UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF INTEGRATED CRITERIA FOR SELECTION AND MONITORING OF SUBCONTRACTORS IN MALAYSIA

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DEVELOPMENT OF INTEGRATED CRITERIA FOR SELECTION AND MONITORING OF SUBCONTRACTORS IN MALAYSIA

By

LEW YOKE LIAN

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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

DEVELOPMENT OF INTEGRTAED CRITERIA FOR SELECTION AND MONITORING OF SUBCONTRACTORS IN MALAYSIA

By

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August 2017

Chairman: Associate Professor Ir Salihudin Hassim, PhD
Faculty: Engineering

Subcontracting practice has become a norm in current construction industry. A performance of construction work is strongly dependant on subcontractors. Problems arising from subcontracting may cause vast influence to the construction project, and may affect the operation of the general contractor's organisation. Previous studies on subcontractors focused on the single phase of subcontracting practice, either on registration, selection of subcontractors, or on monitoring of subcontractors without much integration of different phases. This study aims to fill the gap between these phases. The key criteria used by general contractors in selecting subcontractors before job-awarding, and key criteria used for monitoring of subcontractors during construction work was first identified followed by discovery of the interrelationships between the criteria used for selection of subcontractors and the monitoring of subcontractors during construction stage. The interrelationships between the criteria and effects of these criteria on the project performance were investigated simultaneously using a single model based on structural equation modelling (SEM) method. Data obtained from 162 G7 contractors in Malaysia were analysed. The final model discovered four major criteria that are essential in the selection of subcontractors, namely, 'communication', 'relationship', 'general obligation', and 'resource management' of a subcontractor. Meanwhile, the major criteria for monitoring of subcontractor are 'workmanship', 'awareness of environment, health and safety', and 'communication and relationship'. The four criteria for selection of subcontractors were found to be interrelated among themselves and influence the criteria used to monitor subcontractors during the construction stage. The study also reveals that the criteria used to monitor subcontractor were found to influence the performance of a project. The interrelationships discovered in this study were used to develop a web-based system that allows the general contractor to select the subcontractors, monitor the subcontractors during construction stage, and predict the project performance using a single system. The gap between the criteria used for selection and monitoring of subcontractors is filled with this proposed web-based system.

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

PEMBANGUNAN KRITERIA BERSEPADU UNTUK PEMILIHAN DAN PENGAWASAN SUBKONTRAKTOR DI MALAYSIA

Oleh

LEW YOKE LIAN

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Pengerusi: Profesor Madya Ir Salihudin Hassim, PhD
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Amalan subkontrak adalah satu amalan biasa di dalam industri pembinaan semasa. Prestasi sesuatu kerja pembinaan amat bergantung kepada subkontraktor. Masalah berpunca daripada amalan subkontrak mungkin menyebabkan kesan yang besar kepada projek pembinaan, dan seterusnya mengganggu operasi kontractor am. Kajian lepas ke atas subkontractor barangkali fokus pada salah satu fasa tunggal di dalam amalan subkontractor, pendaftaran, pilihan subcontractor, atau atas pengawasan subkontractor tanpa banyak integrasi antara fasa berlainan. Kajian ini bermatlamat untuk mengalamatkan jurang ini. Pertama, kriteria utama yang digunakan oleh kontractor am untuk memilih subkontractor sebelum penganugerahan kerja, dan untuk mengawas subkontractor semasa pelaksanaan kerja pembinaan dikenalpastikan, diikuti dengan penemuan perhubungan antara kriteria-kriteria ini. Perhubungan antara kriteria dan kesan kriteria ke atas prestasi projek telah dikaji pada masa yang sama dengan menggunakan satu model tunggal berasaskan Model Persamaan Struktur (SEM). Data yang diperoleh daripada 162 G7 kontrator di Malaysia telah dianalisa. Model muktamad mendapati empat kriteria utama yang penting semasa pemilihan subkontrator, iaitu, 'komunikasi', 'perhubungan', 'tanggungan am' dan 'pengurusan sumber'. Manakala kriteria utama yang penting semasa pengawsan subkontrator adalah 'mutu kerja', 'kesedaran kepada alam sekitar, kesihatan dan keselamatan', dan 'komunikasi dan perhubungan'. Empat kriteria utama yang penting semasa pemilihan subkontrator ini mempunyai hubungan korelasi yang signifikan antara satu sama lain dan mempengaruhi tiga kriteria digunakan dalam pengawasan subkontrator semasa fasa pembinaan. Kajian ini juga mendedahkan bahawa kriteria untuk pengawasan subkontrator didapati memberikan kesan ke atas prestasi projek. Hubungan korelasi yang dijumpai didalam kajian ini telah digunakan untuk pembinaan system berasaskan web yang membenarkan kontrator am memilih subcontractor, mengawas subkontrator semasa fasa pembinaan dengan menggunakan satu system tunggal. Jurang antara kriteria yang untuk pemilihan dan pegawasan subkontractor telah diisi dengan system berasaskan web ini.

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I certify that a Thesis Examination Committee has met on 4 August 2017 to conduct the final examination of Lew Yoke Lian on her thesis entitled "Development of Integrated Criteria for Selection and Monitoring of Subcontractors in Malaysia" 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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CHAPTER 1

INTRODUCTION

The construction industry is a complex industry that involves traders from different specialisations. The size and complexity of a construction project, and its nature of "one-time off project" working environment has transformed the construction project as a unique industry.

The need for solicitation of an innovative technology in the construction industry obliges a sustained and steady engagement of innovative technology and acquisition of modern machines. A general contractor is reluctant to invest vastly in machineries, plant, and technology required for a project to remain competitive. In addition, a general contractor is unable to employ skilled labour from each specialisation in the construction for a full-time employment. Therefore, usually a general contractor hires subcontractors in order to achieve a competitive price whilst sharing the cost of the project when undertakes a construction project.

Subcontractors are specialists in the implementation of a particular work. They perform as proxies of the production systems of a construction business in distributing resources, manpower, equipment, tools or designs. The subcontractors are equally liable on the risk and responsibilities as of the general contractor, reduce the overhead cost of the construction project, ensure the quality of the specialist job, and minimise the financial burden of the general contractor.

Nevertheless, extensive subcontracting activities pose risks to general contractors, clients and their project management teams due to difficulties in managing such a sizeable, varied and fragmented groups of subcontractors. The achievement of a construction project in attaining the targeted cost, schedule and quality is highly dependant on the success of subcontracting activities.

1.1 Problem Statement

The capacity of the general contractor, consultant and client in delivering the venture as planned, as per the quality and cost scheduled depends mainly on the performance of subcontractors (Mbachu, 2008). Selecting high performing subcontractors is crucial and it helps to reduce subcontracting risk (Kumaraswamy & Matthews, 2000; Mbachu, 2008; Ng et al., 2008). However, monitoring of subcontractor should be taken into consideration in the practice of subcontracting. Progressive monitoring on job performance is the best strategy to ensure the performance of subcontractors (Manu et al., 2015).

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There was a little integration between the criteria used to select and monitor subcontractors in different stages of subcontracting practices. A series of study were conducted to enhance the subcontracting practice. The focus is on either registration, selection, or monitoring subcontracting practice. Most studies on subcontracting focus on the registration of subcontractor, selection of subcontractor, and monitoring/performance rating during construction stage.

Mbachu (2008) proposed a conceptual framework for both assessment on the evaluation and performance of the subcontractor in the construction project. In the proposed framework, the criteria for the prequalification, pre-contract qualification and during construction stage of subcontractor were assessed separately. The researcher had pointed that there was a possible correlation between the selection stage and construction stage performance of subcontractors. However, this subject matter has yet to be studied extensively. Thus, additional research is needed to ascertain the correlations or causal relations between the criteria to select subcontractor and to monitor the performance of subcontractor during construction stage (Ng et al., 2003; Mbachu, 2008).

Researchers often chose to focus on the single phase of subcontracting practice without paying much attention on the integration of different phases. Majority of these studies used independent criteria in assessing subcontractors during different stages of subcontracting practice. Criteria used on selecting subcontractor were different with the criteria used on monitoring subcontractor during construction stage. Limited attention was given on possible effect on the criteria selection of the subcontractors on their performance during the construction stage. This gap resulted a discontinuity in the subcontracting practice. However, post selection, the strength and weakness of each selection criteria was not taken into consideration. The strength or weaknesses of subcontractor in certain criteria during the selection stage can create a great impact on their performance during construction stage. With the identification of this possible impact, potential problems during the construction stage are resolved or prevented.

The major issues that have not been addressed in the subcontracting literature were the relationship between the criteria used in selecting subcontractors prior awarding a particular job, and the criteria used to monitor the subcontractors during the construction stage. These are important issues to be fulfilled in this study. The identification of the possible correlations between these two important stages could improve the subcontracting practice with the increased involvement of subcontractors in the Malaysian construction industry. General contractor can foresee the benefit or risk in selecting a subcontractor. When prediction on the performance or weaknesses of the subcontractor is possible, the resource allocation can be pre-planned. For example, more resources in terms of time, finance and work force are needed to stabilise performance of a subcontractor if the performance rendered is below par. Furthermore, general contractors are able to select the subcontractors that can fulfil their requirements. For instance, in a project that has high chances of changes, subcontractors

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predicted with good performance on 'communication' during the construction stage is preferred.

Rather than to study the practice of subcontractor in different aspects individually, it is necessary to improve the methods for evaluating and managing subcontractors (Eom et al., 2008). Nevertheless, studies that combine the selection and monitoring of subcontractor are yet to be conducted. Studies are done in the area of improvement of the subcontracting practice, including selection of subcontractors (Abbasianjahromi, Rajaie, Shakeri, & Kazemi, 2016; Polat, 2015; Polat, Kaplan, & Bingol, 2015), and monitoring of subcontractors during construction stage (Manu et al., 2015; Ng & Skitmore, 2014; Yin et al., 2014; Philips-Ryder et al., 2013). The integration between these two stages of subcontracting practice is scarce. This leads to many problems since the construction issues caused by subcontractors are escalating. Therefore, this study is initiated to outline the problems in subcontracting practice with the aim to fill this research gap.

1.2 Background of the Study

The percentage of subcontracted projects has increased comparatively. Subcontracting contributes between 50% to 90% and can reach as high as 90% of the total project value in a construction process (Albino & Garavelli,1998; Frein , 2012 ; Polat, 2015). Subsequently, subcontracting concerns are a matter of discussion among the movers and shakers of construction industry. However, subcontracting associated issues are among the focal hazards of construction projects globally. The risks encountered includes safety of on-site workers (Awwad et al., 2016; Liao & Chiang, 2015), delay in completion date (Chiang, 2009), and failure in message delivery between parties during the construction stage (Piasny & Paslawski, 2015; Manu et al., 2013; Tam Pasławski, 2011; Manu et al., 2009).

In Malaysia, construction works are subcontracted to approximately 50,000 subcontracts annually (BuildInfo, 2010). It is presumed that the proportions of subcontractor for civil projects in Malaysia is between 20 to 100% of the works (Othman, 2006), the Malaysian construction industry may be vulnerable if the problem of subcontracting is not addressed specifically.

Studies conducted by Shehu et al. (2014) posit that problems related to subcontracting undertakings are acknowledged as a vital reason contributing to time overrun in the Malaysian construction industry. Meanwhile, subcontracting related issues are identified among the causes for site work coordination (Yong & Mustaffa, 2013; Adnan et al., 2008; Jusoff et al., 2008; Kadir et al., 2005), site safety (Ismail et al., 2009), and material supply chain (Ali et al., 2008).

Subcontractors are included as the participants in the study of critical success factors of the construction industry (Chen et al., 2012). In a study that examined

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the influence of performance factors of the participant, the efficiency of subcontractor was listed as an item that influences the effectiveness of the project by the participants (Xiong et al., 2014). All of these findings were consistent with the rising of problems in subcontracting practice in the construction industry.

A vital issue in the success of fast paced and complex projects are often linked due to the inability of the subcontractor to comprehend the scope of work and logical dependencies between the general contractor and owners. The ignorance towards the problems of subcontracting can lead to huge influence on the construction project, and may affect the normal operations of the general contractor. Hence, it is vital to pay attention to all of the subcontracting related issues.

1.3 Research Objectives

This study is conducted with the aim to examine the current practice of selection and monitoring of subcontractors in the Malaysian construction industry, and to propose a model in assisting the selection and monitoring of subcontractor. The specific research objectives of this study are as follows:

1. To identify the criteria used by general contractors in selecting subcontractors prior job-awarding, and for monitoring of subcontractors during construction period.

2. To examine the relationship between the criteria for selecting subcontractor (CSSC), criteria for monitoring of subcontractors during construction stage (CMSC), and actual project performances (PP).

3. To develop a model that integrates selection of subcontractors prior job-awarding and monitor of subcontractors during construction stage.

1.4 Significance of Study

This study contributes to the areas of subcontracting practice in the construction industry. With the development of the model that integrates two major phases of subcontracting practice, namely selection of subcontractors and monitoring of subcontractors, general contractor is able to manage the subcontractors effectively.

1.4.1 Theoretical Contribution of the Study

The major contribution of this study is the model developed that integrates the criteria used for selection of subcontractor before job-awarding and criteria to

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monitor the performance of subcontractor during the construction stage. A comprehensive literature review on previous studies on subcontractor selection and subcontractor monitoring were conducted.

Consequently, it was discovered that 'communication', 'relationship', 'general obligation' and 'resource management' are the most important criteria used when evaluating subcontractors before deciding on selection. Meanwhile, for monitoring of subcontractors during the construction stage, important criteria includes 'workmanship', 'awareness to environment, health and safety', 'communication and relationship'.

The model developed in this study is deemed as the basic theoretical framework of its kind, due to limited knowledge on the integration of the phases of subcontractor selection and monitoring in previous studies. It links the criteria for selection and monitoring of subcontractors with indicators of project performance. Furthermore, it allows the prediction of consequences in the later stage of construction with the selection of subcontractors with certain criteria. Prediction of the performance of subcontractor during construction stage based on the score on the criteria is made possible before the selection is done. Then, if the performance of subcontractors deviates from the predicted score on the criteria during the construction stage, the earlier prediction of project performance can be recalculated based on the actual score. This is indeed an important discovery for prediction of project performance using available information of subcontractors.

1.4.2 Practical Implication of the Study

The discoveries described in the theoretical implication of the study are extended into practical implication using the model developed. The findings of this study can assist the general contractor to understand the interrelationship of the criteria used in selecting and monitoring subcontractors to improve the efficiency of subcontracting practice. The model relates between the criteria used to select subcontractor before job-awarding, and the criteria used to monitor the subcontractor during the construction stage. The framework developed based on the model can guide the general contractor when selecting subcontractor, and provides information on possible risks posed by the subcontractor selected during construction stage. For example, when a general contractor decides to award the job to the subcontractor with low score in 'communication', there is a warning on high risk of problem in 'awareness to environmental, health and safety' and 'communication and relationships' during the construction stage. The general contractor can therefore decide whether to continue with this subcontractor or vice versa.

With predicted weaknesses or strength of a subcontractor, general contractor can greatly reduce the amount of time and resources allocated for monitoring of subcontractors during construction stage. Hence, the general contractor could focus on other beneficial activities such as quality improvement and improved

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site safety implementation. In addition, the discovery of current subcontracting practice of the Malaysian construction industry can be included into the research database of subcontracting practice in this region. This would definitely be beneficial to future researchers in Malaysia.

1.5 Overview of the Research Methodology

This study employed a questionnaire survey to a targeted population of registered G7 general contractors in Selangor and Kuala Lumpur, Malaysia. A simple random sampling method was adopted to select the general contractors registered under the Construction Industry Development Board Malaysia (CIDB). The questionnaire was distributed personally, by email and mail.

The data was analysed using Statistical Package for the Social Sciences (SPSS) 16.0 and Analysis of Moment Structures (AMOS) 18.0.0. Data analysis was conducted in three stages. In stage one, inferential statistical analysis on background of respondents, reliability and validity of questionnaire scales were assessed using SPSS. Stage two involved factor analysis to develop the measurement model (the measured variables for each criteria). The Structural Equation Modelling (SEM) was employed to model the relationships between the measurement models in stage three. At the end, the web-based subcontractor selection and monitoring system based on the model from SEM was proposed.

1.6 Scope and Limitations

The aim of this study is to assist the general contractor to select and monitor subcontractors effectively. This study focuses on the general contractor who has an essential role in selecting and monitoring subcontractor. Therefore, the ability of client in managing the general contractor is not included in this study. The performance of the general contractor in managing each project is assumed to be consistent and not affecting the performance of subcontractors.

This study presumes that:
1. The respondents answer truthfully based on their experience related to subcontracting practice.
2. Each questionnaire is based on information of a single project. This has been clearly stated in the cover page of the each questionnaire.

The limitations of this study are enumerated as follows:
1. The focus of this study is on general contractor from grade G7 only. General contractors of other grades and subcontractors are not included.
2. Only active G7 contractors from Selangor and Kuala Lumpur are involved.
3. The model developed is based on the view from G7 general contractors for selection and monitoring of domestic subcontractor. Thus, the model developed is only suitable for G7 general contractors and only limited to domestic subcontractor.

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1.7 Organization of Thesis

This thesis consists of five chapters. The summary of each chapter is described as below:

Chapter One presents the overview of the study background, the practice of subcontracting in construction industry, the problem statement, objectives, research framework and hypotheses, significance of the study, overview of methodology, and scopes and limitations of this research. Lastly, organization of thesis is presented.

Chapter Two reviews the literature of this study, i.e. definitions of subcontracting practice, reasons of subcontracting, types of subcontractors, problems of subcontracting, and pertinent studies on subcontracting. The criteria used for selection and monitoring of subcontractors are summarized. At the end of the chapter, application of SEM in construction management is discussed.

Chapter Three presents the methodology of the research and how the research is carried out to achieve the objectives aforementioned. The overview of the research methodology is presented. Sampling design, questionnaire development, pre-testing of the questionnaire, and data collection are explained. The analytical method for collected data is also presented in this chapter.

Chapter Four presents the data of the questionnaire gathered. Data screening, reliability check, and normality check are conducted before the inferential statistical analysis. The results for other statistical analysis for hypotheses testing are presented and discussed in this chapter.

Chapter Five presents the summary and conclusions for the research. The chapter discusses the limitation and possible usage of the framework developed. Suggestions and recommendations for further research in this area are provided.

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