PROFESSIONAL COLLABORATIVE CULTURAL MODEL FOR MALAYSIAN CONSTRUCTION INDUSTRY

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PROFESSIONAL COLLABORATIVE CULTURAL MODEL FOR MALAYSIAN CONSTRUCTION INDUSTRY

By

MASZURA BT ABDUL GHAFAR

Thesis Submitted to the School of Graduated Studies, University Putra Malaysia, in Fulfillment of Requirement for the Degree of Doctor of Philosophy

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DEDICATION

To my beloved husband

Mohd Jamil Idris,

My children

Muhammad Afiq & Nabila Husna,

and

My parents,

Dato' Abdul Ghafar Abdul Karim

Datin Raziyah Aziz

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Abstract of thesis is presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor Philosophy

PROFESSIONAL COLLABORATIVE CULTURAL MODEL FOR MALAYSIAN CONSTRUCTION INDUSTRY

By

MASZURA ABDUL GHAFAR

June 2016

Chair : Prof. Hajah Rahinah Ibrahim, PhD

Faculty : Design and Architecture

There is missed coordination due to professionals' collaborative culture from design development (DD) to contract implementation (CI) stage resulting in many variation orders (v/o) in the construction industry. The purpose of the study is to understand how CAD visualization culture influences the effectiveness of AEC (architect, engineer and contractor) professionals' collaboration during design development process. This is a case study research on a Malaysian project organization (M Project) and another British project organization (UK Project). It studied the impacts of CAD-assisted visualization collaborative culture that could improve productivity while reducing time and delivery wastage during design of industrialized project. This study hypothesized that with competent technological support, productivity can be improved with increasing understanding of cultural knowledge among professionals during the design phase, hence reducing waste in industrialized project. The study affirms the existence of four American's project operating environmental characteristics occurring in Malaysian and British projects. However, M Project displayed vertical structural organizational configuration and did not use any BIM technology, whilst UK Project displayed horizontal structural organizational configuration and used BIM technology. In the subsequent computational experiment, the study found the M Project demonstrating *multi-hierarchical* structure within *intensive* task intensity, while the UK Project demonstrating *flatter-hierarchical* structure within *reciprocal* task intensity. In testing and validating potential optimal organizational configurations, the study found M Project can be equally productive as the UK Project when multiple-hierarchical structure and reciprocal tasks' complexity were embraced together with BIM technology during its design process. These results would guide in workplace productivity improvement by introducing BIM technology yet, allowing existing multi-hierarchical structure to support the Malaysian construction operational environment. Results of the study are expected to guide multi-national companies in configuring their organizations to equate the productivities of their parent companies. Additionally, local organizations could easily adapt to new operational configuration with minimal

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human costs. Among the benefits for enabling adaptive local operational configurations, local organizations could strategize to partner easily with international collaborators. In such situation, developing countries could gain higher GDP income. The study would like to recommends future study on identifying reciprocal measures throughout the whole industrialized project lifecycle process.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

MODEL BUDAYA KOLABORASI PROFESIONAL BAGI INDUSTRI PEMBINAAN MALAYSIA

Oleh

MASZURA ABDUL GHAFAR

Jun 2016

Pengerusi : Prof. Rahinah Ibrahim, PhD
Fakulti : Rekabentuk dan Senibina

Terdapat koordinasi tersasar disebabkan oleh budaya kolaborasi profesional dari fasa rekabentuk pembangunan (DD) ke fasa pelaksanaan kontrak (CI) menyebabkan banyak arahan perubahan kerja (v/o) berlaku di dalam industri pembinaan. Tujuan kajian ini adalah untuk memahami bagaimana budaya visualisasi CAD dapat mempengaruhi proses kolaborasi professional AEC secara berkesan. Ini adalah kaedah penyelidikan kajian kes pada organisasi projek Malaysia (M Project) dan organisasi projek British (UK Projek). Ia mengkaji kesan budaya kolaborasi−visualisasi CAD yang dapat membantu meningkatkan produktiviti di samping dapat mengurangkan pembaziran masa dan pembuatan semasa proses reka bentuk projek berindustri. Hipotesis kajian ini adalah, dengan sokongan teknologi yang cekap, kecekapan produktiviti dapat ditingkatkan bila mana terdapat peningkatan pemahaman pengetahuan budaya di kalangan profesional semasa fasa reka bentuk, dengan itu, dapat mengurangkan pembaziran dalam projek berindustri. Kajian ini mengesahkan bahawa terdapat kewujudan empat ciri operasi persekitaran ala Amerika berlaku di dalam kedua-dua projek Malaysia dan British. Sungguhpun sedemikian, Projek M memaparkan konfigurasi organisasi struktur yang menegak dan tanpa penggunaan teknologi BIM, manakala Projek UK memaparkan konfigurasi organisasi struktur mendatar dan penggunaan teknologi BIM. Di dalam kajian pengujian pengkomputeran, Projek M menunjukkan struktur hierarki bertingkat di dalam intensiti tugasan yang rapi manakala Projek UK menunjukkan struktur hierarki mendatar di dalam intensiti tugasan yang bertimbal balik. Semasa menguji dan mengesahkan potensi struktur optimal organisasi, kajian mendapati bahawa Projek M boleh menjadi produktif sebagaimana Projek UK apabila struktur hierarki bertingkat dan kerumitan tugas timbal balik diadaptasi bersama-sama dengan teknologi BIM semasa proses reka bentuk. Pengesahan kedapatan ini dapat membantu peningkatan produktiviti di tempat kerja dengan memperkenalkan teknologi BIM, tetapi dalam masa yang sama membenarkan struktur hierarki bertingkat sedia ada untuk menyokong persekitaran operasi pembinaan Malaysia. Hasil kajian ini dijangka dapat membantu syarikat-syarikat multinasional untuk merancang konfigurasi organisasi mereka supaya menyamai produktiviti

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syarikat induk mereka. Selain itu, organisasi tempatan dengan mudah boleh menyesuaikan diri dengan konfigurasi pengoperasian baru dengan menggunakan kos manusia yang minimum. Antara kebaikan lain adalah organisasi tempatan kini boleh berakan kongsi dengan mudah dengan rakan usaha sama antarabangsa. Dengan keadaan itu, negara-negara membangun boleh mendapatkan pendapatan KDNK yang jauh lebih tinggi. Kajian ini mengesyorkan kajian lanjutan mengenal pasti langkah-langkah timbal balik di seluruh kitaran hayat projek berindustri di masa depan.

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I dedicated this thesis to my late father in law Hj. Idris Sirat and my beloved late mother in law Selamah Simus.

My love to my children, Muhammad Afiq and Nabila Husna, for their understanding and filling my life with joy and happiness, and with lots of sibling's squabbles.

Foremost appreciation to my husband, Mohd Jamil Idris, for his never ending generosity of faith, unconditional love, his supports and encouragements in ensuring my successful pursuit towards intellectual excellence.

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I certify that a Thesis Examination Committee has met on……[date]… to conduct the final examination of Maszura Abdul Ghafar thesis entitled "Professional Collaborative Cultural Model For Malaysian Construction Industry" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DEFINITION AND TERMINOLOGIES

In the next chapters, some terms or jargon and concepts are defined. This definition of term is to provide clarity in a commentary where the term is used and to avoid confusion in terminology. The clarifications would give better insight to the readers in supporting ultimate arguments. The following terms or terminologies are used within the study.

AEC: Architect, engineer and contractor

BIM: Building Information Modeling

COT: Computer Organizational Theory

Collaboration: a process of coordinating multi teams in various locations using technology for sharing knowledge, communicating and achieving business objectives, and providing value to customer.

Discontinuous membership: the operating situation where one or more team members join or leave an organization while work process is still on-going due to the need for different skill requirements to complete successive parts of the process (Ibrahim & Paulson, 2008).

Explicit knowledge: A selected and applicable group of facts that is transmittable in a formal systematic language that enables its beholder to take some action to complete a task (Ibrahim, Levitt, & Ramsey, 2005).

Interoperability: A process to allow information exchange between disparate systems without losing data, redundancy of data and the need for re-entering data.

Knowledge management: An efficient method of tacit knowledge transfer during workflow process and *professional collaboration* as utilization of BIM visual communication techniques between stakeholders in project.

Knowledge flow: movement of how to use tacit knowledge from repository in people for accomplishing task (Nissen, 2006)

***n*D**: Various technologies that can be embedded in BIM technology to create a collaborative platform for AEC professional to make decision (e.g. the environmental impact assessment modeling).

Novation: a concept to automatically discharge the original consultants from any obligation on the changes made afterwards by the novation consultants. (West's Encyclopedia of American Law, edition 2. (2008))
Productivity: the ability to perform effective organizational culture, smooth flow of information and competent coordination process.

Professional collaboration: utilization of BIM visual communication techniques between stakeholders in project.

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Tacit Knowledge: The entity of "knowing how" that an individual or an organization possess in selecting and applying a group of facts that enable action to complete task (Nonaka, 1994)

Task interdependence: The degree to which group members needed to rely on one another to perform their tasks effectively (Georgopoulos (1986), in Saavedra, et al., 1993)).

VDC: Virtual Design Construction

4D CAD: 3D Computer Aided Design with added time dimension

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CHAPTER 1

INTRODUCTION

This section discusses context and background of the study, statement of problem, research aim and objectives, justification of the study, main research question, case study research methodology, validation, expected finding, scope and limitation, expected contribution and organization of the thesis.

1.1 Context and Background of Study

Many developing countries such as Malaysia, India, Nigeria etc. are experiencing significant escalation of variation orders in their building projects (Doloi, et al., 2012; Doloi, 2012; Kazaz, et al., 2012; Mohammad, et al., 2010). Among the significant causes of variation orders in projects are change of design by owner and consultants (Kikwasi, 2013; Memon, et al., 2011; Mohammad et al., 2010); lack of professionals' experience in handling projects (Doloi et al., 2012; Memon et al.); poor coordination (Yong & Nur, 2012); and information and payment delays (Kikwasi, 2013). Arain and Low (2005) highlighted that these variation order are 65.29% sourced from the architectural variations that occurred during the design development and contract implementation stage. Here, the study foresees that design changes are a crucial factor that escalating the numbers of variation orders in project.

In developing countries like Malaysia, the use of conventional method still transpires. Scholars found that conventional method such as 2D drawings, sketches, collocated meetings, manual documentation, etc. are still being used due to complacency of usage (Ganah, et al., 2005; Gu & London, 2010; Stewart, 2007). For this reason, many variation orders and construction waste are produced and misunderstanding of information occurs (De Saram & Ahmed, 2001). A collaborative tool is needed to support the traditional ways of coordinating designers' task (Cataldo *et al.*, 2006) and a communication technique is needed to model discrete event in order to coordinate project planning and execution (Christensen *et al*., 1999).

In Malaysia, industrialized building project is popularly known as the Industrialized Building Systems (IBS) (or Modern Method of Construction (Lovell, 2003)) and is currently seen as an effective, quality and cost effective construction system (Buswell *et al.*, 2007). In Buswell et al study's, they saw the applications of BIM would support industrialized productivity process. It could be enhanced when professionals' collaborative culture apply technological and professional components to reduce waste. Other literature highlights industrialized construction downfall with poor technical understanding, poor knowledge transfer from assemblers to workers (Rashidi *et al.*, 2012), and no short-term profits (Lou & Kamar, 2012). Globalization has

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made Malaysian AEC industry interested to utilise BIM enabled visualisation in implementing project delivery through partnerships with their respective counterparts in other countries. Malaysia is interested in utilizing BIM and industrialized construction to facilitate the Construction Industry Transformation Program 2016-2025 (CITP 2016-2025) as a means to direct the future of Malaysian construction industry.

The CITP 2016-2025 aims to ingrain Malaysian construction industry's culture with quality, safety and professionalism; to be a champion in sustainable infrastructure; to double and increase Malaysian construction industry's productivity in having better wages; and to be construction industry's champions that will lead locally and globally. CITP portrays the productivity and internationalization trusses that aim to uplift technology, skill, competencies and expertise, and provide higher incomes commensurate to the construction workforce. As for internationalization, CITP aims to be champions that can enable and lead effective economic activities and opportunities locally and globally. Malaysia's Free Trade Agreements (FTAs) provide industries the opportunity to be part of a larger consumer market. Similarly, FTAs have also spurred foreign companies to increase their presence in Malaysia. This trend is expected to grow, especially given the upcoming FTAs that Malaysia plans to be a part of, such as the Trans-Pacific Partnership Agreement (TPPA). This changing environment is affecting the Malaysian construction industry and it will need to be able to adapt and respond to the increased competition and scrutiny.

The CITP principles are parallel with the need of the Malaysian Government in promoting globalisation of services through exportation of building and professionals services in the last 2012 Budget. Business Watch (2005) estimated the AEC sector in Malaysia as one of the largest industrial employers, representing 4% of Malaysian Gross Domestic Product, employing over 9.5% of workforce, and one of the major contributors to Malaysian economy (CIDB, 2015). Many seminal literature reveal that there are attempts of Malaysian Government to encourage Malaysian AEC practices to adopt BIM via the government's pilot projects (Latiffi *et al.*, 2013).

1.2 Statement of Problem

From the background study through literature survey, the study identifies that variation orders in building project are crucial to be mitigated particularly in developing country like Malaysia. Scholars have identified that these variation orders occur during the design stage and contract implementation stage. The professionals' collaborative culture such as using the 2D conventional drawings method aggravates the variation orders in building projects. Without a supporting collaborative tools and processes, AEC professionals are having further miscoordination resulting escalation of variation orders in building projects. Here, the study foresees a problem gap that needs to be resolved. Therefore, the problem statement of the study is:

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There is miscoordination due to professionals' collaborative culture from design development (DD) to contract implementation stage (CI) resulted many variation orders (v/o) in construction industry.

1.3 Research Aims and Objectives

The researcher uses the Eagle Research Design Framework (Ibrahim, 2011) technique (refer to Table 1.1) to rationalize the objectives of the study.

Table 1.1: Development of research questions using the Eagle Research Design Framework
(Adapted from Ibrahim (2011))

Problem: **There is miscoordination due to professionals' collaborative culture from design development (DD) to contract implementation stage (CI) resulted many variation orders (v/o) in construction industry.**		
Main RQ: **How can CAD's visualization culture [What 1] improve project's productivity [How 1] for reducing construction wastage [How 2] in industrialized project [Who]?**		
RQ Construct	**Description of RQ constructs**	**Description of sub-RQ**
[Who] Element used/ impacted by study	Industrialized project	What is industrialized project in Malaysia?
[What $_1$] Body of knowledge required to solve problem	CAD's visualization culture	**Sub RQ 1:** How does **AEC professionals collaborate effectively using CAD visualization tool** in construction industry? **RO 1:** To determine the **level of AEC professionals' collaborative culture using CAD visualization tool** in construction industry.
[How $_1$] Action or impact on the who or what$_{1\&2}$ & how	Improve project's productivity	**Sub RQ 2:** **What** are the **factors supporting AEC professionals' collaborative culture for improving productivity** in industrialized project? **RO 2:** To analyze the factors supporting **AEC professionals' collaborative culture for improving productivity** in industrialized projects.

*Table continued next page

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RQ Construct	Description of RQ constructs	Description of sub-RQ
[How $_2$] Action or impact on the who or what$_{1\&2}$ & how	Reduce construction wastage	**Sub RQ 3:** **How** can professional's **CAD visualization collaborative culture be integrated into the productivity process to reduce time and delivery waste** during design phase in industrialized project**?** **RO 3:** To propose a **professional collaborative culture model** to reduce time and delivery waste during design process in industrialized projects.

Referring to the eagle table in Table 1.1, the objectives of the study are:

1. To identify the level of AEC professionals' collaborative culture using CAD visualization tool during design process.
2. To analyze the current AEC professionals' collaborative culture processes for creating productivity efficiency in industrialized project.
3. To propose the AEC professional collaborative cultural model to reduce time and delivery waste during design process in industrialized project.

1.4 Justification of the study

In various countries, construction industry has long suffered from productivity and quality problem. There has been miscoordination from design development stage to contract implementation resulting to large variation orders in construction industry especially in many developing countries particularly in Malaysia. Modular coordination in design, poor integration of building subsystem during design stage, poor detailing, lack of optimization during design in the use of resources are among the miscoordination detected during project deployment (Formoso, Isatto, & Hirota, 1999). The researcher agrees with Baldonado, Woodruff and Kuchinsky (2000) that miscoordination problem especially in big project is due to clashes of culture among practices and poorly maintained information and communication barrier. These phenomena are causing construction wastage to escalate and raise concern especially in developing countries like Malaysia.

In the last twenty years, massive building and infrastructure developments have resulted in increased production of construction waste in Malaysia (Begum *et al.*, 2009). AIIM (2014) and several scholars (Begum *et al.*, 2009; Osmani, *et al.*, 2006; & Poon *et al.*, 2004) have identified that social and cultural factor have been the extent and intensity of the problem. In line with this reason, Malaysian Government has supported Malaysian AEC professional to utilize BIM and industrialized project to address the Construction Industry Master Plan 2006-2015 (CIMP 2006-2015) as a means to direct the future of Malaysian construction industry.

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1.5 Main Research Question

In the study, the main research question (MRQ) is *How can CAD's visualization culture improve project's productivity for reducing construction wastage in industrialized project?* To answer the MRQ, there are three sub research questions that where addressed in the study:

1. How does AEC professionals collaborate effectively using CAD visualization tool in construction industry?
2. What are the factors of AEC professionals' collaborative culture for improving productivity efficiency in industrialized project?
3. How can AEC professional's CAD visualization collaborative culture be integrated into the productivity process to reduce time and delivery waste during design phase in industrialized project?

1.6 Case Study Research Methodology

Research methodology is a systematic process of theoretical analysis applied in a field of study, and covers paradigm, theoretical model, stages and research techniques. Unquestionably, there are three types of research design available for researchers to consider namely the qualitative approach, the quantitative approach or the mixed method approach. From these, the researcher employs qualitative research methodology.

This study opts for the case study research method and refers to Yin (2009) in developing the case study research design. The selection of the case study research approach is based on factors highlighted by Yin (2009). In general, this section gives an overview of the general typology of research methods. Then, it describes the five approaches available in the qualitative research design. Subsequently, the researcher explains the five components of the case study research method and justifies the selection of units of analysis in this study.

Qualitative approach is a research design which "explores and understand the meaning of individuals or groups ascribe to a social or human problem" (Creswell, 2009; pg. 4). Qualitative approach usually anticipates a theoretical proposition in its study to advocate the researcher's theoretical lens. On the other hand, quantitative approach involves "testing objective of theories by examining the relationship among variables" (*ibid*.). Variables in this sense are measurable attributes or characteristics that vary among the people or organization being studied (*ibid*.). In addition, quantitative approach predicts a hypothesis statement to answer the researcher's research question. As for the mixed method approach, it is a combination of methods used by a researcher to make a philosophical hypothesis with the use of qualitative and quantitative approach, mixing both approaches in tandem to gain greater strength in a study (Creswell & Plano Clark, 2007).

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Qualitative approach encompasses five choices of inquiry approaches namely the narrative research, phenomenological research, grounded theory research, ethnographic research, and case study research (Creswell, 2007). According to Creswell, narrative research is an approach of using metaphoric framework to analyze stories of participants in life history projects. As for phenomenological research, this approach discusses the understanding of cognitive presentation of an actor such as patients within a phenomenon. Whereas grounded theory research involves generation of construct- oriented theory based on laborious procedures to verify researcher's theory statement. Consequently, ethnographic research entangles with how the participants see the world and describe how their culture ticks (Somekh & Lewin, 2005).
Pertaining to the five qualitative approaches explained by Creswell (2007), the researcher deems that case study research approach is the most well-suited for this study.

1.6.1 Five components of case study

To further answer the logic of the study's case study research design, the researcher used the five components proposed by Yin (2009). They are:

1) ***The study's question***: The main research question (MRQ) is: **How** can visualization technology improve productivity efficiency for reducing construction waste?

According to Yin (2009) when a research question starts with a *how* or *why*, it confirms the appropriateness of use of case study research methodology in a research. Per se, these two questioning techniques could guide a researcher to rationalize the strategies in their studies. Pertinently, the main research question of this study starts with a *how*, indicating the essential use of case study as a research technique.

2) ***Proposition statement***: The second component is a study's theoretical proposition. According to Yin (2009; pg 28) "each proposition directs attention to something that should be examined within the scope of study".

Propositions could help a researcher to reflect important issues and begin to find relevant evidences. The researcher descriptively explained the systematic and verifiable steps of the theoretical proposition to examine the key components of visualization technology to improve productivity efficiency in reducing construction waste. These theoretical constructs such as work culture, technology support, productivity efficiency, knowledge management and professional collaboration will be discussed in the case study's component number four. This proposition is motivated by Abdul Ghafar, *et al.* (2013) and Abdul Ghafar, Ibrahim and Shari (2014), work culture and cultural knowledge theory in reducing industrial waste.

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3) ***Unit of analysis***. The third component of the case study research is the unit of analysis. Unit of analysis is defined as the main subject/ event/ entity that is being analyzed in a study (Yin, 2009).

The unit of analysis is a single project team in a multiple case design. In the study the researcher used two cases of industrialized mixed development projects within two different settings, one in Malaysia (M project) and one in the United Kingdom (UK project) with the M project having 16 team members and the UK project having 18 team members. The industrialized projects of comparable complexity were selected based on project's characteristics of multidisciplinary practice, practice's attributes (such as organizational style, authority, formalization of communication and organizational hierarchy), the use of BIM technology in delivering project, and comprehension of professionals' value preferences (such as task coordination and decision making).

4) ***The logic linking of data to proposition***. The fourth component is the logic of linking data to proposition. (Refer to Chapter 3 for detailed explanation)

5) **The criteria for interpreting the findings**. The researcher anticipates that 60% of industrialized waste could be reduced when productivity efficiency value is high (80%), when technology (BIM) and culture (*work culture, knowledge management and professional collaboration*) is controlled.

The equation is measure when there is 60% reduction of time and delivery waste from the project schedule growth durations, and when there is 80% efficiency of productivity from project risk indices in the Malaysian project model with modified parameters.

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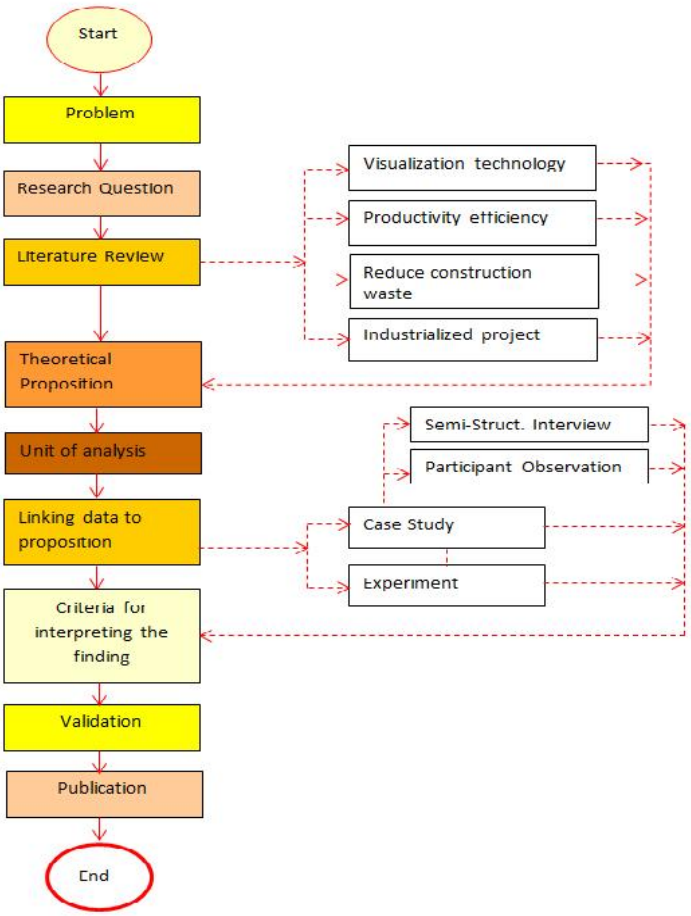

Figure 1.1: Case Study Research Methodology Design Workflow

1.7 Validation

In this section, the researcher discusses the validity steps of this case study research method. In order to present the logic, credibility, confirmability, and data dependability of the study's research design, the researcher used Yin (2009) four steps of validity tests for case study. The tests are constructs validity, internal validity, external validity and reliability. Detailed explanations were discussed in chapter three.

1.8 Expected Finding

The overall results and outputs of this study are expected as follow:-

1. The study would document the best BIM technology, procedure, hardware and software; classify the components of BIM's visualization processes; and identify gaps in BIM's application.
2. The study would document the best productivity technology and process; productivity procedures, hardware and software; distinguish the components of productivity process; and discover gaps in productivity processes.
3. Upon completion of results and outputs of number one and two, the study would be able to identify the best BIM−productivity technology to reduce waste during industrialized construction.
4. The study would recommend BIM, its productivity procedure, hardware, and software during industrialized construction.
5. Pertinently, key components of BIM in productivity process would be recommended to reduce wastage during industrialized construction.

From these results and outputs of the study, this study would give a significant impact on the industrialized project delivery in reducing construction waste particularly in Malaysia.

1.9 Scope and Limitation

This study limits its focus from Design Development stage to Contract Implementation within AEC building projects' lifecycle only. The study did not address cost issue as part of waste characteristic due to companies' confidentiality and data archrival is limited to the collection of minutes of meeting of the projects. Hence, the results are validated through computational experiment based on intellective experiment using SimVision© (see Chapter 3 section 3.3).

1.10 Expected Contribution

This study will make significant contribution to both theory and practice of AEC professionals' collaboration using CAD visualization tool during design process together with culture knowledge differences between professionals by adding knowledge flow to improve productivity efficiency. The literature relating to CAD's visualization technology and improving project productivity efficiency has shown a gap (see Chapter Two) about how the understanding of cultural knowledge in AEC delivery could improve productivity efficiency in industrialized projects. The researcher identified that the AEC professionals' cultural knowledge encompasses the work culture, knowledge management and professionals' collaboration keywords.

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1.11 Organization of Thesis

This study consists of seven chapters. The content of each chapter is structured as follows.

Chapter one: Introduction

Chapter one presents the background of the study, statement of problem, main research questions, aim and objectives of study, knowledge contribution and justification of study.

Chapter Two: Literature Review

The literature survey is dichotomized into two parts. Part one includes the literature study on visualization technology culture. Part two includes relevant literature surveys on improving productivity and reducing construction wastage. This section explains the inferential theoretical framework for the whole study.

Chapter Three: Case Study Research Methodology

Chapter Three discusses the three case study's components that are the unit of analysis, the logic linking data to proposition and validation in detail. This chapter explains the observation and interview strategies, data collection protocols, computational experiment protocols and hypothetical testing.

Chapter Four: Result and Analysis

Chapter Four presents the result and findings of the two parts of case study's data analysis and findings. From the computational experiment, further discussions were made to propose the best case of M project model to achieve similar productivity as the UK project.

Chapter Five: Discussion and Recommendations

Chapter Five discusses the improvement of the current M Project and the reformation of Malaysian AEC education curriculum.

Chapter Six: Conclusion

Chapter Six summarizes and discusses the findings, knowledge contribution, impact of study and recommendations for future studies by answering the sub-research questions.

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