PROJECT MANAGEMENT INFORMATION SYSTEM IMPLEMENTATION FRAMEWORK FOR BUILDING CONSTRUCTION

NORSHAKILA MUHAMAD RAWAI

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Faculty of Engineering
Universiti Teknologi Malaysia

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DEDICATION

Specially dedicated to my beloved parents, husband, and children.

Thank you for all the support.

This thesis is dedicated to them.

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ABSTRACT

Project Management Information System (PMIS) today embraces numerous advanced technologies including context awareness, wireless communication technologies, Global Positioning System (GPS), cloud computing, quantum technology, and robotics. These technologies enhance the efficiency of a PMIS and its effectiveness in information communication (improve the information transfer and improve collaboration). PMIS has existed in the Malaysian construction industry for quite a while. However, PMIS has not been fully utilised where construction management (CM) teams are unable to take advantage of the benefits of PMIS as they are still trying to discover the right way to implement PMIS into current practices. Most construction managers do not know how and when to adopt PMIS in the construction management lifecycle due to a lack of guidelines in the form of detailed processes and steps involved in the implementation of PMIS. These guidelines are expected to be able to assist the construction management team in implementing a PMIS effectively in their project. Therefore, this research aims to develop a PMIS implementation framework for building construction management in Malaysia that would be able to assist construction management teams in implementing PMIS in a structured manner. A semi-structured interview was carried out with respondents that have experience and currently involved in managing building projects using PMIS in Malaysia. Findings from a thematic analysis of the interview data show that the CM team is lacking in knowledge, experience, and proper guideline in adopting the PMIS in their construction management process. Consequently, they were unable to fully benefit from the existing PMIS. The implementation framework was developed and validated with construction managers in the industry as a strategic approach for PMIS implementation in the Malaysian building construction management. The framework is also expected to be able to fill the gap in PMIS implementation by enhancing the capabilities of the CM team in implementing PMIS with the right process and the benefit of PMIS implementation could be fully obtained in improving the construction project management, specifically for beginners to PMIS either in Malaysia or other countries. In addition, the framework supports the increased productivity in construction projects by using new technology and building a solid base towards Construction 4.0.

ABSTRAK

Sistem Maklumat Pengurusan Projek (SMPP) hari ini merangkumi pelbagai teknologi yang canggih termasuk Konteks Kesedaran, Teknologi Komunikasi Tanpa Wayar, Sistem Kedudukan Global (GPS), Pengkomputeran Awan, Teknologi Quantum, dan Teknologi Robotik. Teknologi ini meningkatkan kecekapan SMPP dan keberkesanannya dalam komunikasi maklumat (meningkatkan pemindahan maklumat dan meningkatkan kerjasama). SMPP telah wujud dalam industri pembinaan Malaysia sejak sekian lama. Walau bagaimanapun, SMPP tidak digunakan sepenuhnya di mana pasukan pengurusan pembinaan (PP) tidak dapat memanfaatkan kelebihan SMPP kerana mereka masih berusaha mencari cara yang tepat untuk menerapkan SMPP ke dalam amalan pembinaan semasa. Sebilangan besar pengurus pembinaan tidak tahu bagaimana dan bila untuk menerapkan SMPP dalam kitaran pengurusan pembinaan kerana kekurangan garis panduan dalam bentuk proses terperinci dan langkah-langkah yang perlu dalam pelaksanaan SMPP. Garis panduan ini diharapkan dapat membantu pasukan PP dalam melaksanakan SMPP secara berkesan dalam projek mereka. Oleh itu, penyelidikan ini bertujuan untuk membina kerangka pelaksanaan SMPP untuk pengurusan pembinaan bangunan di Malaysia yang akan dapat membantu pasukan PP dalam melaksanakan SMPP secara tersusun. Temu bual separa berstruktur dilakukan dengan responden yang mempunyai pengalaman dan penglibatan terkini dalam pengurusan projek pembinaan dengan SMPP di Malaysia. Penemuan dari tematik analisis data temu bual menunjukkan bahawa pasukan PP kekurangan pengetahuan, pengalaman dan panduan yang tepat dalam menerapkan SMPP dalam proses pengurusan pembinaan mereka. Akibatnya, mereka tidak dapat memanfaatkan sepenuhnya SMPP yang ada. Rangka pelaksanaan dibina dan disahkan dengan pengurus pembinaan di industri sebagai pendekatan strategi untuk pelaksanaan SMPP dalam pengurusan pembinaan bangunan di Malaysia. Kerangka kerja ini juga diharapkan dapat mengisi kekurangan dalam pelaksanaan SMPP dengan meningkatkan kemampuan pasukan PP dalam melaksanakan SMPP dengan proses yang tepat dan manfaat pelaksanaan SMPP dapat diperoleh sepenuhnya dalam meningkatkan pengurusan projek pembinaan, khusus untuk mereka yang baru dalam SMPP sama ada di Malaysia atau negara lain. Di samping itu, kerangka kerja ini menyokong peningkatan produktiviti dalam projek pembinaan dengan menggunakan teknologi baru dan membina asas yang kukuh ke arah pembinaan 4.0.

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PM	-	Project Management
CM	-	Construction Management
CPM		Construction Project Management
PMIS	-	Project Management Information System
BIM	-	Building Information Modelling
IS	-	Information System
IT	-	Information Technology
PMBOK	-	Project Management Book Of Knowledge
CA	-	Context Aware
CAD	-	Computer Aided Design
GPS	-	Global Positioning System
AEC	-	Architecture, Engineering and Construction
ICT	-	Information and Communications Technology

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Modern Malaysian construction projects have grown in size and complexity. Multiple projects running concurrently are typical in major Architecture, Engineering, and Construction (AEC) organisations. As a construction project becomes bigger, its complexity in the technical aspect becomes greater. Project requirements, demands from clients, regulations by the government, and public needs in terms of lifestyle quality have considerably increased. With Information and Communications Technology (ICT) being so highly developed, the construction industry has a great potential to increase the effectiveness of information management between project parties (Adriaanse et al., 2010; Alaghbandrad et al., 2011). Computerised information systems in the construction industry have been built purposely to integrate the information and data; processing and transferring that information so that stakeholders can obtain a clear view of the project operations that they are managing (Zakaria et al., 2012).

Therefore, to manage the huge influx of project information, an integrated and standardised project management information system (PMIS) is required. PMIS has been identified as the tool to achieve the objectives of better collaboration and integration among projects (Rawai et al., 2015). Despite the many benefits of these technologies and all the efforts that have been put into developing and facilitating the information system in AEC projects, utilisation of this technology has been unable to efficiently support the extreme changes in construction project management (Braglia & Frosolini, 2014). The implementation of PMIS becomes a risk to the organisations. Failure to adopt a correct and effective PMIS leads to more problems rather than the benefits that it should have (Liu et al., 2019; Peansupap & Walker, 2006).

This chapter presents and discusses the background of the research project, research objectives, research problems, scope, and research significance. This is followed by a brief introduction of the research programme and methodological approach. Finally, the structure of the thesis is presented as guidance on the general course and content of the thesis. The next section will present the research background.

1.2 Research Background

Current construction projects have grown bigger and greater. The construction industry is now considered a major industry in many countries' development strategies, including Malaysia. The more significant the project, the greater and more elaborate its technical complexity (Whyte et al., 2016). As the project becomes more complex, the demand from client and regulations from the government also significantly increase. In addition, public requests for a high-quality lifestyle also significantly increase (Crawford, 2013). A large and complicated project demands a better and more intelligent construction project management team. The efficient communication and integration between project parties are among the critical aspects of successful construction project management (Chitkara, 1998; Frederick & Nancy, 2003; Sears et al., 2015). Poor communication means potential disasters in managing and developing the projects.

Billions in cost have been wasted by the construction industry just to cover defects i.e. to repair and rebuild construction mistakes (Peansupap & Walker, 2006). These defects were part of the outcome of poor communication between project parties due to reasons like misunderstanding the given instructions, inability to trace the technical information of a project, and problems in drawing details (Abdul et al., 2010; Peansupap & Walker, 2006). Advancements in communication technology in recent years, especially in mobile devices, mobile computing, and wireless technology have changed the way people and organisations communicate and collaborate (Rawai et al., 2012). It is evident that information management and information exchange have evolved in the construction industry. These advances in communication technology have also improved the information flow and project collaboration (Bowden et al.,

2006; Fathi, 2012c; Fathi et al., 2006) and significantly reduce the information transfer related cost. For years , information technology has assisted the design and management of construction projects through programs such as Computer Aided Design (CAD) and systems such as Building Information Modelling (BIM) and PMIS, making the design process easier and more efficient as new designs can be quickly tested and changes made easier (McAdam & Elafi, 2019; Mardiani, 2018). Smiliar with CAD and BIM there are a number of constructions web-based information management systems.

The efficiency of project information management can be significantly improved by adopting mobile computing and information communication technology in the construction industry (Adriaanse et al., 2010; Bowden et al., 2006; Fathi et al., 2009; Stewart et al., 2002; Xue et al., 2012; Zhu et al., 2013). This technology adoption will be able to open a path to performance and strategic improvement in the construction industry (Adriaanse et al., 2010; Stewart, 2007). Thus, the adoption of advanced information technology, especially through mobile devices, offers the opportunity for construction managers to meet the need for accessing project information instantly and spontaneously (Al-Qazzaz, 2010; Bowden et al., 2006) as one of the major demands of clients is efficient construction management that meets their expectations. As opposed to project directors who may spend a lot of their time in the office or to attend meetings, project managers and the project team members spend the majority of their working time at the project site. Because of this, they are often disconnected from the head office due to the site's remote location or because the site is far away. Therefore, the available IT system is a better way to improve the communication between the parties (Al-Khzasouri, 2015).

The advent of smartphones and tablet devices combined with advanced mobile technology that can deliver software and applications has significantly expanded the possibilities for mobile IT on site (Nourbakhsh, 2012). This can also be taken as an important chance for the executives in construction to participate using enterprise mobility while not at their workplace. However, what is most important is how beneficial the software system adoption can be in supporting their daily work tasks,

while helping to reduce the workload and increase efficiency (Fathi et al., 2006; Rawai et al., 2013a).

An Information System (IS) is an integrated set of data collection, storage, and processing components to provide information, knowledge, and digital products. Businesses and other organisations rely on information systems to execute and control their activities, communicate with consumers and suppliers, and perform in the marketplace (Kamarol Zaman, 2005). An IS in construction management or formally known as a project management information system (PMIS) consists of software that assists all knowledge fields of project management such as implementation management, project context, project time, project cost, project quality, human resources, project communications management, project risk management, project procurement, and project stakeholder management (Zambare & Dhawale, 2017).

A project management information system (PMIS) defines the projects as cost, time, scope, and quality (Zambare & Dhawale, 2017). According to the Project Management Institute (2013), PMIS can be defined as an information system that consists of the tools and techniques adopted to collect, incorporate, and disseminate project management process outputs. It is used to assist all project aspects from initiating through closing and can involve both manual and automated systems. The definition of PMIS includes the people, the organisation, and the roles of the construction management team where it also supports the management of agreements in terms of the project contract, permits related to projects, approvals from the authorities, and organised commitments (Ali, 1998). PMIS is also said to support the management of project documents as it is used to produce standards and reports (Ali, 1998). Finally, PMIS provides a guide to the best practice in collaboration and communication with the adoption of policies, document management, and the workflow diagram (Zambare & Dhawale, 2017).

PMIS can be categorised into two types which are Computer-Based PMIS and Web-Based PMIS (Braglia & Frosolini, 2014). An example of Computer-Based PMIS is Microsoft Project (MS Project), which is fully compatible with Microsoft Office and team members can conveniently transfer documents created in any Office program to

the database. Although it needs installation on the computer of every user, most users become familiar with it quickly because it has the same toolbars as MS Office applications (Biafore, 2013). Another example is Primavera, which offers four software products (Sure Trak Project Manager, Project Planner®, Primavera Expedition® Contract Control, and Webster for Primavera®). This software permits simultaneous project planning and scheduling of up to 10,000 tasks per project. With one click, activities can be added or rearranged on Gantt maps and PERT tables (Wali & Othman, 2019). Actual completion dates and costs can be compared with goals, expected progress for each operation or for the entire project, and projections generated of the resources required to bring a project back on track. Meanwhile, the Web-Based PMIS is a project Web site and Web-based project software that are used in situations where project team members are placed at different sites. Placing project details on the Internet or other Web standards-using networks speeds up projects that typically would be delayed due to scattered project team members (Sarkar & Jadhav, 2016; Zimmer et al., 2019). Web-based project management has advantages that include the instant accessibility of project knowledge, flexibility and easy communication with staff, easy learning and use, and reliable and accurate information as it is entered and shared in real time.

In Malaysia, the government also have their own PMIS. The in-house development of software applications named SKALA was developed and managed by the Public Works Department (PWD) (Sin, 2011). The SKALA system is used for the registration, performance monitoring, and reporting of all projects implemented by the Malaysian PWD. The reports produced are highly critical for fast decision and policy making to overcome the problems that occur during project implementation (Sin, 2011; Suharti & Basiron, 2009). All project related information including the level of implementation of a project carried out by the PWD can be accessed through this online system (Radzakrisnan, 2007; Sin, 2011) .

PMIS contributes to efficient team collaboration by providing the necessary information related to the project. It has proven to be the most effective and low-cost solution in information gathering because it only needs to be performed once. PMIS acts as a clear window to the project information where project leaders, teams, and

stakeholders are able to access and view the project details without having to wait for unreliable reports that have been screened by multiple layers of management (Kiptum, 2017; Obeidat & Aldulaimi, 2016). PMIS is the most reliable method for project information transparency, where mistakes and issues are easy to find and corrected instantly by the project team (Marjolein, 2012; Stewart et al., 2002). One of the benefits of PMIS is it can measure the performance of the project and the performance of the project management team members as PMIS can act as a report card for the project team and management. Therefore, managers can learn more while the management team can be educated based on real project information (Dhawale, 2016; Zambare & Dhawale, 2017).

Despite the many benefits of PMIS, the wrong adoption of information systems may lead to more problems rather than benefits. Thus, there is a need for a PMIS implementation guideline such as an implementation framework that can be used to ensure that the adopted information system increases the performance of organisations, specifically their projects can be effectively managed and monitored (Bartenschlager & Goeken, 2010; Carvalho et al., 2019). By adopting proper guidelines, the organisation is able to determine any failure in the project quality and develop a strategy to avoid it (Rawai et al., 2015). In addition, the adoption of proper guidelines is also expected to assist the construction management team in efficiently implementing PMIS. By transforming the practices of PMIS implementation, the construction management team is able to gain the full benefits of PMIS.

The problem statement for this research is discussed in the next section and addresses the current issues related to the PMIS implementation that drives the motivation for this research.

1.3 Problem Statement

The global increase in economic development has required many organisations to become more competitive and work to improve their services and product delivery (Rawai et al., 2013b). In the construction industry, this current demanding trend has

also emerged and become increasingly noticeable. Project clients expect projects that meet their specifications and requirements with the delivery of high-quality services and projects. These demands make the construction industry more competitive than before (Bowden et al., 2006).

The most common issue identified within construction management is related to the integration between project parties and stakeholders, including facilitating documentation, communications, and the interoperability aspects of the projects. Among the issues are loss of information and difficulties in communications, poor interoperability between the system/software used, poor management of knowledge, lack of information sharing, repeated work, and the difficulty of tracking the information or document when needed. Because of the dynamic environment in construction information and the participation of multiple parties, the integration of teamwork is important to the construction industry (Nourbakhsh & Zolfagharian, 2012). Information integration among construction parties is a fundamental component for achieving success in a construction project (Nourbakhsh et al., 2012).

ICT is one of the significant tools that enable people to share understanding, skills, knowledge, and expertise through the highly evolved technologies of tablet computers, smartphones, and computing devices. The construction industry has grown more sophisticated as it changes with respect to the advancements in ICT. Numerous advanced collaborative technologies are also applied in PMIS today including Context-Awareness (CA), wireless communication technologies, the Global Positioning System (GPS), cloud computing, and other emerging technologies such as quantum technology and robotics. The project management information system (PMIS) has also evolved through the years and provides collaborative support between project parties (Zambare & Dhawale, 2017). It is able to provide great benefits to the AEC industry as the advancements in communication technologies mean that project information can be transferred efficiently (Rawai et al., 2012).

The PMIS is well perceived by the government as they are among the holders and administrators of most properties in Malaysia. The government have aggressively promoted PMIS adoption as an important tool in their projects. They developed the in-

house development of software applications named SKALA by the Public Work Department (PWD) who is also responsible for managing the system (Sin, 2011). The SKALA system is used for the registration, performance monitoring, and reporting of all projects implemented by PWD Malaysia (Sin, 2011; Suharti & Basiron, 2009). All project related information including the level of implementation of a project carried out by the PWD can be accessed through this online system (Radzakrisnan, 2007; Sin, 2011). The Malaysian government have agreed to and insisted on the implementation of PMIS in all their future projects (Construction Research Institute of Malaysia, 2014). Therefore, the construction players are expected to be ready with all the preparations for the changes. The PMIS adoption is becoming necessary in the industry today towards the effort of increasing construction quality, affordability, and introducing sustainable practices (Bryde et al., 2013). Initiatives and support are provided by the government in efforts to make ready the necessary support for PMIS implementation such as the IT infrastructure, database, and guideline or procedure to implement PMIS before the mandatory regulation can be enforced (Construction Research Institute of Malaysia, 2014).

Problems in PMIS implementation have been identified to consist of a number of critical issues such as technology barriers, knowledge in PMIS, and readiness to change (Davies & Harty, 2013; Sanchez et al., 2017). Construction managers have also raised the issue of incompatibility in the adopted PMIS that affects the communication and data interoperability among the project team (management, contractor, others) (Dhawale, 2016; Sanchez et al., 2017). Therefore, there is a need for guidelines and standards on how to choose or to develop the right PMIS.

Although PMIS has been established for a while in Malaysia, it is still considered as a new tool in construction management and not many construction managers have knowledge and understanding about it. The construction managers are convinced that they lack understanding and knowledge related to PMIS technology. Although most experienced construction managers are experts in work process and information, they still have little or no knowledge and skill in PMIS. Therefore, construction companies are given an option to practice some of this strategy in the implementation of PMIS in their organisations, and option number one is the staff

involved in PMIS implementation needs to attend training related to PMIS. An adequate time is needed to become experts in PMIS. The second option is to hire external expertise in PMIS who can accelerate the process. However, both options need the organisation to bear an additional overhead cost (Construction Research Institute of Malaysia, 2014; Vieru & Rivard, 2014).

Moreover, the readiness of the project management team to change from the traditional approach to PMIS is also among the problems in PMIS implementation. The readiness of operational and managerial level staff in the organisation is still at the lowest (Vieru & Rivard, 2014). This is due to the lack of a guideline, standard, or procedure for PMIS implementation (Rawai et al., 2014). Other than that, the lack of acceptance of PMIS implementation among contractors may be due to usability issues and the complexity of the adopted system. Issues related to stakeholders also contribute to the problems in PMIS implementation where there is an argument on who should develop and control the PMIS system and how the cost of operations should be distributed among them (Dhawale, 2016).

Consequently, there is a need for a PMIS implementation framework that will provide a proper guideline that can assist the project management team in successfully implementing PMIS for managing a construction project. This research is expected to be able to provide significant insights into why an implementation framework is an essential foundation to help a researcher or project manager adopt an effective and efficient PMIS by providing an appropriate guideline. Integrating and standardising systems are strategically demanding today. Therefore, having a standard framework that complies with the global standard such as the PMI's PMBOK will greatly benefit the practitioners and organisations (Brioso, 2015; Project Management Institute, 2017). This implementation framework benefits the practitioners in anticipating potential problems and creating solutions in their information system deployment.

Thus, the development of a framework for the implementation of the PMIS with the adoption of an appropriate standard is expected to solve the problems related to PMIS implementation in construction management. The following part of this research will briefly discuss the research aims and objectives for this research.

1.4 Research Questions

The research questions were developed to support the achievement of research objectives and are as follows:

1. What are the current practices, challenges, and barriers of PMIS implementation in building construction projects?

2. How can the implementation of PMIS be improved among the construction management team so that they would appreciate its benefits?

3. How the construction management team can be assisted in construction projects using PMIS in a form of implementation framework?

4. How is the delivery of the implementation framework in helping the construction management team to implement PMIS in their construction projects?

1.5 Research Aim and Objectives

The research aim is the development of a project management information system implementation framework for building construction management in Malaysia. To fulfil the research aim, the research objectives were derived as follows:

1. To assess the current state of project management information system implementation in building construction management in Malaysia.

2. To identify the fundamental requirements and needs analysis of the Malaysian construction management team for project management information system implementation.

3. To develop a project management information system implementation framework.

4. To validate the project management information system implementation framework with the construction management team.

1.6 Research Scope

The implementation framework is established to focus on the standardisation along with the process involved and technologies needed in managing a project. Hence, it is important to pinpoint the way construction management teams implement PMIS in their construction projects. Therefore, the scope of this research is limited to construction management teams in the Malaysian construction industry who have participated in projects that implemented PMIS. The research scope will be discussed as follows:

1. Type of Respondents

   Respondents are chosen based on their experience and their involvement in construction projects that implemented PMIS. In addition, respondents are specifically chosen based on the types of projects that they have managed throughout their roles in the construction management team as the research area is restricted to building construction projects. Thus, the information collected from all the respondents will be analysed to provide information on PMIS practices in the Malaysian construction industry.

2. Research Area

   1. Current Practice: The main focus of the research is the current PMIS practices in construction management teams in Malaysia. The aim of the study related to current PMIS practices is the process of PMIS implementation by a construction management team including the

challenges and PMIS implementation barriers. To better understand the implementation process involved, information on the project managers needs to be gained The information needed for the PMIS implementation framework includes PMIS practices, project management work process, project types, the roles as well as the assigned responsibilities of the construction management team, and the adopted technology in the PMIS. Therefore, this research concentrates on a specific type of construction project which is building construction projects. This allows the researcher to focus on the specific group of managers as construction is an enormous industry involving many areas. The challenges and barriers against PMIS implementation in construction project management teams that hold them back from reaching the PMIS benefits are discussed in Section 2.5.3.

2. Type of Building Construction Project: This research concentrates on a specific type of construction project i.e. building construction projects. This research also focus on the building projects that are carried out by Malaysian private and public organisations. There are many types of building construction projects in Malaysia. However, residential and commercial types of buildings comprise most building construction in Malaysia. Therefore, this specific type of building project is expected to provide more details and supplies targeted respondents who are able to provide rich and meaningful information for the PMIS implementation.

1.7 Research Significance

PMIS implementation contributes significant benefits in improving the management of construction projects related to project time, cost, and overall quality. By implementing PMIS, project management becomes efficient with clear communication, integration, and collaboration between the project team and stakeholders. Thus, the research significance are as follows:

1. Current PMIS implementation practices in the building construction management have been acknowledged along with the challenges and their implementation barriers. In this research, the construction management team is also supported in the understanding and knowledge about the activities or actions that need to be taken to improve their implementation of PMIS and for the benefits that can be gained.

2. The activities to support successful PMIS implementation are established in a layered process form with the appropriate stage by stage progress. The implementation framework is anticipated to be guideline for the construction management team to implement PMIS using an appropriate process by completing the required activities in the progressive stages. Thus, the construction management team can increase their awareness of PMIS, ready with the knowledge and confidence to implement the right PMIS for their organisation.

3. The construction management team involved in a building construction project (client, developer, consultant and contractor) can benefit from the PMIS implementation framework. This framework is expected to be adopted as a guideline for PMIS implementation; therefore the PMIS can be implemented in an appropriate and organised way. So, the risk of inefficient or failed systems adoption can be avoided.

4. The implementation framework is anticipated to support the construction project management team in the adoption of an accurate PMIS process. The PMIS implementation framework follows a PM process from PMBOK. Consequently, the implementation framework is able to assist the construction management team in adopting a standardised process and guidelines in their project's PMIS implementation, hence avoiding the risk of failure in information system implementation.

5. To support the Malaysian CITP in increasing global competitiveness (Construction Industry Development Board, 2016), encouraging and promoting the adoption of construction techniques such as PMIS in

construction projects. The implementation framework could provide a guideline to assist in successful PMIS adoption. Furthermore, this framework could be a solid foundation for construction PMIS adoption to prepare the construction management team towards Construction 4.0 which comes with much greater and advanced technologies. Technologies such as blockchain, robotics, and quantum technology will become a norm in Industry 4.0 and the construction industry will have to adapt and move together with this transformation.

1.8 Research Methodology in Brief

The combination of research methodology and research approach adopted in this research aims to demonstrate and validate the appropriateness of the PMIS implementation framework in construction project management Therefore, the methodology and approach adopted in this research are discussed as follows.

Research Design

The aim of this research is to develop the PMIS implementation framework for building construction managers. An investigation of the current state of PMIS implementation (current practices, challenges and barriers, recommendations) needs to be carried out to improve the efficiency of PMIS implementation among the construction management team. Therefore, in achieving the research aim and objectives, a qualitative mono-method is adopted as the research design in this research as this method is able to provide in-depth information on the related matter.

Research Approach

The inductive with qualitative research approach is adopted in this research to identify the detailed information related to the implementation of PMIS in construction projects by the construction management team. This information includes the way they practice the PMIS concept and technologies in projects, the PMIS implementation's challenges and barriers, and the recommendations of activities that can improve the implementation of PMIS by the construction management team.

Data Collection Method

Qualitative data collection involves two main activities. First a literature review and secondly face-to-face semi structured interviews are conducted with respondents from construction management teams. The literature review on PMIS provides support in understanding and identifying the current practices of PMIS implementation in construction management related to the knowledge, the way PMIS is being practiced in the industry, and the latest issues that arise among the construction management team members. The semi structured interview is carried out to gain in-depth information on the current practices of PMIS and to obtain information on the challenges and barriers of PMIS implementation.

Data Analysis Method

This research applies a thematic analysis for the method of analysing the qualitative data from the survey interview. Thematic analysis is selected for this research because it helps to bring out as many sub-themes as possible and the coding is more detailed.

1.9 Thesis Structure

This thesis has seven chapters. Chapter 1 discusses the introduction of the thesis interest and provides the research background derivation, problem statement identification, the establishment of research aim and objectives, the determination of research scope, the realisation of research significance, and research programme and its methodological approach.

Chapter 2 is the review on existing literature related with the PMIS and examines the current context of PMIS implementation This chapter also reviews the current context in information system implementation for construction project management, discusses the trends and reveals the important issues in information system implementation in Malaysia construction management The chapter then investigates the existing implementation framework including its content coverage and issues which influence the new requirements for project management information

system implementation. Finally, this chapter introduces the proposed implementation framework.

Chapter 3 reviews the overall research philosophy and methodology approach available in information system research followed by an explanation and justification of the philosophies and methodology approach adopted.

Chapter 4 describes the framework requirements studies, needs analysis, and the requirement and the development of framework specification. First, data collected from the face to face interviews are analysed and discussed in detail. Then, the user requirements and user needs are produced and charted by the development of the fundamental requirement for PMIS framework development. Next, a discussion on the findings from this research is presented. This section presents the major benefits and issues, the identified limitations in framework development and suggestions on improvements for the framework and potential barriers for the users, researchers, and developers of the framework in the future.

Chapter 5 begins with the description and detailed discussion of the implementation of the PMIS framework development. Primarily, the conceptual framework is introduced followed by a description of the stages that are involved in the framework development. Then, the main features of the system are presented and described. Next, the framework validation and evaluation including the usability and perceived usefulness of the main features of the framework is presented. This section also presents the benefits and issues, the identified limitations in the framework, and suggestions for improving the framework. Finally, the framework specification is presented.

Chapter 6 concludes the research by summarising the key findings and providing the research conclusion, research limitations, and research contribution. Finally, the research recommendations are outlined for further research and practice.

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