RELATIONSHIP BETWEEN KNOWLEDGE MANAGEMENT AND INFORMATION TECHNOLOGY INFRASTRUCTURE WITH PROJECT PERFORMANCE IN CONSTRUCTION CONSULTING COMPANIES

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Management)

Faculty of Management and Human Resource Development
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NOVEMBER 2009

ABSTRACT

The purpose of this study is to empirically and systematically investigate how Information Technology Infrastructure (ITIC) and Knowledge Management (KM) can improve Project Performance (PP). The study also aims to recommend the best model how to predict PP based on ITIC and KM and seeks to discover possible relationship between factors that affect the PP based on demographic background of the construction consulting companies. This study deployed sequential mixed methods conducted over two phases. The first phase is the quantitative approach where one hundred and forty three practitioners from the Malaysian construction consulting companies were selected to form the sampling frame. The second phase is the qualitative approach where seven practitioners were selected for detailed interview and observation. In the quantitative study, single mean t-tests were conducted to identify whether the level of KM, ITIC and PP are significantly high, where as One-way ANOVA and independent sample t-tests were conducted to identify which demographic variables have influence on the components of Project Performance. Subsequently, correlation and multiple regression analyses were conducted to identify the correlation and model that best predict PP based on ITIC, PP and demographic variables. A positive correlation was found between KM and PP as well as ITIC and PP. As for multiple regression, a best model comprises of selected variables from KM, ITIC and demographic variables was derived. The qualitative research also conducted to complement and expand the findings from quantitative study. Significant patterns and themes were identified and the findings suggest that the internal and external factors as well as barriers are the contextual factors that affect the implementation of KM and ITIC to support PP. Finally, the revised framework of KM-IT-PP based on the findings from quantitative and qualitative analysis was recommended accordingly.

ABSTRAK

Penyelidikan ini bertujuan untuk mengkaji secara impirikal dan sistematik tentang bagaimana keupayaan infrastruktur teknologi maklumat (KITM) dan pengurusan pengetahuan (PT) boleh meningkatkan prestasi projek (PP). Penyelidikan ini terbahagi kepada dua fasa. Fasa pertama menggunakan pendekatan kuantitatif di mana 143 staf daripada syarikat perundingan pembinaan di Malaysia dipilih untuk kajian ini. Fasa kedua menggunakan pendekatan kualitatif dimana 7 orang staf dari syarikat perunding telah dipilih untuk ditemuduga secara mendalam. Melalui pendekatan kuantitatif, ujian-t satu min digunakan untuk mengenalpasti tahap perlaksanaan PT, KITM dan PP. Dalam masa yang sama, ujian ANOVA sehala dan ujian-t bersampel bebas telah digunakan untuk mengenalpasti maklumat latarbelakang syarikat yang memberi kesan kepada PP. Seterusnya, analisa kolerasi dan regrasi berganda dilaksanakan untuk mengenalpasti korelasi dan model terbaik untuk meramal prestasi projek berdasarkan KITM dan PT serta latarbelakang syarikat. Terdapat korelasi positif antara KITM dan PT dengan PP. Bagi regrasi berganda pula, model terbaik telah dikenalpasti yang terdiri daripada sebahagian dari pembolehubah KITM dan PT serta latarbelakang syarikat. Walaubagaimanapun, ujian tersebut tidak dapat membuktikan kesan latarbelakang syarikat kepada PP. Disamping itu analisa kualitatif menyokong hasil kajian kuantitatif di mana pola dan tema penting telah dikenalpasti. Maklumat penting yang telah dikenalpasti yang memberi kesan kepada perlaksanaan KITM dan PT dalam membantu meningkatkan PP adalah beberapa faktor dalaman dan luaran serta halangan. Akhirnya, konsep hubungan pengurusan pengetahuan, keupayaan infrastruktur teknologi maklumat dan prestasi projek dihasilkan berdasarkan daripada hasil kajian kuantitatif dan kualitatif.

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PP	-	Project Performance
KM	-	Knowledge Management
ITIC	-	Information Technology Infrastructure Capability
AI	-	Artificial Intelligence
WCM	-	World-class Manufacturing
PMQ	-	Performance Measurement Questionnaire
OLAP	-	Online Analytical Processing
DSS	-	Decision Support System
EIS	-	Executive Information System
PKK	-	Pusat Khidmat Kontraktor (Contractor Service Center)
CIDB	-	Construction Industrial Development Board, Malaysia
CII	-	American Construction Industry Institute
PMBOK	-	Project Management Body of Knowledge
PMI	-	Project Management Institute
IS	-	Information System
SPI	-	Schedule Performance Index
CPI	-	Cost Performance Index
BCWP	-	Budgeted Cost for Work Performed
ACWP	-	Actual Cost of Work Performed
BCWS	-	Budgeted Cost for what is Planned To Do
PPF	-	Project Performance Factor

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CHAPTER 1

BACKGROUND OF THE RESEARCH

1. Introduction

Construction consulting companies are among the critical players in ensuring the success of construction projects. The main roles of construction consultants are to assist the client and contractor in designing, cost estimating, scheduling and planning, construction project management and trouble shooting or resolution services (Ministry of Railway-Government of India, 2007).

These days, construction industry is a very competitive and risky business. It faces many problems such as not receiving enough co-operation, limited trust, and ineffective communication often resulting in low project performance. Throughout the last two decades, a considerable amount of research has been done on identifying important factors that affect construction project performance (PP). To date, however, researchers have not reached a consensus as to what are the most important or critical factors that influence achievements with respect to each performance measure (Beamon, 1999). Most construction projects are large, extensive, expensive and are subject to tight schedule and budget (Chao, 2001). Many of construction projects fail due to being incomplete, over budget, or late. Sir Michael Latham (1994) in his report, Constructing the Team stated that poor project performance was caused by lack of attention to the details relating to project structure, communication, and execution. Also he argued that construction consultants such as design architects and engineers played a major role of the project decline. This was proved by the amount of insurance and damaged claimed in construction arbitration cases (Latham, 1994). Until

recently, the claim is still valid where in 2001, report from Construction Industry Review Committee still highlight the same problems exist in AmericanÑs construction industry. Furthermore, report from the Global Construction Survey (KPMG, 2008) found that eighty four percent of the surveyÑs participants from global contractors agree that they are having construction problems including low project quality and project delay due to chronic skill shortage.

In Malaysia, based on the latest report from Pusat Khidmat Kontraktor, many construction projects in Malaysia have failed due to the project performance issues including budgetary, quality and schedule problems (Pusat Khidmat Kontraktor, 2007). Hence, the Government of Malaysia through Ministry of Entrepreneur and Co-operative Development is strengthening the mechanisms for project monitoring to ensure high project performance in construction industry (Report on Effectiveness of Policy on Permit Approval to Contractor Class F and Proposal for Improvement, 2005).

In the new construction era, a construction project needs to be more unique, complex and custom-built to fulfill the customerÑs requirement. At the same time, the success of construction projects are influenced by many variables and, sometimes subjected to unpredictable factors. Furthermore, in general, there is a shortage of specialized and supervisory staff conversant with latest construction techniques in construction developer. Hence the role of construction consultants to influence the management of the project is very important in order to ensure the management and supervision of the construction project is done professionally and at the same time helping the developer to control the schedule, cost and quality of the project (Ministry of Railway-Government of India, 2007). The overall influence of project consultant is to add value to every stage of project life cycle.

As major players in the construction industry, construction consulting companies which provide the expertise and professional advice need to find sources to sustain the competitive advantage in an unpredictable environment. Based on Nonaka and Taguechi (1995), one of the major sources of sustaining competitive advantage is knowledge. Organisations have started realizing that assets include

knowledge assets such as human skills, experience, know-how, best practices, databases provides opportunities to cut cost, save design time and reduce processing time. As part of the supporting element to knowledge, Information Technology Infrastructure Capability (ITIC) has been identified as one of the critical factors for effective Knowledge Management (KM) (Junnarkar and Brown, 1997; Trussler, 1997; Ruggles, 1998; Syed, 1998, Skyme, 1999, Sarvary, 1999, Zack 1999, Choi, 2000).

Many construction consulting companies employ KM and ITIC programs in one form or another to manage and share their knowledge, particularly, to store and transfer explicit forms of knowledge as well as for capturing and storing tacit knowledge in repositories which are becoming increasingly vital to enhance organisational effectiveness (Rasli et al., 2004).

Though realizing that KM and ITIC shall affect Project Performance (PP), the question of what are the critical components of KM and ITIC to be focused strategically and the best combination of KM, ITIC and demographic background being implemented to achieve positive impact on PP in construction consulting companies is still open for research.

With regards to the performance of construction based projects, Abd. Majid et al. (2005) has highlighted that new skills, mind-sets, models and commitment as well as new ways of interpreting the concept of effective management are needed to improve construction project performance. The study derived a model based on a matrix which identifies the categories of KM as well as ITIC and PP within Malaysian construction consulting companies. However, no clear relationship between KM, ITI and PP was studied in the research.

1.1.1 Knowledge Management

Knowledge Management (KM) can be defined as a systematic and strategic approach of managing knowledge through KM cycle starting from discovery until

recreation of new knowledge to turn an organisationÑs intellectual assets into greater productivity, new value and increase competitiveness (Choi, 2000). KM also includes the entire process of discovery, creation, dissemination, and utilisation of knowledge (Kim, 2001).

There is no longer any doubt among practitioners and academicians about the significance of KM to organisation. Among the important literature to KM are ÈKnow How CompanyŠ (refer Sveiby, 1980) and ÈThe Knowledge-Creating CompanyŠ (Nonaka and Takeuchi, 1995). Davenport and Prusak (1998) introduced the concept of ÈWorking KnowledgeŠ which presented successful KM case studies and provided practical advice about implementing KM system. KPMG Consulting highlighted that KM has been adopted by eighty percent of the worldÑs biggest companies (KPMG Consulting, 2000). International Data Corporation shows that KM shifts from early adopting phase towards majority phase (Dyer, 2000). Furthermore, Dyer stated that in early adopting phase, companies tried to implement KM activities such as documenting all business processes to capture explicit knowledge as well as initiating the intellectual discourse to capture tacit knowledge. As in majority phase, companies started to establish KM infrastructures such as special unit to manage KM activities as well as ITIC infrastructures to support KM (Dyer, 2000).

In recent study, various KM initiatives have been introduced such as collaboration initiatives in work group sessions where it is designed to protect and to maximize each participantÑs interest and to allow each participation to raise her/his voice, as well as becoming the speaker or the documenter of the group (Ataov et. al, 2009). Subsequently, a study on KM introduced Logistic Operations Knowledge Dissemination (LOKD) which is defined as logistic operation personnelÑs timely sharing of knowledge of the business environment with appropriate logistic operation and other personnel within the firm and constantly scanning the business environment which will improves the likelihood that knowledge is captured promptly, making it available to disseminate in a timely manner, increasing logistic operation knowledge dissemination (LOKD) (Stock et al., 2000; Flint et al., 2002; Chen and Paulraj, 2004; De Treville et al., 2004; Gunasekaran and Ngai, 2005;

Kotelnikov, 2006; Rosenzweig and Roth, 2007). In a later study by Dantas and Bell (2009) found that through a thorough analysis of network emergence and development, the following five selected properties of knowledge networks in late-industrialising economies: intentionality in decision-making, nature of technological accumulation activities, content and direction of knowledge flows, sources of knowledge flows and division of labour in knowledge production.

Furthermore, various KM system have been developed such as e-COGNOS (e-Cognos, 2000) which is designed to manage knowledge of construction industry, PROJECT MEMORY (Reiner and Fruchter, 2000) focused on the development of a project memory capture system for design evolution capture, visualisation and reuse in support of multidisciplinary collaborative teamwork, CLEVER (Kamara et al., 2002) focused on the development of a framework for the transfer of knowledge in a multi-project environment in construction, KLICON (Patel et al., 2000) focused on the role of IT in capturing and managing knowledge for organisational learning on construction projects, KNOWBIZ (Robinson et al., 2003) which is developed for improved business performance aimed at establishing the link between knowledge management and business performance in construction firms and CSAND (Khalfan et al., 2003) which is designed for creating, sustaining and disseminating knowledge for sustainable construction.

1.1.2 Information Technology Infrastructure

An empirical study on construction firm performance shows that ITIC is positively associated with firm performance, schedule performance and cost performance. The study shows that for every 1 unit increase in IT utilisation, there are increments of about 2, 5 and 3 percents in firm performance, schedule performance and cost performance respectively (Mashaleh and OÑBrien, 2004). Furthermore, ITIC has also been recognized as an important supporting element or enabler to successful KM (OÑDell and Grayson, 1998; Weil and Broadbent, 1998; Skyrme, 1999; Choi, 2000). Most of successful KM projects are associated with ITIC; Ruggles (1998) found that four most popular KM projects are related to ITIC

in a survey of 431 U.S. and European companies. Technology advancement in IT creates opportunity to manage knowledge efficiently and effectively to support project performance. Data Mining and Data warehousing are tools for KM among others available in the market for managing, manipulating and analyzing data and transforming to knowledge (Chase, 1997; Skyrme, 1999). The other tools such as online analytical processing (OLAP), decision support system (DSS) and executive information system (EIS) facilitate the knowledge management activities. Currently, the advancement in internet, portal and web applications and services create opportunity to disseminate and transfer knowledge efficiently and quickly (ONDell and Grayson, 1998). Furthermore, the research and development in artificial intelligence (AI) has aided in developing knowledge-based and expert system to manage narrow domains of knowledge (Davenport and Prusak, 1998). In addition, Abd. Majid et al. (2004) emphasize on exclusive and standardized use of ITIC. Exclusive ITIC reflects the specialized and more advanced IT infrastructure capability and standardized ITIC reflects the general or generic IT infrastructure capability to support the KM activities.

Based on the literature review, ITIC infrastructure capability with respect to KM can be defined as capability of IT infrastructure to support and facilitate the Knowledge Management activities.

1.1.3 Project Performance

After a long dependence on financial measures, Keegan et al. (1989) promoted the classification of performance measures into cost and non-cost measures, and Maskell (2004) promoted the use of performance measures based on world-class manufacturing (WCM) which measures quality, time, process, and flexibility. Furthermore, Dixon et al. (2000), when devising the performance measurement questionnaire (PMQ), recognized the need for performance systems to identify areas of improvement and worked on developing them. In another study, Azzone et al. (1991) promoted the importance of time criteria in their matrix for time-based companies. Kaplan and Norton (1992) founded a new concept of performance measurement framework with four broad perspectives: financial,

customer, internal processes, and innovation. The framework was further improved as a strategic management system by Sinclair and Zairi (1995), Flapper et al. (1996) and Bititci et al. (1997). Though there are various framework introduced, all previous frameworks stressed the fact that performance measurement should be derived from strategy. Neely (2000), however, focused first on measuring stakeholdersÑneeds and contributions and then on the required strategies, processes, and capabilities. Other than the above mentioned performance measurement, there are frameworks like performance scorecard or õtableau de bordÑbut its use is being limited to French companies only (Mendoza and Zrihen, 2001). In recent research on construction project performance, lean management model for construction has been introduced to improve project performance (Ballard, 1999; Sacks and Goldin, 2007). A wide range of benefits have been obtained from lean production including (1) waste reduction; (2) production cost reduction; (3) decreased production cycle times; (4) labor reduction; (5) inventory reduction; (6) capacity increase of existing facilities; (7) higher quality; (8) higher profits; (9) higher system flexibility; and (10) improved cash flows (Kotelnikov, 2006; Sacks and Goldin, 2007)

The study in project performance was further expanded to identify the algorithm to measure project performance such as Cost Performance Index (CPI) (CII, 2004), Schedule Performance Index (SPI) (CII, 2004) and Project Performance Factors (PPF) (Attalla et al., 2003). Subsequently, project performance variables have been identified; Project cost variables, time variables and quality variables (Abd. Majid et al., 2004); ProjectÑs variables, contractorÑs variables, environmentÑs variables and ownerÑs variables (Cho et al., 2009); and Kim et al. (2009) introduces key variables based on the structural coefficients that significantly determine the performance of a construction project. The primary variables drawn from the study are: contractorÑs ability and experience, quality of design, quality of estimation, cost management, commitment of organisation, claim and dispute resolution, contract condition, project environment, project condition, attitude and ability of owners, architects or engineers, project information in early stage, bidding competition, relationship on a join-venture (J/V) and condition of host country.

1.2 Research Objectives

The research has the following objectives:

1. To identify the main components of KM, ITIC and PP among Malaysian Construction Consulting Companies;
2. To identify the implementation level of KM, ITIC and PP in Malaysian construction consulting companies?
3. To identify the effect of demographic background to the level of PP in Malaysian construction consulting companies.
4. To develop a model for PP based on KM and ITIC and companiesÑ demographic background;
5. To identify how do KM and ITIC influence PP.

1.3 Statement of Purpose

Although, there is no doubt that KM and ITIC affects PP, the question remains to be answered as to what are the critical components of KM and ITIC which should be focused strategically and which combination of KM, ITIC and PP can be best implemented to have a positive effect on PP in construction consulting companies. The effective model of KM, ITIC and PP is deemed necessary as a guideline for the improvement of project performance in construction industry.

The purpose of this study is to empirically and systematically investigate how ITIC and KM influence PP and what factors are important to facilitate the implementation of ITIC and KM in order to enhance PP in construction consulting companies. The study also aims to recommend the best model for predicting PP based on ITIC and KM. In addition, the study will seek to discover possible relationship between factors that affect the PP based on demographic background of the construction consulting companies.

1.4 Research Questions

To address the aforementioned objectives and provide solutions to the research problem, four research questions were identified and formulated as follows:

RQ1: What are the critical components of KM, ITIC and PP in Malaysian Construction Consulting Companies?

RQ2: What are the levels of KM, ITIC and PP among Malaysian Construction Consulting Companies?

RQ3: What are the differences in the level of PP based on demographic background of Malaysian Construction Consulting Companies?

RQ4: What model could be developed to best predict PP based on KM, ITIC and demographic background of Malaysian Construction Consulting Companies?

RQ5: How do KM and ITIC influence PP?

1.5 Significance of the Study

Despite the findings from previous studies on the impact of ITIC on KM (Junnarkar and Brown, 1997; Trussler, 1997; Ruggles, 1998; Syed, 1998; Skyme, 1999; Sarvary, 1999; Zack, 1999; Choi, 2000), the following are the significance of the study:

a) The integration of ITIC, KM and PP has received limited investigation. An empirical study to discover the relationship is crucial as nowadays the important role of KM and ITIC cannot be easily denied in construction consulting companies. This study is significant because it attempts to utilize more than one research method or data collection technique, as each method refers to a different dimension of the research problem.

b) Furthermore, a combination of quantitative and qualitative methods was used. Data sources from a survey questionnaire on practitioners from the

construction consulting companies and supported by structured interviews and observations on expert consultants have been utilized to conduct the research.

c) This study is also significant because it identifies critical factors or indicators that contribute towards KM capability to enhance PP in construction industry.

d) It also studies the causes of effectiveness (enablers) and ineffectiveness (barriers) of KM and ITIC implementation to support the PP. A tested and tried theoretical model derived from this study would be beneficial to the construction consulting companies in planning the implementation of KM and ITIC.

e) The study highlights the important knowledge areas of construction industry and ITIC also provides the input for the development of cohesive re-engineering programmes, professional project management and monitoring activities, professional construction development activities and organisational restructuring that could provide methods to upgrade their existing performance and acquire new techniques as well as redefine the work process.

f) Additionally, the findings provide input for the following areas:

    i. The contribution towards the body of knowledge on KM, ITIC and PP among the construction consulting companies.
    ii. The preparation of guidelines or implementation model on the most effective implementation strategy to apply KM and ITIC in construction consulting companies.
    iii. The preparation of guidelines for construction consulting companies and policymakers in the reduction of barriers and/or enhancement of enablers that will enhance PP for construction industry.

iv. Finally, the findings from the study provide insights into the extent to which perceptions of construction consulting companies vary by the influence of type of services and other demographic background. Also provides information regarding the extent to which the critical components and indicators may have changed due to changes in technology and the re-engineering of business operations and procedures. This information can be used to compare the extent to which current KM, ITIC and PP are perceived as important by construction consulting sector with current guidelines.

1.6 Operational Definition

a) Knowledge Management:- the process of the creation, collection, organisation, dissemination, and utilisation of knowledge to turns an organisationÑs intellectual assets, both recorded information (explicit knowledge) and the talents of its members (tacit knowledge) into greater productivity, new value and increase competitiveness in order to maximize an enterpriseÑs knowledge effectiveness and returns from its knowledge assets.

b) Information Technology Infrastructure Capability:- A set of shared and tangible information resources that provide a foundation to enable present and future business applications which includes integration, collaboration, data management, security and utility capability.

c) Project Performance:- A common approach to access success/failure of construction projects which evaluate performance on the extent to which clientÑs objectives like cost, time and quality were achieved.

1.7 Limitations

The primary objective of this research is to investigate the relationship of KM, ITIC and PP. However, the objective of this research is not to prove or disprove theories that have some bearing on KM, ITIC and PP. The focus is purely on relevant concept and interrelationship identification:

a) This research does not focus on the philosophical meaning of knowledge; in other words, it does not dwell on epistemology. Rather, its focus is on devising an action-oriented knowledge characterisation that can be used in organisations.

b) It has been assumed that an organisationÑs knowledge grows over time. An organisation may not be aware of it, may not be making best use of it, or may not be managing well in order to enhance those activities that lead to efficient and effective knowledge growth. Therefore, the focus is not on how and why an organisation ÈknowsŠ, or ways of ÈknowingŠ, but rather on developing a framework that allows one to understand and apply KM and ITIC to achieve PP.

1.8 Organisation of the Thesis

This thesis is organized as follows:-

Chapter 2 is devoted to a review of concepts of knowledge management, information technology infrastructure and project performance and development models. The review of literature starts by discussing issues related to KM, ITIC, PP and their integration. Subsequently, several models on KM, ITIC and PP are elaborated.

Chapter 3 discusses the theoretical and conceptual frameworks and research hypotheses for the study as well as provides an overview of the methods for the study and the research design.

Chapter 4 commences with a discussion on the mixed method used for the study. Rationales for using case study as a qualitative method by utilising critical incidents, semi-structured interviews and observations are provided throughout the chapter. The assessing of expertsÑ opinion and survey questionnaire for the quantitative method was introduces. The main purpose of chapter 4 is to provide an overview of the instruments, sampling frames and findings for the quantitative studies and subsequently.

Chapter 5 provides findings of the qualitative methods. These findings complement and expand the findings from quantitative analysis as stated in the mixed method.

Chapter 6 draws the conclusions of the study with a discussion on the findings and contributions of the study as well as the direction for further research.

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