	4 Agree	5 Totally Agree
T01 Relative Advantages	AI technologies are more productive as compared to traditional way of project risk management	3 (1.4%)	15 (7%)	26 (12.1%)	118 (55.1%)	52 (24.3%)
	AI technologies are more advance and helpful in project risk management as compared to other methods practiced by the organization.	9 (4.2%)	11 (5.1%)	14 (6.5%)	113 (52.8%)	67 (31.3%)
	AI technologies are more time saving in project risk management as compared to other methods practiced by the organization.	3 (1.4%)	14 (6.5%)	28 (13.1%)	96 (44.9%)	73 (34.1%)
T02 Compatibility	AI technologies can meet the expectation of organization in project risk management.	9 (4.2%)	22 (10.3%)	26 (12.1%)	115 (53.7%)	42 (19.6%)
	AI technologies can solve organization problems in project risk management.	3 (1.4%)	24 (11.2%)	48 (22.4%)	110 (51.4%)	29 (13.6%)

Table 4.2, continued: Results of readiness of influencing factors (Source: Author derived)

Influencing Factors		Statement	1 Totally Disagree	2 Disagree	3 Neutral	4 Agree	5 Totally Agree
T02	Compatibility	AI technologies can fit into the organization practices in project risk management.	12 (5.6%)	8 (3.7%)	57 (26.6%)	110 (51.4%)	27 (12.6%)
T03	Hardware and Software Availability	Hardware of AI technologies for project risk management is available at the local market.	18 (8.4%)	41 (19.2%)	49 (22.9%)	77 (36%)	29 (13.6%)
		Software of AI technologies for project risk management is available at the local market.	33 (15.4%)	60 (28%)	35 (16.4%)	74 (34.6%)	12 (5.6%)
O01	Culture	Organization has a well-established platform of sharing ideas and thoughts to engage with the IT portfolio for AI adoption.	9 (4.2%)	51 (23.8%)	65 (30.4%)	69 (32.2%)	20 (9.3%)
		Organization has a decentralized decision-making process that facilitates the engagement of all business areas to use the IT portfolio for innovations.	18 (8.4%)	54 (25.2%)	75 (35%)	64 (29.9%)	3 (1.4%)

Table 4.2, continued: Results of readiness of influencing factors (Source: Author derived)

Influencing Factors	Statement	1 Totally Disagree	2 Disagree	3 Neutral	4 Agree	5 Totally Agree
O01 Culture	Organization takes reasonable risk assessment of engaging AI to facilitate innovations.	9 (4.2%)	55 (25.7%)	61 (28.5%)	71 (33.2%)	18 (8.4%)
O02 Organizational Size	Organization has adequate financial resources necessary for AI adoption.	9 (4.2%)	46 (21.5%)	52 (24.3%)	69 (32.2%)	38 (17.8%)
	Organization has adequate human resources necessary for AI adoption.	15 (7%)	66 (30.8%)	63 (29.4%)	41 (19.2%)	29 (13.6%)
	Organization has adequate IT infrastructure resources necessary for AI adoption.	15 (7%)	75 (35%)	60 (28%)	48 (22.4%)	16 (7.5%)
O03 Resources	Organization is flexible and willing to allocate adequate financial resources necessary for AI adoption.	12 (5.6%)	47 (22%)	82 (38.3%)	59 (27.6%)	14 (6.5%)
	Organization is flexible and willing to allocate adequate human resources necessary for AI adoption.	9 (4.2%)	48 (22.4%)	77 (36%)	70 (32.7%)	10 (4.7%)

Table 4.2, continued: Results of readiness of influencing factors (Source: Author derived)

Influencing Factors	Statement	1 Totally Disagree	2 Disagree	3 Neutral	4 Agree	5 Totally Agree
O03 Resources	Organization flexible and willing to allocate adequate IT infrastructure resources necessary for AI adoption.	6 (2.8%)	49 (22.9%)	78 (36.4%)	60 (28%)	21 (9.8%)
O04 Organizational Structure	Organization structure of current facilitates AI adoption in organization.	15 (7%)	65 (30.4%)	50 (23.4%)	65 (30.4%)	19 (8.9%)
	Organization structure of current is capable for AI adoption.	24 (11.2%)	78 (36.4%)	42 (19.6%)	56 (26.2%)	14 (6.5%)
O05 Business strategy	Organization strategic goals are clear to employees when engaging the IT portfolio to facilitate AI adoption.	18 (8.4%)	56 (26.2%)	55 (25.7%)	80 (37.4%)	5 (2.3%)
	Organization strategic goals are relevant to employees when using the IT portfolio to facilitate AI adoption.	15 (7%)	61 (28.5%)	52 (24.3%)	65 (30.4%)	21 (9.8%)
	Employees are well-aware of organizational strategic goals communicated for AI adoption.	16 (7.5%)	71 (33.2%)	49 (22.9%)	67 (31.3%)	11 (5.1%)

Table 4.2, continued: Results of readiness of influencing factors (Source: Author derived)

Influencing Factors	Statement	1 Totally Disagree	2 Disagree	3 Neutral	4 Agree	5 Totally Agree
E01 Competitive Pressure	Organization being pressured from AI adoption in competitor organization.	15 (7%)	77 (36%)	45 (21%)	61 (28.5%)	16 (7.5%)
	Organization senses the need of AI adoption from competitor organization.	15 (7%)	67 (31.3%)	45 (21%)	73 (34.1%)	14 (6.5%)
E02 Government Regulations	Government bodies being supportive to the organization in adopting AI technologies.	29 (13.6%)	62 (29%)	50 (23.4%)	64 (29.9%)	9 (4.2%)
	Government bodies provides incentives to the organization in adopting AI technologies.	23 (10.7%)	72 (33.6%)	61 (28.5%)	44 (20.6%)	14 (6.5%)
	Government bodies encourages organization to adopt AI technologies.	20 (9.3%)	69 (32.2%)	53 (24.8%)	47 (22%)	25 (11.7%)
E03 Industry Requirements	There are constructive collaborations between organizations in adopting AI technologies.	24 (11.2%)	69 (32.2%)	50 (23.4%)	56 (26.2%)	15 (7%)

Table 4.2, continued: Results of readiness of influencing factors (Source: Author derived)

Influencing Factors	Statement	1 Totally Disagree	2 Disagree	3 Neutral	4 Agree	5 Totally Agree
E03 Industry Requirements	There are enforcements of laws and regulations to organization for AI adoption.	43 (20.1%)	69 (32.2%)	42 (19.6%)	50 (23.4%)	10 (4.7%)
E04 Partnership readiness	Organization has a good relationship with software vendors to facilitate AI adoption.	27 (12.6)	65 (30.4%)	45 (21%)	66 (30.8%)	11 (5.1%)
	Organization has a good relationship with management consultants to facilitate AI adoption.	30 (14%)	60 (28%)	58 (27.1%)	50 (23.4%)	16 (7.5%)
	Organization has a good relationship with suppliers or vendors to facilitate AI adoption.	24 (11.2%)	67 (31.3%)	59 (27.6%)	56 (26.2%)	8 (3.7%)
P01 Cognitive Readiness	Employees have appropriate knowledge to facilitate AI adoption.	30 (14%)	57 (26.6%)	54 (25.2%)	55 (25.7%)	18 (8.4%)
	Employees have appropriate skills to facilitate AI adoption.	39 (18.2%)	66 (30.8%)	42 (19.6%)	56 (26.2%)	11 (5.1%)

Table 4.2, continued: Results of readiness of influencing factors (Source: Author derived)

Influencing Factors	Statement	1 Totally Disagree	2 Disagree	3 Neutral	4 Agree	5 Totally Agree
P01 Cognitive Readiness	Employees have appropriate adaptability to facilitate AI adoption.	25 (11.7%)	42 (19.6%)	76 (35.5%)	61 (28.5%)	10 (4.7%)
P02 Innovation Valance	Employees have the right attitudes that facilitate innovations.	27 (12.6%)	24 (11.2%)	94 (43.9%)	57 (26.6%)	12 (5.6%)
	Employees are motivated to facilitate innovations.	21 (9.8%)	20 (9.3%)	82 (38.3%)	76 (35.5%)	15 (7%)
	Employees are empowered to make decisions that facilitate innovations.	30 (14%)	36 (16.8%)	74 (34.6%)	64 (29.9%)	10 (4.7%)
P03 Training & Education	Organization provides adequate training and education to staffs for AI adoption.	28 (13.1%)	58 (27.1%)	63 (29.4%)	54 (25.2%)	11 (5.1%)
	Organization actively engages external professionals to train and education staffs on AI adoption.	32 (15%)	68 (31.8%)	52 (24.3%)	57 (26.6%)	5 (2.3%)
	Employees are willing to participate in training and education provided on AI adoption.	15 (7%)	21 (9.8%)	69 (32.2%)	84 (39.3%)	25 (11.7%)

4.4 Data Analysis

Results obtained from data collection via questionnaire survey has been analyzed in accordance with the research procedures. The data analysis has been divided into three parts. On the first part, importance ranking of all influencing factors have been determined by considering the mean importance score (MIS) and relative important index (RII). Readiness of the influencing factors from organizational perception has been determined by taking into consideration of the MIS which are obtained in part I of data analysis and organizational readiness of each influencing factors are ranked. In part III, gap analysis is performed, and the gap intervals of each influencing factors are able to be identified, hence, the status of organizational readiness for AI adoption in project risk management of Malaysian construction industry was able to be determined.

4.4.1 Importance Ranking

Based on the data collected from Section 2 of questionnaire survey, importance of the influencing factors identified towards organizational readiness for AI adoption in project risk management was analyzed and shown in Table 4.3. Based on Table 4.3, "organizational size", "resources", and "training & education" are ranked as the top 3 most important factors for organizational readiness towards AI adoption. Despite the fact that the other influencing factors are comparatively lesser in terms of degree of importance towards the subject, the RII of each of the influencing factors are still above 70% which proves that all influencing factors are relevant and vital to the readiness for AI adoption from organizational viewpoint.

4.4.2 Readiness Ranking

Primary results as presented on Table 4.2 which according to Section 3 of the

questionnaire survey are further analyzed for the mean readiness score (MRS) of each influencing factors. The gap scores are able to be determined from the MRS and MIS, hence the readiness of each influencing factors are recognized. The outcome from the data analysis of this part is displayed at Table 4.4. The calculation has output that "relative advantages", "compatibility", and "competitive pressure" are the top 3 rank at the readiness ranking that determined from the results. On the other hand, "organizational size", "training & education", and "resources" have the highest gap score and ranked at the bottom of the rank. Based on Table 4.4, it is worth to note that component of "relative advantages" has closed the gap of MIS and MRS and with gap score of -0.064, which falls on the status of "very ready" for the organizational readiness on AI adoption. In terms of "compatibility", Malaysian construction company is opined to be ready with gap score of 0.411. Besides, "training & education" falls on the category of "less ready" However, out of 15 influencing factors, there are 12 influencing factors are indicated to be not ready for AI adoption in project risk management.

On top of that, readiness status has been computed and tabulated in Table 4.5 to provide more insight and detail beneath the primary data obtained from the questionnaire survey for the sake of this study. The results indicate that Malaysian construction industry is perceived at the status of "ready" on the element of technology and being "quite ready" in terms of organizational, environmental, and people factors.

4.4.3 Gap Analysis

To accomplish the research objective of establishing the status of organizational readiness of Malaysia construction companies gap analysis is crucial to determine the maturity level of each influencing components that identified in the theoretical framework of the study. The outcome of gap analysis is plotted in a spider-web graph as shown in Figure 4.8 with

reference to input from Table 4.4.

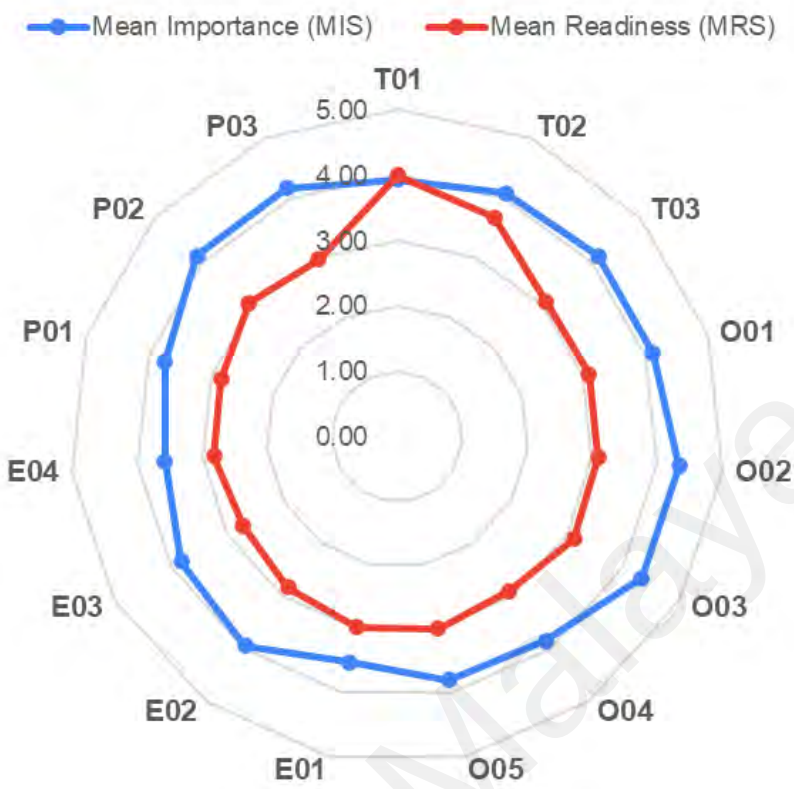

Figure 4.8: Spider-web Diagram (Source: Author derived)

4.4.4 Status of Organizational Readiness

After taking into consideration of all parameters from data analysis, the status of organizational readiness for the 4 major elements from the framework developed have been identified as shown in Table 4.5. The status of organizational readiness for AI adoption in project risk management of Malaysian construction industry as overall is able to be established. Company readiness index (CRI) is calculated, and the overall status of organizational readiness of Malaysian construction industry is found at 62% which falls on the status of "quite ready".

Table 4.3: Importance Rank (Source: Author derived)

Influencing Factors		Mean Importance (MIS)	Weighted Factors (WF)	Relative Important Index (RII)	Importance Rank
T01	Relative Advantages	3.935	6.61%	78.79%	9
T02	Compatibility	4.079	6.86%	81.59%	7
T03	Hardware and Software Availability	4.140	6.96%	82.80%	4
O01	Culture	4.117	6.92%	82.43%	6
O02	Organizational Size	4.341	7.29%	86.92%	1
O03	Resources	4.318	7.26%	86.36%	2
O04	Organizational Structure	3.860	6.49%	77.20%	10
O05	Business strategy	3.808	6.40%	76.26%	12
E01	Competitive Pressure	3.523	5.92%	70.47%	15
E02	Government Regulations	3.958	6.65%	79.25%	8
E03	Industry Requirements	3.818	6.42%	76.45%	11
E04	Partnership readiness	3.584	6.02%	71.68%	14
P01	Cognitive Readiness	3.738	6.28%	74.86%	13
P02	Innovation Valance	4.126	6.93%	82.62%	5
P03	Training & Education	4.164	7.00%	83.36%	3

Table 4.4: Readiness Rank (Source: Author derived)

Influencing Factors		Mean Importance (MIS)	Weighted Factors (WF)	Mean Readiness (MRS)	Weighted Score (WS)	Gap Score (MIS-MRS)	Readiness Status	Readiness Rank
T01	Relative Advantages	3.935	6.61%	3.998	0.264	-0.064	Very Ready	1
T02	Compatibility	4.079	6.86%	3.668	0.251	0.411	Ready	2
T03	Hardware and Software Availability	4.140	6.96%	3.070	0.214	1.070	Not Ready	9
O01	Culture	4.117	6.92%	3.084	0.213	1.033	Not Ready	8
O02	Organizational Size	4.341	7.29%	3.092	0.226	1.249	Not Ready	15
O03	Resources	4.318	7.26%	3.126	0.227	1.192	Not Ready	13
O04	Organizational Structure	3.860	6.49%	2.921	0.189	0.939	Not Ready	7
O05	Business strategy	3.808	6.40%	3.000	0.192	0.808	Not Ready	5
E01	Competitive Pressure	3.523	5.92%	2.977	0.176	0.547	Less Ready	3
E02	Government Regulations	3.958	6.65%	2.850	0.190	1.107	Not Ready	12
E03	Industry Requirements	3.818	6.42%	2.729	0.175	1.089	Not Ready	11
E04	Partnership readiness	3.584	6.02%	2.826	0.170	0.759	Not Ready	4
P01	Cognitive Readiness	3.738	6.28%	2.840	0.178	0.899	Not Ready	6
P02	Innovation Valance	4.126	6.93%	3.055	0.212	1.072	Not Ready	10
P03	Training & Education	4.164	7.00%	2.969	0.208	1.195	Not Ready	14

Table 4.5: Company Readiness Index (CRI) (Source: Author derived)

Element	Influencing Factors	Mean Importance (MIS)	Weighted Factors (WF)	Mean Readiness (MRS)	Weighted Score (WS)	CRI	Readiness Status
Technology	T01	3.935	32%	3.998	1.294	71.4%	Ready
	T02	4.079	34%	3.668	1.231		
	T03	4.140	34%	3.070	1.046		
Organizational	O01	4.117	20%	3.084	0.621	61.0%	Quite Ready
	O02	4.341	21%	3.092	0.657		
	O03	4.318	21%	3.126	0.660		
	O04	3.860	19%	2.921	0.551		
	O05	3.808	19%	3.000	0.559		
Environmental	E01	3.523	24%	2.977	0.705	56.9%	Quite Ready
	E02	3.958	27%	2.850	0.758		
	E03	3.818	26%	2.729	0.700		
	E04	3.584	24%	2.826	0.680		
People	P01	3.738	31%	2.840	0.883	59.2%	Quite Ready
	P02	4.126	34%	3.055	1.048		
	P03	4.164	35%	2.969	1.028		
					Overall CRI = 62%		**Quite Ready**

4.5 Results Validation

4.5.1 Reliability Test

As specified on the research methodology, Cronbach's alpha as the reliability coefficient has been employed to determine the reliability of the data obtained from the questionnaire survey. The Cronbach's alphas of presented in Table 4.6 for each of the importance and readiness of each influencing factors. The results have shown that reliability coefficients of all influencing factors are acceptable as more than 0.7.

Table 4.6: Cronbach's Alphas (Source: Author derived)

Influencing Factors	Cronbach's Alphas	
	Importance	Readiness
T01	0.864	0.936
T02	0.854	0.940
T03	0.854	0.936
O01	0.854	0.929
O02	0.858	0.930
O03	0.860	0.930
O04	0.848	0.927
O05	0.851	0.927
E01	0.849	0.930
E02	0.850	0.931
E03	0.847	0.928
E04	0.846	0.926
P01	0.846	0.926
P02	0.848	0.931
P03	0.852	0.929

4.6 Chapter Summary

In short, this chapter presented the data collected from questionnaire survey. The data is thoroughly analyzed to meet the research objectives with reference to the research methodology which designed from Chapter 3. Results including the respondent background, importance of influencing factors, and readiness of influencing factors are portrayed in this chapter. Status of organizational readiness has been investigated and established from the data collected. The results are deemed to be reliable as discussed in this chapter.

CHAPTER 5: FINDINGS AND DISCUSSION

5.1 Chapter Introduction

This chapter will further discuss on the results presented on previous chapter. The results are compared with previous studies to provide an insightful perspective on how ready organizations are towards the adoption of AI technologies in Malaysian construction industry for project risk management. Advantages and capability of AI technologies in project risk management on Malaysian construction industry will be discussed. Key influencing factors of the topic will be explained for the outcome from the study. Besides, organizational readiness from each of the key influencing factors perception will be discussed fully with the support of previous studies. Overall organizational readiness of Malaysian construction industry that has been identified from previous chapter is talked through in this chapter.

5.2 AI Technologies in Project Risk Management (RO1)

With the rapid advancement of technology in the era of digital transformation especially on the construction industry, AI technologies are listed as one of the innovations that targeted to be adopted within duration of less than 5 years (CIDB, 2020). AI technologies such as OO-EFNIS, IPM, ANN, RF-GA, etc have been identified from previous studies which deem to be applicable to the Malaysian construction industry (Cheng & Ko, 2003; Arditi & Pulket, 2010; Yousefi et al., 2016; Muizz et al., 2020; Zaher et al., 2020). The statement has been supported by the result of the study which indicates AI technologies are acknowledged for the advantages towards the construction companies in Malaysia. The organizations recognize AI technologies as innovation that able to meet and fit the operations and practices from the business nature of the organizations as claimed from the study.

5.3 Importance of Influencing Factors (RO2)

Based on the findings from Chapter 4, the key influencing factors for organizational readiness for AI adoption in project risk management of Malaysian construction industry have been identified and ranked. In view of RII of all influencing factors are above 70% which at the high level of importance, the relevancy and influential of the factors identified is beyond all doubt. Hence, the perceptions from previous studies that captured in Chapter 2 of this study have been proven to be applicable in the subject of organizational readiness towards AI adoption in project risk management for Malaysian construction industry for being the key influencing factors.

Among all the key influencing factors, "organizational size" has been ranked as the most important component for Malaysian construction organization to be ready for AI adoption. Organization size is understood as the resources that available for the organization to adopt AI in project risk management, which includes financial, human, and IT resources. The finding is very much in line with previous studies by Alsheibani et al. (2018) and DePietro et. al. (1990) that highlighted the significance of availability of organizational resources for the implementation of relatively new innovations. With appropriate and sufficient scale of organizational resources, it reveals high possible to bring positive impacts for the adoption of AI technologies in Malaysian construction industry as confirmed from a research effort by Iacovou et al. (1995).

Besides, "resources" with RII of 86.36% are among the top three most important influencing factors which brings impact to the organizational readiness on the subject. Resources are described as the flexibility and willingness of the organization on allocating their available resources which not only limited to monetary and human resources, but

also IT infrastructures and quality data with appropriate protections. Based on the results from the study, organization of being more willing and flexible on resource allocation will influence the readiness for an organization to adopt AI in a constructive way. The study finding has further complemented the extensive study by Pumplun et al. (2019) that mentioned the value of resources allocation inclusive of budget, employees, and data in implementation of an innovation.

Other than that, it is noticeable that "training & education" is on top of the list for being the 3rd highest ranking on the key influencing factors for readiness for AI adoption in project risk management of Malaysian construction industry from perception of an organization. Training and education to the employees of an organization is one of the people factors that have been picked up from previous studies by Pumplun et al. (2019), Hatmoko et al. (2019), and Lokuge et al. (2019). The appreciation of people factors, particularly on employee's training and education that facilitates knowledge transfer have once again been verified to be an importance component for Malaysian construction company to move on AI adoption in this study.

In addition to the above findings, the study has also provided solid evidence in validating the theoretical framework to be relevant and practical as RII of all components included in the framework have been determined are above 70%. The theoretical framework developed with reference to the previous studies are inclusive of all key influencing factors of organizational readiness towards AI adoption that proven from the data obtained in the study. Hence, it is not exaggerating to mention that the generic framework developed from this study is reasonably applicable to study organizational readiness for adoption of AI technologies in project risk management particularly on the Malaysian construction industry which also additionally evinces knowledge from previous studies

(DePietro et al., 1990; Rogers, 1995; Pumplun et al., 2019; Hatmoko et al., 2019; Lokuge et al., 2019).

5.4 Readiness of Influencing Factors (RO3)

To accomplish the research objective of the study, readiness of each influencing factors has been surveyed and resulted in Table 4.4. MRS for each of the key influencing factors are analyzed and the readiness ranking has been identified to provide an insight on the organizational readiness from the perceptive views of each aspect.

With regards to the outcome of data analysis, "relative advantage" of AI technologies as one of the technology elements from the framework is found out to be "very ready" and ranked as the readiest aspect for construction companies in Malaysia to adopt AI technologies in project risk management with MRS of 3.998. A negative gap score represents the organization has gone beyond the expected readiness with the consideration of the importance of the "relative advantage" factor. The status of readiness of such for this technology element factor indicates that the advantages of AI technologies are well acknowledged and appreciated by the Malaysian construction industry. Organizations believe and have adequate degree of acceptance that AI technologies are able to bring more constructive values to the organization in project risk management than the conventional methods. The finding is agreeable with the supports of research outcome from study by Makarius, Mukherjee, Fox, and Fox (2020) which stated that with the ascendancy being least acknowledged, organization would not move any further in adopting AI technologies. Hence, with the increasing awareness of AI technologies, advantages from technology of such would be highly appreciated by the organization and create a sense of necessity for their organizations to adopt AI technologies. However, this is inconsistent to the low level of awareness of AI application for construction projects in

Malaysia as determined from the research by Basaif, et al. (2020). Therefore, the finding from this study suggests the appreciation of AI technologies in Malaysian construction industry has potentially increased from the organizational perception over the years and ready for AI adoption in project risk management.

Besides, "compatibility" is ranked as the 2nd highest in terms of organizational readiness towards the subject from data analysis performed. The aspect of AI technologies compatibility is opined at the category of "ready" from the organizations' point of view. Malaysian organizations from the construction industry are suggested to have adequate understanding on the relevancy of AI technologies towards operations of the organizations. AI technologies are comprehended for being able to meet the expectations as well as fit well on the organization practices on project risk management and proven at the level of "ready" for Malaysian construction industry to adopt AI technologies. The finding of such is complementing research by Pan and Zhang (2021) that confirmed the role of AI technologies and value that can be brought to the construction industry.

Other than that, environmental factor of "competitive pressure" which at the level of "least ready" is mentioned to be placed at the 3rd highest ranking on the readiness rank resulted from Table 4.4. Competitive pressure has been defined as the intensity of pressure from the external competitors in the construction industry. The gap between the importance score (MIS) and readiness score (MRS) has revealed the status in terms of readiness on this aspect. The result indicates that there is relatively smaller gap for the expectation and current circumstance of organization in terms of competitive pressure the organization is facing. The finding could be explained as the overall construction industry has comparatively lower expectation on the AI adoption in project risk management, hence, organizations although own comparatively lower sense of need from external

competitive pressure, the gap is still closer as compared to the remaining 12 key influencing factors. Study by Kentouris (2017) has interpreted the progress of AI adoption in project risk management for Malaysian construction industry is far behind of other industries which best explains the above-mentioned finding of low expectations from Malaysian construction industry.

5.5 Gap between MIS and MRS

Figure 4.8 on the spider-web diagram plotted from the output of the survey has expressed the gaps for how ready of the Malaysian construction industry is and compared to what is the expected level on each aspects for Malaysian organization of construction nature to be ready in adopting AI technologies. It provides insightful findings on the relationships between importance and readiness of every individual aspect from the 4 major elements (technology, organizational, environmental, and people), and impacts of these influencing factors towards the overall organizational readiness status.

Based on the outcome from the questionnaire survey and data analysis, it is noticeable that technology element is found at status of "ready" for Malaysian construction industry to adopt AI in project risk management with CRI value of 71.4%. This indicates a positive sign as for the technology has been recognized by the organizations in construction industry and also capable to deal with organizational practices for project risk management. It is meaningful to point out that the availability of hardware and software of AI technologies in local market is relatively less which contributed to the gap of MIS and MRS for this key influencing factor. The result is predictable as statistics from BIGIT (2020) has proven that maturity of ICT technologies in Malaysia is at an infancy level, hence, it is not surprise that hardware and software of AI technologies are needed to be developed in the market.

As captured from Figure 4.8, the organizational factors are at the state of "quite ready" as proven from the study. However, current state of Malaysian construction organizational size has the biggest gap to be closed in order for the organization to be ready on adopting AI technologies in project risk management. The scale of Malaysian construction companies is far lesser than the expected level for budget, human and IT resources based on the importance of the factor. The results from questionnaire survey have pointed out criticality of this aspects fall on the unavailability of adequate IT infrastructures in the organizations to adopt AI technologies. According to CIDB (2020), Malaysia is ranked on 33rd out of 69 countries in terms of digital competitiveness and hence inadequacy of IT infrastructure is expected from Malaysian construction companies. The results of the gaps that have been picked up from the study between MIS and MRS on the organizational culture, resources, organizational structure, and business strategy are not a surprise from the study as awareness of AI implementation in Malaysian construction industry is investigated at low level and most of the construction practitioners have not used AI technologies in their project before, hence, organizations are having a reasonable gap in terms of culture and strategy for AI adoption (Basaif, et al., 2020).

Other than that, major element of environmental which represents the external factors that influences organizational readiness towards AI adoption has been identified to be "quite ready" in Malaysian construction industry. With reference to the outcome of the questionnaire survey, results show that environmental element of the framework has brought value to the study with the identification of the key influencing factors. However, competitive pressure has been discovered to have the least important among the other factors. This finding is (Literature – overall market). In spite of government regulations are proven to be available as can be referred from CIDB (2020), the effort from the

government to make up the organizational readiness is still insufficient as output from the gap analysis. Besides, requirements from the construction industry are determined to be inadequate for the industry to move-forward adoption of AI technologies in project risk management. The finding corresponds to the landscape of Malaysian construction industry towards AI technologies as confirmed on the statistics as presented by BIGIT (2020) and CIDB (2020) for the comparatively lower level of competencies for IT technologies adoption in Malaysian construction industry as well as studies by Kentouris (2017) and Basaif et al. (2020) on the same issue. Gap of MIS and MRS on partnership between organizations and IT service providers to incorporate AI technologies within the organizations is realized. Scenario of such is resulted from the uncommonness of AI technologies related vendors available in the Malaysian market as supported by statistics from BIGIT (2020).

The people element is acknowledged as part of the framework to study on how ready Malaysian construction organizations are towards AI adoption, however, contemporary state of affairs for Malaysian construction industry has to be improved. Knowledge and skill level of employees are yet to be enhanced to an appropriate level as cognitive readiness of the employees from construction organizations are still lower than expected. Since AI technologies are relatively new to the construction industry, hence, the finding is deemed to be reasonable. The finding is in line with research by Alsheiabni, Cheung, and Messom (2019) which mentioned that technical knowledge and skill from the human resource of an organization is a barrier to AI adoption for the characteristics of AI is comparatively unique. Hence, it makes sense that employee should have the right attitudes and motivations to adopt AI technologies in the organization project risk management with sufficient training and education provided by professionals internally or externally. The logic is in line with research by Mohd, et al. (2017) which stated the

gaps of organizations on employee training and education has to be bridged with an innovative organizational culture. The statement has proven by the outcome of the questionnaire survey that innovation valance, and training and education from Malaysian construction industry has yet to be elevated.

5.6 Status of Organizational Readiness (RO3)

In view of the gaps determined between MIS and MRS of each key influencing factors, status of organizational readiness for Malaysian construction industry to adopt AI technologies in project risk management is at the level of "quite ready". Despite low level of awareness was encountered from the studies by Kentouris (2017) and Basaif et al. (2020), this study has concluded that the status of organizational readiness for Malaysian construction industry is actually at the medium level with 62% of CRI. The statement provides an insight on construction industry of Malaysia have moved positively towards the adoption of AI technologies.

However, with reference to the results from thorough data analysis, it shows that most of the elements which are judged to be crucial from the important ranking have not been focused by the Malaysian construction companies to get themselves ready on the road of AI technologies adoption. Hence, efforts from organizations to bridge the gaps of all aspects with reference to the results of this study is recommended.

5.7 Chapter Summary

In short, this chapter explains the research findings with reference to the previous studies as explored by the author. Significance of AI applications on Malaysian construction industry for project risk management is discussed. Key influencing factors that bring

impacts to organizational readiness for AI adoption have been thoroughly interpreted and explained. Besides, readiness on each of the key influencing factors from the perception of Malaysian construction organizations is elaborated and compared to the previous studies. Lastly, status of organizational readiness towards AI adoption for overall Malaysian construction industry has been established with reasonable supported findings.

CHAPTER 6: CONCLUSION

6.1 Chapter Introduction

This chapter will provide a summary to the research project as overall and explains on how this study have achieved the established research objectives and aim in order to bridge the research gap. Contribution of the study towards body of knowledge and construction industry for AI technologies adoption in Malaysia will be elaborated. Lastly, limitations and recommendations for future research have been concluded.

6.2 Organizational Readiness for AI Adoption in Project Risk Management of Malaysian Construction Industry

In this era of technology advancement, digital transformation is unavoidable especially on the fast-forwarding steps towards IR4.0. This has urged the application of AI technologies to incorporate big data into businesses. However, the level of awareness is deemed to be low at the Malaysian construction industry for AI adoption which discovered by several research and statistics (Kentouris, 2017; Basaif et al., 2020; CIDB, 2020; BIGIT, 2020). Landscape of such at the construction industry of Malaysia has triggered the gap of research to look into the actual readiness of Malaysian construction industry for AI adoptions in project risk management.

The study has been designed with three main research objectives to achieve the ultimate research aim which is to investigate the organizational readiness in Malaysian construction companies towards AI adoption in project risk management. To accomplish the research objectives, a series of methodology is developed and framed to capture the research motives and procedures. The fulfillments of research objectives are reflected as following:

6.2.1 RO1 - To identify the AI related technologies used in project risk management.

AI technologies have been developed in a great amount from the field of academic and business and encountered for the advantages and usefulness in project risk management of construction industry. Hence, to be relevant to the study, several applications on AI related technologies from the body of knowledge such as OO-EFNIS, IPM, ANN, RF-GA, etc. have been identified. The applications are picked up from previous research and innovative developments. To study on the relevancy of these applications, thorough literature review has been carried out and opinions from the construction industry practitioners have been captured from questionnaire survey. The survey has concluded that the AI related technologies are relatively important and relevant to the construction industry of Malaysia in project risk management for the advantages and capabilities of the applications could contribute.

6.2.2 RO2 - To determine the key factors that influence the organizational readiness of Malaysian construction companies for AI adoption in project risk management.

To accomplish the second research objective, factors that potentially be influencing the organizational readiness for AI adoption are recognized from previous studies. Frameworks of several research for relevant topics are compared and proposed framework as shown in Figure 6.1 has been extensively developed with four (4) major elements been taken into consideration, namely technological, organizational, environmental, and people.

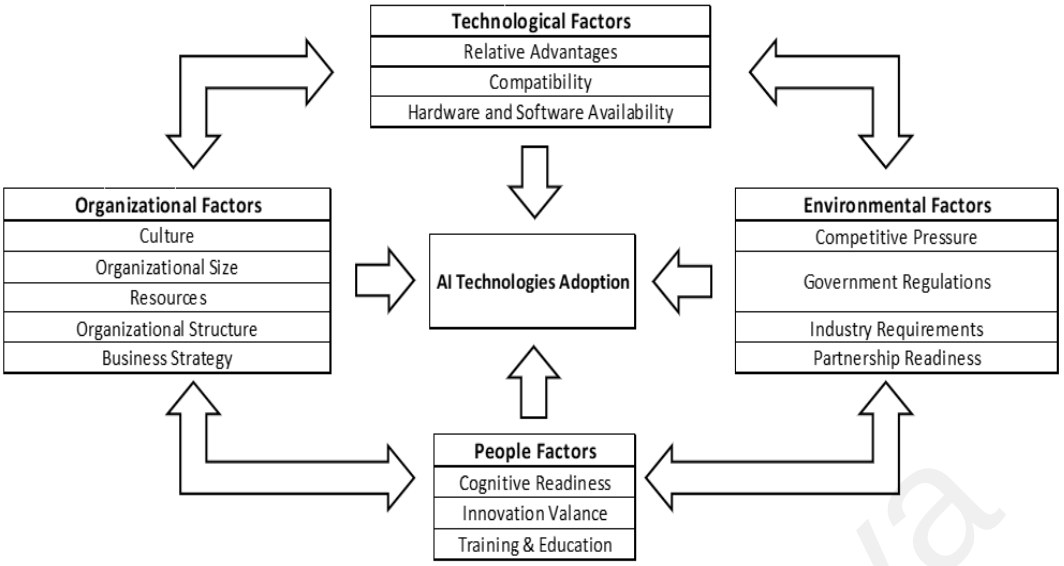

Figure 6.1: Proposed framework for AI technology adoption (Source: Author derived)

The potential key factors are studied with the input of construction industry practitioners and results from the study show that factors identified from previous studies are applicable to the circumstance of AI technologies adoption in Malaysian construction industry as the key influencing factors. However, to establish a sense of priority from the 15 aspects of organizational readiness, a ranking in terms of importance has been identified. The ranking is as shown in Table 6.1.

Table 6.1: Importance Rank (Source: Author derived)

Influencing Factors	Importance Rank
Organizational Size	1
Resources	2
Training & Education	3
Hardware and Software Availability	4
Innovation Valance	5
Culture	6
Compatibility	7

Table 6.1, continued: Importance Rank (Source: Author derived)

Influencing Factors	Importance Rank
Government Regulations	8
Relative Advantages	9
Organizational Structure	10
Industry Requirements	11
Business strategy	12
Cognitive Readiness	13
Partnership readiness	14
Competitive Pressure	15

6.2.3 RO3 - To establish the status of organizational maturity level of Malaysian construction companies towards AI adoption in project risk management.

For the third objective of the research study, organizational readiness of all key influencing factors is analyzed from the results of the study. From Table 4.4 and 4.5, the study can conclude that 12 out of 15 influencing factors are not ready for Malaysian construction companies to adopt AI. Organizations are opined to put more effort to close the gap identified from the study from each influencing factors presented with regards to the gap analysis performed and illustrated.

However, with reference to the parameters and magnitude of each influencing factors, the overall organizational maturity level of Malaysian construction companies towards AI adoption in project risk management is identified to be “quite ready” which shows a positive sign for Malaysian construction companies for moving forward on this technology advancement.

6.2.1 Fulfillment of Research Aim

To conclude the research study, research aim which is to investigate the organizational readiness of Malaysian construction towards AI adoption in project risk management has been accomplished by revealing the organizational readiness level of "quite ready" with 62% of CRI. The organizational readiness level has provided an insightful information for Malaysian construction industry to realize what is the contemporary state of affair on the process of AI adoption in project risk management and also able to strategize efforts to improve themselves by bridging the gaps of readiness investigated.

6.3 Contributions to Body of Knowledge and Construction Industry

The study has ultimately bridged the gap of knowledge on the readiness of Malaysian construction industry to adopt AI from the organization point of views. The proposed framework and specific research procedures developed from the study are deemed to be applicable as a generic framework for studying organizational readiness for AI technologies adoption. The framework somehow provides a direction the organizations for what aspects shall be prioritized for better adoption of AI technologies in a construction company.

Other than that, the results on the status of organizational readiness have revealed the contemporary circumstances of Malaysian construction industry in adopting AI technologies. Results from the study can be referred by organization decision makers for assisting the organization to be ready towards AI adoption.

6.4 Limitations of the Study

The limitations of study are as following:

- The study population has only involved the Grade 7 CIDB registered construction companies due to time constraint allocated for the study, which potentially triggers the biasness on sample selections. Involvement of more organizations with different nature of business such as developers, consultants, vendors, surveyors, etc. would bring values to the study.
- The establishment of potential influencing factors are fully based on available literatures which potentially additional potential factors are missed out. It is recommended to take into consideration thoughts from the experts of the industry for the input of potential influencing factors by conducting interviews in obtaining list of influencing factors.
- It is recommended that the proposed framework to be tested further in future study to ensure on the applicability in Malaysian construction industry.

6.5 Recommendations for Future Research

The proposed framework is recommended to be further developed and updated time to time to ensure completeness and competency of the framework theoretically. The framework is recommended to be adopted for studying organizational readiness in AI technologies implementation on other industry or another region.

As the recommendations for future research are not only based on the limitation from this study, but it is also proposed that future research should thoroughly study on the barriers on organizations to adopt AI technologies as well as the measures to overcome the barriers in detail to serve as a guideline for Malaysian construction industry to step-by-step get themselves ready for the AI technologies adoption.

6.6 Final Note

This chapter has outlined the conclusions from the study by having an exclusive summary on how the study is meeting the research objectives and ultimately the research aim. This study has concluded insightful and resourceful information for Malaysian construction industry to move forward the AI adoption by stating how ready they are on the subject. The research gap has been bridged by extensively studying the issue from point of view of construction organizations in Malaysia.

The study also provides a direction on aspects to be prioritized for the organizations to get ready in AI adoption especially on project risk management practices, which can be referred by the organization decision makers and strategy planners constructively. This justifies the contribution of the study towards the construction industry and body of knowledge.

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