DEVELOPING A PROCESS FRAMEWORK FOR MANAGING THE REALIZATION OF INFORMATION TECHNOLOGY BENEFITS FOR CONSTRUCTION COMPANIES

by

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MEMBANGUNKAN KERANGKA PROSES UNTUK MENGURUS PEROLEHAN FAEDAH TEKNOLOGI MAKLUMAT SYARIKAT PEMBINAAN

oleh

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TABLES OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

2-D CAD	Two Dimension Computer Aided Design
3-D CAD	Three Dimension Computer Aided Design
4-D CAD	Four Dimension Computer Aided Design
ABR	Active Benefit Realization Model
ANOVA	Analysis Of Variance
BRS	Business Requirement Study
BP	Business Picture
CBS	Client Base System
CEO	Chief Executive Officer
CIDB	Construction Industry Development Board
CL	Change Leader
CMMS	Contracts Maintenance Managements
CSFs	Critical Success Factors
DR	Disaster Recovery
DS	Descriptive Statistic
FA	Factor Analysis
FP	Financial Picture
G7	Grade Seven
IRR	Internal Rate of Return
IS	Information Systems
IT	Information Technology
LANs	Local Area Networks
MIS	Management Information Systems

LIST OF ABBREVIATIONS

NPV	Net Present Value
PDCAE	Plan, Do, Check, Analyse, and Evaluate
PDI	Plan, Do and Improve
POC	Proof of Concept
PP	Project Picture
ROI	Return on Investment
TQM	Total Quality Management
UAT	User Acceptance Test
WWW	World Wide Web

MEMBANGUNKAN KERANGKA PROSES UNTUK MENGURUS PEROLEHAN FAEDAH TEKNOLOGI MAKLUMAT SYARIKAT PEMBINAAN

ABSTRAK

Syarikat pembinaan melabur banyak wang untuk merealisasikan teknologi maklumat (information technology, IT). Namun demikian, faedah yang diperoleh tidak seperti yang dijangkakan. Penyelidikan ini mengkaji prosedur semasa yang digunakan dalam merealisasikan faedah IT, mengenal pasti faedah IT yang direalisasikan, mengenal pasti faktor kejayaan kritikal (*critical success factors*, CSF) dalam mengurus realisasi faedah IT; dan membangunkan satu kerangka proses konseptual untuk mengurus realisasi faedah IT. Kajian ini dijalankan berdasarkan kerangka konseptual daripada sorotan literatur bagi pengurusan realisasi faedah IT. Kerangka proses merupakan penjelasan tentang tindakan dan tugas yang perlu ditangani dalam usaha menyediakan suatu pendekatan yang berjaya bagi merealisasikan faedah IT.

Realisasi faedah IT melibatkan kitaran hidup projek IT. Sehubungan itu, ia terdiri daripada suatu proses mengurus faedah IT serta merealisasikan projek IT. Proses ini bermula dengan mengenal pasti keperluan pelaburan IT, memilih projek terbaik berdasarkan kajian, mengenal pasti jangkaan daripada projek IT, merancangan merealisasikan projek dan faedah, melaksanakan projek IT dan pelan realisasi faedah IT, menilai projek IT untuk merealisasikan faedah IT, serta mengenal pasti potensi faedah IT selanjutnya.

Kajian ini menggunakan suatu soal selidik yang diolah dan ditambah baik melalui satu kajian rintis. Kajian ini memfokuskan pada populasi 3,750 buah syarikat pembinaan gred 7 (G7). Walaupun jumlah minimum sampel yang

diperlukan adalah 98, namun penyelidik mengedarkan soal selidik kepada lebih kurang 21% daripada populasi—805 buah syarikat— dan hanya 125 buah syarikat yang memberikan jawapan, yang mewakili 15% daripada soal selidik yang diedarkan. Daripada jumlah tersebut, hanya 103 mengisinya dengan lengkap. Beberapa kaedah digunakan untuk menganalisis data, antaranya statistik deskriptif (*descriptive statistic*, DS), analisis faktor (*factor analysis*, FA) dan analisis varians satu hala (*one way analysis of variance*, ANOVA).

Dapatan menunjukkan bahawa item prosedur realisasi faedah IT, seperti penilaian dan perancangan faedah kos, tidak digunakan. Kajian juga mendapati bahawa sesetengah faedah IT, seperti penambahbaikan pengurusan, penambahbaikan perniagaan serta penambahbaikan hubungan kerja, adalah direalisasikan. Faedah IT lain seperti kepuasan klien, pengurangan kos dan peningkatan kadar respons, tidak direalisasikan. Ditemui bahawa CSF adalah kesedaran, perancangan perubahan yang berjaya, pertukaran atau perkongsian pendapat, pendokumenan, viabiliti sistem semasa, dan sebagainya. Selanjutnya, kajian ini mengesahkan bahawa item proses bagi mengurus realisasi faedah IT termasuklah mengenal pasti masalah, menganalisis nisbah kos faedah, perancangan, pelaksanaan, pemantauan, pembelajaran, mengenal pasti faedah yang berpotensi dan sebagainya.

Untuk menguatkan serta meningkatkan dapatan kajian kuantitatif, maka dalam kajian kualitatif , soalan berstruktur digunakan semasa temu bual dengan pengurus IT daripada syarikat pembinaan G7 . Hal ini bertujuan membangunkan suatu kerangka proses konseptual untuk mengurus realisasi faedah IT dalam syarikat pembinaan. Oleh itu, kerangka proses bagi mengurus realisasi faedah IT terdiri daripada mengenal pasti keperluan pelaburan IT, menjustifikasi serta memilih projek pelaburan IT terbaik, mengenal pasti jangkaan, perancangan realisasi, pelaksanaan

projek IT dan pelan realisasi, penilaian projek IT dan potensi bagi projek dan faedah IT selanjutnya.

DEVELOPING A PROCESS FRAMEWORK FOR MANAGING THE REALIZATION OF INFORMATION TECHNOLOGY BENEFITS FOR CONSTRUCTION COMPANIES

ABSTRACT

Construction companies are spending large amounts of money being to realize IT. However, they are achieving less-than-expected benefits. This research explores the current procedures for realizing IT benefits, identifying realized IT benefits, identifying Critical Success Factors (CSFs) for managing the realization of IT benefits, and developing a conceptual process framework for managing the realization of IT benefits. The study based its conceptual framework on a comprehensive review of the literature on managing the realization of IT benefits. The process framework is a description of the required courses of actions and tasks to provide a successful approach to realize IT benefits. Also, it can be used to prescribe how the activities and tasks should be done in the process.

The realization of IT benefits involved in the lifecycle of IT project. Accordingly, it consists of a process with which to manage IT benefits and realize IT project. This process begins with identifying the need for IT investment, then selecting the best project based on a study, identifying the expectations of the IT project, planning for realizing project and benefits, implementing IT project and IT benefit realization plan, evaluating IT project to realize IT benefits, and identifying potential for further IT benefits.

This study uses a questionnaire that was designed and improved through the execution of a pilot survey to determine the final questionnaire form. This study focused on a population of 3,750 grade 7 (G7) construction companies. Although the calculated minimum required sample size is 98, about 21% of the population—805

companies—of the questionnaire were sent and, of those, 125 companies replied, representing about 15% of the sent questionnaires. Only 103 of the returned questionnaires were completed. This study used some methods to analyse the data, including Descriptive Statistics (DS), Factor Analysis (FA) and one-way Analysis of Variance (ANOVA).

The findings revealed that such procedural items of realizing IT benefits, as cost-benefit assessment and planning for realization, were not really used. The study, also, found that some IT benefits, such as improving management, improving business and improving work relationships, realized. Other IT benefits like client satisfaction, cost reduction and increasing response rate, were not realized. The established CSFs were awareness, successful planning for changes, exchanging viewpoints, documentation, viability of current system, etc. Furthermore, the study confirmed that the process items for managing realization of IT benefits included identifying problems, analysing benefits-cost ratio, planning, implementing, monitoring, learning, and identifying potential benefits, etc.

To strengthen and enhance the findings of quantitative study, the qualitative study used structured questions with which to conduct interviews of IT managers from G7 construction companies to develop a supportive conceptual process framework for managing the realization of IT benefits in construction companies. As a consequent, the process framework for managing the realization of IT benefits consists of identifying needs for IT investment, justifying and selecting best IT investment project, identifying the expectations, planning for realization, implementing IT project and realization plan, evaluating IT project and potential for further IT projects and benefits.

CHAPTER ONE - INTRODUCTION

1.1 Research Background

The nature of work in the construction industry is information-based and the majority of works are related to projects. Large amounts of data and information required for smooth project management must be generated, documented, and exchanged among the members of a construction team (Sommerville & Craig, 2006). However, the industry lacks proper documentation and communication standards, leading to low productivity on construction projects because of its fragmented multiprocessing nature (Fischer & Kunz, 2004). Moreover, many problems arise when a construction company launches a number of large projects in overseas locations. Construction companies face challenges stemming from the concurrent management of a project's scope, cost, schedule, and complexity or inter-relativity of the construction tasks. To address these complexities, they must ensure up-to-date work progress reports, manage work-related problems, and fulfil the optimum distribution of resource management (Svidt & Christiansson, 2006). To overcome the problems and achieve the required objectives, many construction companies have decided to adopt an Information Technology (IT) platform and invest in IT projects whenever and wherever it can benefit their operations.

IT functions as a tool that generates, documents, updates, and exchanges data and information which adopted by different industries both to enhance work processes in different disciplines and to achieve digital-based documentation and communication—forming a real-time connection between work stakeholders and suppliers (Fisture & Kunz, 2004). IT consists of the electronic machines and

programs for processing, storing, transferring, and presenting data and information (Stewart, 2002). Many expect the rapidly increasing use of IT to be the dominant form of business communication between organizations in the near future. IT offers interesting improvements potential for widespread use through the description and documentation of the work of many disciplines involved in construction projects. Project information has been keyed into software, generated by computer programs, and represented by different formats in the different disciplines involved in a project (Fischer & Kunz, 2004).

Many of the latest technologies, including knowledge-based systems, computer-based decision support systems, and object-orientated CAD, represent IT applications in construction (Stewart, 2002). Such applications consist of all the electronic means of information transfer as computer networks, local area networks (LANs), Internet, mobile phones, and faxes.

In general, IT use offers organizations such numerous benefits as reducing the time required for documentation, increasing the speed of work, providing better financial controls, achieving better communications, simplifying and speeding up the access to common data, decreasing documentation errors, and improving the coordination and collaboration between the companies participating in a construction project to realize better communication practices (Nitithamyong & Skibniewski, 2004). At the high level of IT use which IT networks and systems today represent, many benefits could be achieved in coordinating information, reducing carrying costs, decreasing cycle time, and improving responsiveness to customer needs.

In the context of construction organizations, IT can increase the efficiency, the productivity, and the performance of the construction work; furthermore, IT

reduces the loss of information and presents opportunities for enhancing the communication (Jaafar et al., 2007a, 2007b; Peansupap, 2004).

IT benefits construction companies in operational, tactical, or strategic ways through establishing some changes in work process (Love et al., 2004; Stewart, 2008), hence, IT benefits may be tangible direct or intangible indirect (Suwardy, 2003; Love et al., 2004). IT benefits are usually measured according to the business success criteria of work efficiency, effectiveness, and performance of the construction projects (Alshawi et al., 2003). Briefly, IT can improve management, increases flexibility, and increases profits (Alshawi et al., 2003; Suwardy, 2003; Love et al., 2004; Stewart, 2008).

The implementation of IT is not always economically justified and does not usually provide all the benefits initially envisaged at the expected time (Andresen et al., 2000; Alshawi et al., 2003). However, a lack of knowledge and awareness exists about how IT benefits construction companies (Sarshar & Isikdag, 2004); and this has led to many IT projects failed to achieve satisfactory levels of adoption and usage (Jaafar et al., 2007a, 2007b). To control this problem, the companies' managements should base IT justification upon the evaluation of the direct and indirect costs and benefits. In addition, they must understand the benefits that IT will provide and how these benefits will be used to introduce better ways of working, in addition to knowing who is responsible for ensuring that this happens (Alshawi et al., 2003). In other words, the procedure that should be followed by the company to realize IT benefits consists of two major components, strategy and evaluation (Ward, 1969; Alshawi et al., 2003; Lin & Pervan, 2003).

1.2 Research Problem

Studies in developed countries showed that successful IT implementation in the construction industry delivered many benefits in work effectiveness, efficiency, and performance. Furthermore, ample evidence exists which suggests that IT improves the performance of a company regarding its business process (Alshawi et al., 2003). IT implementation may not be economically justified in all construction companies and may not provide all the strategic benefits initially envisaged at the expected time (Andresen, 2000; Alshawi et al., 2003). The realized benefits from IT have been considerably less than initially expected, while other unforeseen benefits have materialized (Remenyi, 2000; Lin & Pervan, 2003; Alshawi et al., 2003).

In particular, the industry still lacks appropriate measures that managers can confidently employed to monitor the performance of their IT investments (Love et al., 2004). Investment in IT is increasing and requires management attention (Suwardy et al., 2003). Given these concerns, the question of how to realize IT benefits in order to justify the high level of related expenditures is attracting the attention of both researchers and practitioners. Few organizations have approaches to manage IT benefits while many others pay attention to ways of justifying investments, with little interest to ensure the realization of expected benefits (Ballantine & Stray, 1998; Lin & Pervan, 2003). IT managers found it increasingly difficult to justify rising IT expenditures (Silk, 1990; Willcocks, 1994). The mangers are often under immense pressure to find a way to measure their investments' contribution to business criteria, as well as to find reliable ways to ensure a realization of the business benefits from the investments. This problem of this

approach has become more complex as the nature of IT investments and the benefits that can be delivered have evolved over time (Lin & Pervan, 2003).

Currently, a number of recommended procedures for realizing IT benefits exist—namely benefits management or a benefit realization process (Lin & Pervan, 2003). These procedures focused on managing IT benefits rather than on realizing IT, these procedures lack some processes such as selecting the appropriate IT project based on the requirements. In the context of Malaysia, Yusuf and Osman (2008) found three levels of IT use, namely computerizing work, advanced application, and online technologies. The results of their survey in the construction companies of Malaysia showed that 91% have computerized their work, 78.6% have adopted advanced IT applications, and 77% have subscribed to broadband facilities. Further, their study reported that the local construction industry faced insufficient bandwidth, lacked training, and encountered significant unavailability of expert users. Yoke et al. (2002) highlighted early issues related to IT applications in construction, having found that Malaysian construction companies did not use the full potential of the Internet. Moreover, Yoke et al. found that around 50% of the construction companies decided to adopt IT without considering their needs and requirements; instead, they followed the other successful companies. Furthermore, Yoke et al. (2002) suggested the need to improve the existing infrastructure of IT and to construct more trained workers.

Ramayah et al. (2003) and Jaafar et al. (2007a, 2007b) found that the managers of the construction companies in Malaysia experienced considerable discomfort and insecurity towards the use of IT. Hussan et al. (2008) went further to conclude that, in Malaysia, no explicit understanding of how to use IT to improve a company performance existed. Despite many companies being aware of and familiar

with IT, few had fully embraced it while many others were still in the early adoption stage (Rogers, 1995). The previous research findings in Malaysia reflect the issues highlighted in the developed countries. This indicates the need for management interference in both the process of IT implementation and the realization of benefits in construction companies. However, in Malaysia, a lack of studies exists for managing IT benefits to maximize the expected benefits, avoiding or minimizing the problems and barriers, and ensuring the successful IT implementation and realization of IT benefits.

1.3 Research Questions

From the research problem discussed in Section 1.2, this research has the following research questions:

1. Do the construction companies in Malaysia have a clear approach or procedure for managing the realization of IT benefits?
2. What are the benefits of IT in the construction companies in Malaysia?
3. What are the Critical Success Factors (CSFs) that influence the realization of IT benefits in the construction companies in Malaysia?
4. How can construction companies in Malaysia more efficiently manage the realization of IT benefits?

1.4 Research Objectives

Depending on these research questions, the research objectives are as follows:

1. To explore the current approaches or procedures for realizing IT benefits in construction companies in Malaysia.
2. To identify the realized IT benefits in construction companies in Malaysia.
3. To identify the Critical Success Factors (CSFs) which influence the realization of IT benefits in construction companies in Malaysia.
4. To develop a supportive conceptual process framework for managing the realization of IT benefits in construction companies in Malaysia.

1.5 Research Methodology

The adopted methodology of this study, shown in Figure 1.5, has three major phases: literature review, quantitative study, and qualitative study. The preliminary literature review served to detect research problems. The methodology consisted of a comprehensive literature review related to IT benefits and the management of the realization of IT benefits to identify IT benefits, CSFs and elements of the process of managing the realization of IT benefits.

In this study, the quantitative research approach was performed through using a research survey consisting of a Likert Scale questionnaire. Based on the literature review, this study tested the preliminary questionnaire using a pilot survey to determine the final questionnaire format. This study has a research population of 3,750 companies, representing the total number of active and new construction companies (Construction Industry Development Board [CIDB], 2008). For

management research, Easterby et al. (1991) recommend a sample size of 98 respondents in order to achieve level of confidence 95% and margin of error of +/- 5%.

This study uses three methods of data analysis using SPSS software, namely Descriptive Statistic (DS), Factor Analysis (FA), and One Way Analysis Of Variance (ANOVA) (Pallant, 2001). In this study, The DS used to obtain the frequencies and mean values with standard deviation and the FA to find the hidden factors which may explain most of the underlying variance in the data which constitute the real dependent variables One way ANOVA is to test the differences of answers regarding the variables.

This analysis used interviews as the method for collecting qualitative data to enhance and strengthen the results of questionnaire survey. The study uses findings from interviews with IT managers in construction companies to strengthen the findings of the quantitative data. Final findings of this study will be helpful in developing a supportive process model for managing the realization of IT benefits in construction companies in Malaysia. This research will present conclusions and recommendations based upon the findings of the quantitative study, the qualitative study, and the process model.

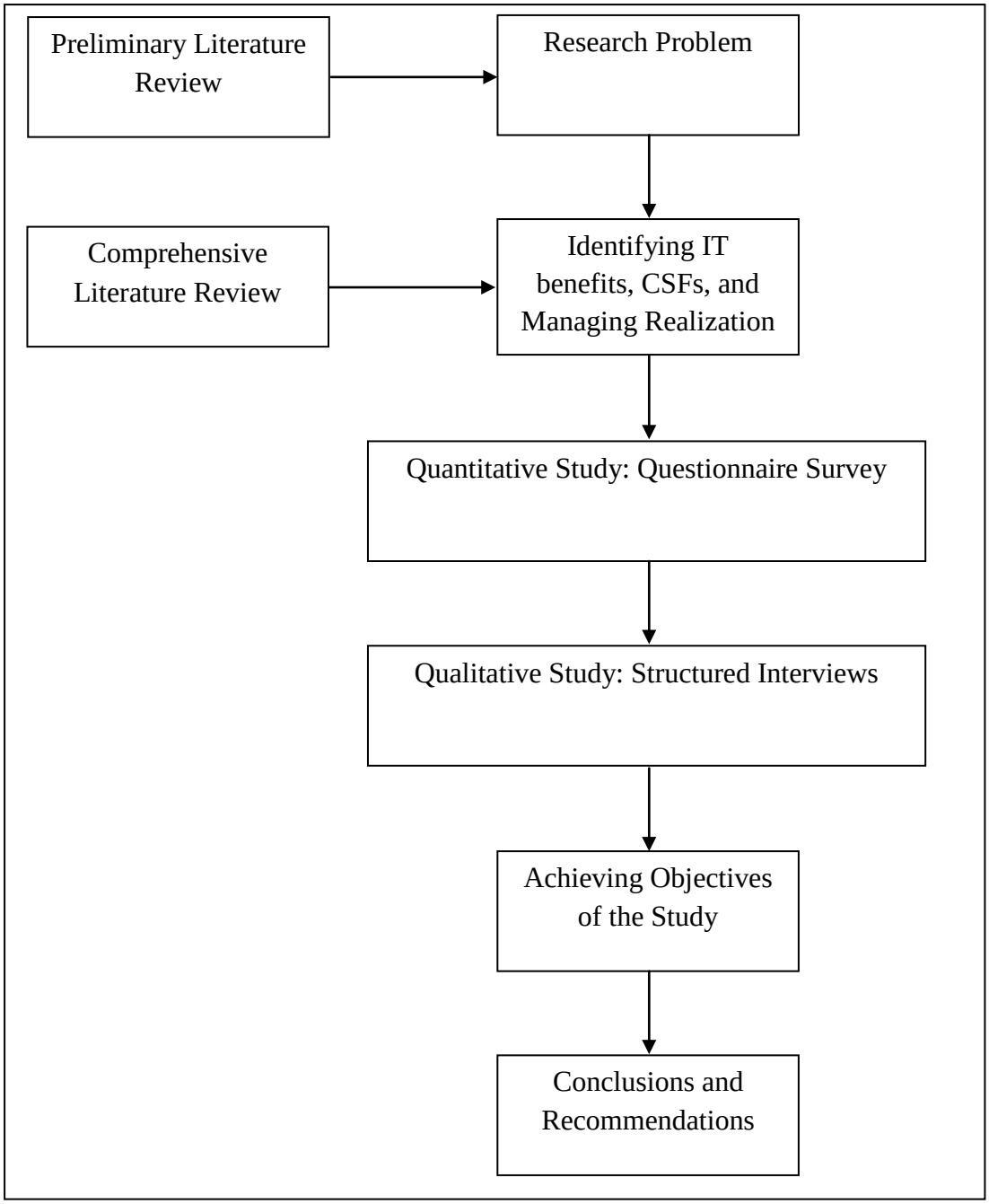

Figure 1.5: Flowchart of Research Methodology

1.6 Research Scope

The construction companies of Malaysia fall into seven categories based on the tendering capacity (RM) and the paid-up capital (RM) (CIDB, 2007, 2008). The research scope of this study includes the Grade Seven (G7) construction companies

because these contractors use and need to use IT (Yusuf & Osman, 2008). The G7 Grade Company consists of at least two persons having five years' experience in construction, with one of them holding a degree in a construction-related field and the other holding a diploma in a construction-related field or holding a degree in another field. The G7 company should have capital of not less than RM 750,000, and have unlimited tendering capacity beyond RM 10 million (CIDB, 2008).

1.7 Thesis Organization

This study consists of seven chapters. Chapter 1 introduces the thesis, and explains the research's background, the research problem, and the research questions, objectives, methodology and research scope. Chapter 2 constitutes the literature review which classified into five themes, namely introduction, Information Technology (IT) in Construction, managing the realization of IT benefits, research Framework, and summary. IT theme describes many aspects of IT; IT project; need for IT in the construction companies; IT applications in construction companies; IT in Malaysian construction companies; value, risk and cost of IT; IT investment; IT implementation and use, and IT benefits. Further, this chapter explains such various issues related to managing the realizing of IT benefits as managing IT benefits methodology with comparison of these methodology; problems and barriers of managing and realizing IT benefits; procedure and process of managing the realization of IT benefits; CSFs for managing the realization of IT benefits; and research framework based on the weaknesses of existing frameworks.

Chapter 3 discusses the research methodology. This consists of two main research methods, a quantitative study by survey questionnaire and a qualitative

study by interview. The quantitative study consists of a number of steps, including the research sample size; questionnaire design; pilot survey; methods of data analysis; and qualitative study. Chapter 4 is data analysis and findings. This chapter includes reliability analysis; analysis of data; result and findings of quantitative study. Chapter 5 constitutes the method of collecting and analysing the qualitative data, in addition to the qualitative findings. Chapter 6 presents the developed process framework for managing the realization of IT benefits. This framework consists of identifying the need for IT investment, justifying and selecting the best IT investment project, identifying the expectations, planning for realization, implementing an IT project and a realization plan, evaluating an IT project, and the potential for further IT projects. Chapter 7 offers conclusions and recommendations, describing and discussing contributions, implications, limitations, and recommendations for future study.

CHAPTER TWO – LITERATURE REVIEW

2.1 Introduction

Tremendous changes in the ways companies do business have occurred over the last twenty years; scholars attribute much of this change to the so-called information revolution (Stewart, 2003). The fragmentation of the construction industry—due to its multidisciplinary organizational nature—has led to documentation problems and low productivity on construction projects (Fischer & Kunz, 2004).

The construction industry has an information-based nature, with the majority of jobs related to projects requiring the generation, documentation, and exchange of large amounts of information among the parties of a construction team (Sommerville & Craig, 2006). The fragmented communication and documentation processes lead to reduced productivity. Furthermore, launching numerous or large overseas projects generates numerous problems (Fischer & Kunz, 2004). The major problems and concerns of construction companies relate to this challenging data documentation and exchange. In order to overcome these problems and achieve their objectives, construction companies frequently use Information Technology (IT). The integrated interaction between IT and business processes has changed from technology's initial function of automating clerical tasks (e.g., payroll and inventory) to providing pertinent information for operational, managerial, and executive groups within the organization (Stewart, 2003). In recent years, IT has enabled some organizations, including those in the construction industry, to transform or reengineer their business processes in the face of the rapidly changing business environment (Stewart, 2003).

The use of IT can reduce fragmentation by improving the coordination and collaboration among the companies which are participating in the realization of the construction project, leading to better communication practices (Stewart, 2003).

Furthermore, IT improves the business process by increasing the efficiency, the effectiveness, and the performance of companies in the construction industry (Alshawi et al., 2003 and Andresen et al., 2000). For many companies, IT implementation and usage represents an essential, large, and growing financial investment; therefore, management must increase the attention paid to IT (Fink, 2003; Lin & Pervan, 2003).

Although many analysts have acknowledged the construction industry's lag in adopting IT (Sun & Howard, 2004) as compared to other industries, the penetration of computers in the construction industry has been increasing in recent years due to rapid improvements in computer hardware and software. Many benefits may be achieved by using IT in the construction industry, such as improving work processes, reducing costs and time, and minimizing information waste in construction projects; however, there is a long slow path of developing in IT implementation in construction companies (Schwegler et al., 2001).

A large amount of money has been lost because of the ignorance of a company's management in realizing IT benefits (Dhillon, 2000). The amount of computer and telecommunications investments can reach up to half, or more, of the annual expenditures of large companies (Lin & Pervan, 2003). Different studies during the last twenty years have reported large capital investment in IT (such as Stiroh, 2001; Fink, 2003). IT investment remains one of the major factors determining the success or failure of a company (Lin et al., 2005). Despite these

findings, not all construction industry IT investment should be justified economically, because IT projects may not provide strategic benefits immediately.

Companies' managements should focus on how to realize benefits in order to justify the expenditures of IT investment. This important consideration has attracted attention from both researchers and professionals (Lin et al., 2005). Formal methodologies and techniques determine monetary matters in IT investments exist, less formal methodologies and techniques manage and realize intangible benefits (Lin & Pervan, 2003). However, many such studies have found an increasing need for effective management of IT benefits as Fink (2003), Lin et al. (2005) and Ward et al. (2007) where management has not been reacting fast enough to situations when IT benefits have not been realized as quickly expected (Fink, 2003). However, Smith et al. (2008) noted that IT managers have recognized the need for an improvement in benefit-realization management techniques.

Benefits management represents a process of organizing and managing so that potential benefits, arising from the use of IT, actually become realized (Ward et. al., 2007). The results of Lin and Pervan study (2003) showed some value in the use of formal methodologies, benefits measurement, formal reviews, and allocation of specific responsibilities, but highlight a lack of uniformity in their formality.

This chapter describes aspects of IT; IT project; value, risk and cost of IT; IT investment; IT implementation and use, and IT benefits. Also, this chapter explains managing IT benefits methodology with comparison of these methodology; problems and barriers of managing and realizing IT benefits; procedure and process of managing the realization of IT benefits; CSFs for managing the realization of IT benefits; and research framework based on the weaknesses of existing frameworks.

2.2 Information Technology (IT) in Construction

The IT refers to all forms of technology applied to processing, storing, and transmitting information in electronic form. Many physical types of equipment used for this purpose include computers, communication equipment and networks, and fax machines (Lucas, 2000). The comprehensive development of IT within the past decades has contributed significantly to both the economy and society. The participation and cooperation of IT stakeholders has guided and supported this development (National Research Council [NRC], 2009).

IT in construction serves as the enabling technology of the twenty-first century and the major component of economic growth and innovation because IT has both real and perceived positive contributions to economic output and growth. Consequently, IT supports all fields of construction industry in product development, sales, and distribution. IT places a high demand on the capabilities of the workforces in construction industry. The importance of IT lies in yielding a cost reduction in traditional products and productivity gains in service sectors of construction industry (NRC, 2009). IT usage and application gages the success of all construction organization, business, and governmental communities because IT transformed and continues to transform all aspects of life in commerce, education, employment, health care, manufacturing, government, national security, communications, entertainment, science, and engineering (NRC, 2009). The effects of IT in construction fall into three main groups: productivity growth in the innovating sector due to technological change, falling prices, and significant reorganization of production goods that embody the new technology (Lee, 2003).

In general, all levels of a construction company's management are involved with IT because of its rapid and widespread use (Lucas, 2000). Human interpretation of information remains central in understanding how an organization reacts to the output of a system. However, each construction manager understanding things differently from another manager; therefore, the same result may mean different things to two construction managers. A marketing manager may use statistical programs and graphs to look for trends or problems with sales (Lucas, 2000), whereas a financial manager may see a problem with cash flow given the same sales data.

2.2.1 IT Project

The use of IT reduces task fragmentation and improves coordination and collaboration, resulting in better communication practices among team members of a construction project (Stewart, 2003). Because many issues need to be considered in the early stages of an IT project, IT does not necessary have a straightforward implementation process and use. The IT project process achieves the realization of an IT application or facility through the execution of a number of such processes as: identifying the business case to produce a clear statement of company problems and opportunities, selecting a proper IT project that achieves company objectives, planning for the required changes in work procedures, and implementing the changes and evaluating the implementation.

The decision of realizing IT project based on assessing the available proposals of IT project to select the best of them. This process should be based on calculations of predicted costs, value, risk, and benefits. For intangible benefits that

cannot be measured, the calculations consist of value, risk, and benefits. The assessment of tangible benefits is based on calculations of benefit-cost (Stewart, 2003). Stewart (2008) found five-step in the process of IT project selection as shown in Figure 2.2.1. These steps are:

1. Identifying monetary and non-monetary factors of IT proposals: The term "factors" refers to all costs and benefits of a proposed IT project. Total ownership costs include all direct and indirect costs related to the initiation, design, development, operation and maintenance of the proposed IT project.
2. Defining possibility distributions: Possibility theory is one of decision-making tools used to select the best IT project (Taylor, 1996; Stewart, 2003). Using possibility theory as a modelling tool means defining each of the costs and benefits in an IT project as a possibility distribution
3. Developing resultant aggregated possibility distribution: Monetary factors can be calculated by using net present value (NPV) because this appraisal method enables comparison between the tangible costs and benefits of proposed IT projects. The aggregated non-monetary possibility distribution can be established by adopting three steps, weighting value and risk factors, combining the weighted possibility distributions of these factors (Mohamed & McCowan, 2001; Stewart, 2008), and combining the aggregated value and risk possibility distributions.
4. Combining resultant aggregated possibility distribution: The resultant monetary possibility distributions for each IT project proposal must be modified so that they have the same range and units by converting them to normalized form. By combining monetary values with the resultant non-monetary possibility distribution, unified distribution is developed.

5. Rank IT project proposals. Proposals for an IT project could be ranked by using the ranking index method (Mohamed & McCowan, 2001). Once projects are ranked according to their index value, an organization can select best project (Steward, 2003, 2008).

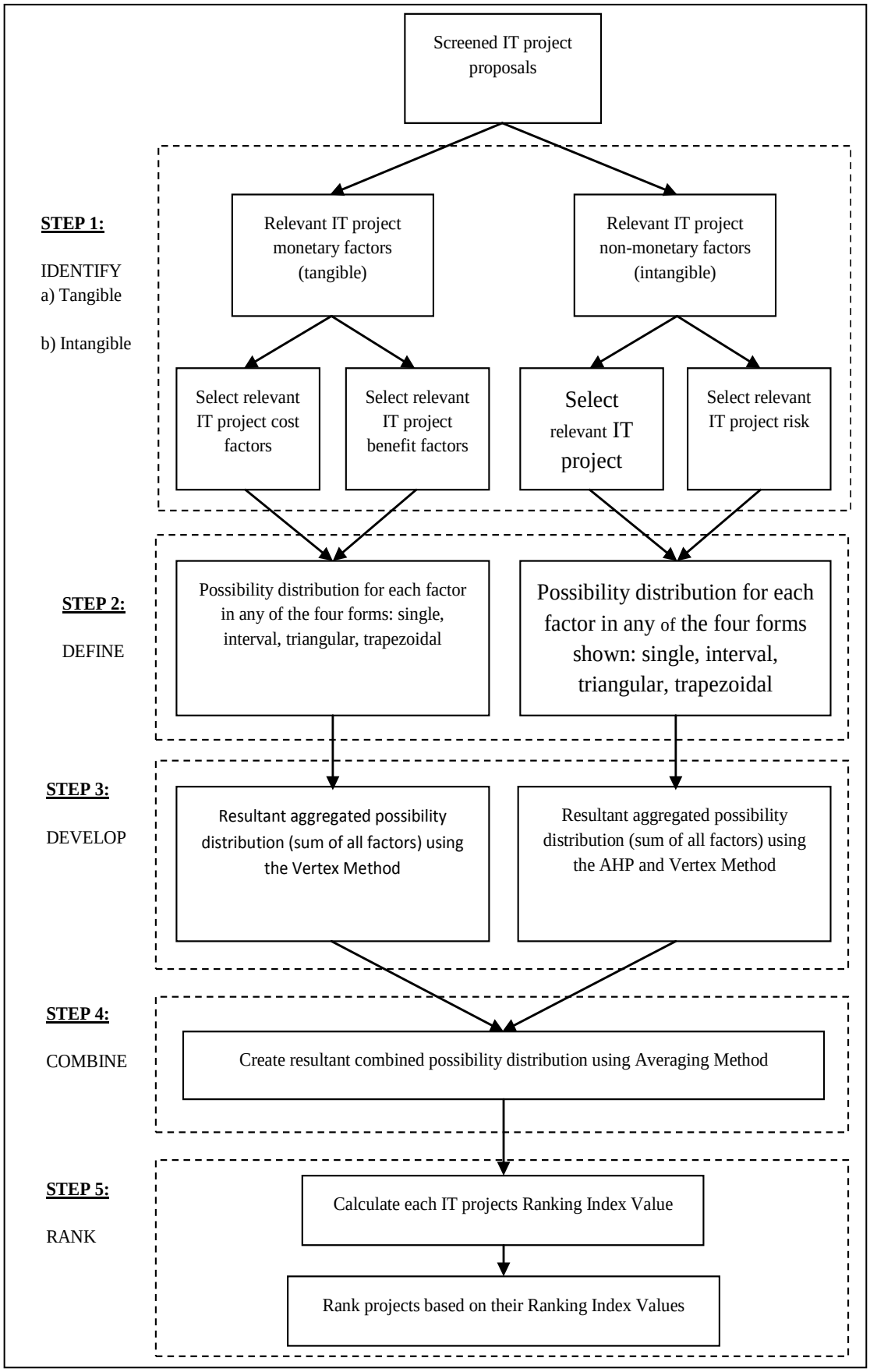

Figure 2.2.1: IT Project Selection Module (SelectIT),
Source: Steward (2008)

2.2.2 Need for IT in the Construction Companies

Construction projects present many problems, in particular when a construction company implements a number of overseas projects or when a number of construction companies implement one project. The problems include tracking work progress to date, work problems, and achieving the optimum distribution of resource management (Svidt & Christiansson, 2006). A paper-based system for handling the multiple processes of construction work usually results in lower productivity and profitability than does a digital-based system. Worldwide, numerous construction companies have experienced problems with the effectiveness and efficiency of their workflows. An international investigation pointed out that one must strengthen the industry's innovation by increased use of information technology and increased collaboration with education and research institutes (Svidt & Christiansson, 2006).

Many consider IT both the best solution for all problems and the tool that all construction companies need. Providing a local network inside a construction company with appropriate software systems can make the documentation and processing of data and information easier with fewer errors. In most of the world's economies, the construction industry has suffered from poor productivity and, more recently, from poor profitability. As in other sectors of the economy, IT comes into focus when discussing these problems. IT appears as the solution to the strategic problem arising from such current economic trends as globalization and deregulation, in addition to political turmoil and other factors. IT has risen to a place of strategic significance in modern business from a position as a support technology for information processing. Furthermore, IT plays a role in the competition between

construction companies to be up to date with new technology and innovations (Betts, 1999).

2.2.3 IT Applications in the Construction Companies

Proper management of IT investments can lead to an enhancement of peoples' lives and improves organizational performance. Some organizations consider the use of local area networks as an essential improvement in processing data and information. The software applications provide an appropriate assistance for the industry to save data and discover resources relationships (U. S. General Accounting Office [GAO], 2000).

IT extends far beyond the computational capabilities of computers; today people extensively use computers for communications as well as for their traditional roles of data storage and computation. Many computers connect together using various kinds of communications lines to form networks. An organization's employees accomplish their work with the help of such electronic communications and linkages as e-mail. Individual computers connect via a network to larger computers that act as servers at organizations that have an internal intranet; internal client computers connect to the Internet so the members can link to customers, suppliers, and others with whom they need to interact. They can also access the huge store of information contained on the Internet and the organization's intranet. Furthermore, an organization can adopt and use such electronic means as a software robot to execute different tasks over networks. IT achieves linkages between an organization and customer and supplier, and these linkages increase responsiveness, improve accuracy, reduce cycle times, and reduce the amount of overhead (Lucas,

2000). However, along with the potential to improve lives and organizations, IT projects can become risky, costly, and unproductive mistakes. IT projects—too frequently—incur cost overruns and schedule delays while contributing little to increased outcomes.

The management should focus more on the results achieved through IT investments during the IT acquisition process. In addition, an organization must implement a process both to maximize the value of IT investments and to assess and manage the risks of IT acquisitions (GAO, 2000, 2004).

The construction industry has seemed to make slow progress toward the effective use of IT. The main uses of IT in construction include office software, computer aided design (CAD) tools software, and communication networks. Construction software includes cost evaluation software, management software, material-quantity calculation software, and steel-quantity calculation software. The Internet—one of the important and dispread IT applications, represents the area with fastest growth because most construction companies are connected to internal and external networks. However, the technology industry considers the applications of IT in the construction industry weak because managers ignore the importance of recognizing whether the high level of capital investment in computer systems and communication networks can achieve satisfied gains in productivity and economic returns (Feng, 2006).

2.2.4 IT in Malaysian Construction Companies

The Malaysian government becomes a large supporter of using Internet technology in the early nineties, and it has employed a range of policies to encourage

Malaysian businesses to venture into an online presence. The government has also invested in such large projects as the Multimedia Super Corridor—a 50 km area stretching north from the Kuala Lumpur International Airport—which has attracted more than 900 local and international IT and communication companies (APNIC, 2004).

As early as 1996, the plan outline permeated all aspects of the Malaysian economy and society, including initiatives in telemedicine, e-government, education, and industry. Malaysia's Vision 2020 remains one of the most aggressive and comprehensive IT plans in the world and faces one of the greatest challenges—using IT to address the economic development hurdles of a highly rural developing country (Kirkman et al., 2002). However, security remains the most important barrier to e-commerce, as found by Abd.Mukti (2000).

Malaysia has entered in an international public relations campaign to draw technology research and development to its IT applications, where a high level of business center and communication infrastructure designed to make Malaysia an international IT leader. The internet constitutes a state priority (Malaysia National ICT Institute (MSC), 2008). Also, Malaysian construction companies using web to promote their business, products and services (Yusuf & Osman, 2008). The awareness of IT is increasing rapidly and the number of construction companies that use IT in Malaysia is growing because IT applications and tools moves further towards advanced information and communications (Yusuf & Osman, 2008). Furthermore, many construction companies in Malaysia have an increased awareness about internet search engine (Yusuf & Osman, 2008). With the increasing of IT growth and level in Malaysia, the marketing efforts go to establish digital marketing (Lim, 2009).

The results of a survey by Yoke et al. (2002) indicated that construction companies' employees had access to the Internet and considered the Internet important to their work. On the other hand, they found that the companies did not use the full potential of the Internet and only implemented such basic functions as email. Yusuf and Osman (2008) found three levels of IT usage in Malaysia, namely, computerizing work, advanced application, and online technologies. Their results showed that, in construction companies, 91% have computerized their work, 78.6% have adopted advanced IT applications, and 77% have subscribed to broadband facilities.

2.2.5 Value, Risk and Cost of IT

To achieve the full potential of IT, A management must first identify and evaluate direct and indirect benefits, costs, and risk prior to IT implementation and then manage and control it (Alshawi et al., 2003; Love et al., 2004). An accurate decision criterion for selecting the appropriate IT project should be based on the value-risk analysis, with tangible costs and benefits remaining only an indicator (Alshawi et al., 2003).

IT value constitutes the contribution that enables the success of business items (Stewart, 2003). Scholars define the definition of IT business value as the economic contribution of the technology to maximize profit and provide service, and that satisfies human organizational and structural benefits (Banker & Kauffman, 1992; Stewart, 2003).

On the other hand, a management must consider the risk of IT investment in order to encourage and enable the management to plan to address any occurrences

that may arise by putting in place the mechanisms to manage and reduce risks (Willcocks & Graeser, 2001; Kumar, 2002; Love et al., 2004). An example of IT risk is the probability of not finishing the IT project on time or on budget (Love et al., 2004). Although risk management remains an integral process of construction project management, construction companies rarely use it as part of the justification process for their IT investments (Love et al., 2004).

Misunderstandings of IT cost and benefit measurements can become an obstacle for managers in determining the true costs of deploying IT. Therefore, managers often do not estimate the real direct costs of IT accurately (Alshawi et al., 2003). Alshawi et al. (2003) specified that these costs include the costs of hardware, software, and installation; these costs may include unexpected additional hardware accessories, such as increases in processing power, memory, and storage devices. Indirect costs of IT involved in the processes of implementation and use have greater impact than the direct costs (Love et al., 2004). Represented in lower productivity, indirect costs include the learning curve on procedures and guidelines stemming from insufficient training of employees, the loss of experienced employees to competitors (Alshawi et al., 2003; Love et al., 2004), and the management time spent in the process—the most significant cost experienced by construction companies (Love et al., 2004). Love et al. (2004) defines management time as the time for leading, planning, and organizing the integration of new systems into current work practices.

In general, senior management pays less attention to the indirect costs of IT, despite the potential for indirect costs to be four times higher than direct IT cost. The implications of ignoring indirect costs can have long-term consequences for a company, for example, reduced productivity because employees have not been