CONTRACTOR PERFORMANCE MEASUREMENT FOR PUBLIC SCHOOL PROJECTS

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To my husband and parents who have given me the peace of mind and blessing to concentrate on my studies and their tremendous moral support throughout my studies.

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ABSTRACT

Project performance is measured by the project duration, cost and quality at the project level. However, any project success depends mainly on the contractor's performance. Indeed, the majority of factors that led to poor project performance are due to the contractor's action. Many studies conducted recently have identified several factors that influence the project success which was due to deficiencies of the contractor's performance. However, none of these studies have focussed on combination of performance during tender stage and construction stage. Hence, this study aims is to investigate and integrate project performance during the tender stage and the construction stage. This research introduces the major criteria and its measurement indicators that influence the selection of contractors for tender evaluation; and the major factors and its measurement indicators that influence the construction performance at the construction stage. In addition, this research also introduces the performance matrix that integrates both stages which provide the estimation of the possible contractor performance at completion. Subsequently, the major criteria and major factors were determined via pilot study and followed by the full scale questionnaire surveys. Similarly, in stage three, pilot study and full scale questionnaire survey were employed to develop the measurement indicators. Interviews with selected experts were conducted to validate the research findings. The method of analysis engaged in this study are factor analysis; relative importance index (RII); descriptive analysis; frequency analysis and correlation analysis. The results from the analysis has successfully determined six major factors for the construction stage as the major factors that influence the project success among the 104 factors which were identified initially through literature review and pilot study. This includes contractor's management problem; labour problem; subcontractor's problem and experience; contractor's financial problem; machineries and material problem; and weather conditions. This finding has subsequently led to the establishment of weights, scale and points for each of the major criteria/factors. In addition, a framework was also established to calculate the total score for each stage and this finding has resulted to the development of the performance matrix. Following that, validation of the measurement indicator was performed by comparing the construction score which was determined from the measurement indicator against the actual completion duration and the result suggests that the accuracy of the measurement indicator is 77%. In conclusion, this study has successfully developed the performance matrix which provides the prediction tools in predicting the contractor performance at completion. The research also addresses the advantages and limitations of the performance matrix as well as recommendations for future research.

ABSTRAK

Prestasi projek dinilaikan berdasarkan tempoh projek, kos dan kualiti pada sesuatu tahap projek dan prestasi kontraktor. Walaubagaimanapun, kejayaan sesuatu projek adalah bergantung terutamanya pada prestasi kontraktor. Malah, kebanyakan faktor yang menyebabkan kelemahan pada prestasi projek adalah disebabkan oleh perilaku kontraktor. Banyak penyelidikan yang dilakukan baru-baru ini telah mengenalpasti beberapa faktor yang mempengaruhi kejayaan sesuatu projek yang mana dianggap sebagai kekurangan dari segi prestasi kontraktor. Namun tiada penyelidikan yang memfokuskan pengabungan prestasi semasa tender dan semasa pembinaan. Penyelidikan ini bertujuan menyelidik dan mengintegrasikan prestasi projek semasa penilaian tender dan semasa pembinaan projek. Penyelidikan ini memperkenalkan kriteria utama dan indikasi pengukurannya yang mempengaruhi pemilihan kontraktor semasa penilaian tender; dan faktor utama beserta indikasi pengukurannya yang mempengaruhi prestasi kontraktor semasa pembinaan. Penyelidikan ini juga memperkenalkan matriks prestasi yang mengintegrasikan kedua-dua tahap bagi mendapatkan kebarangkalian prestasi kontraktor semasa penyiapan projek. Seterusnya, bagi mendapatkan kriteria utama dan faktor utama, soal-selidik awal dijalankan dan diikuti oleh kajian soal-selidik secara menyeluruh. Kaedah yang sama turut dijalankan pada tahap ketiga, iaitu soal-selidik awal dan soal selidik menyeluruh untuk merangka indikasi pengukuran. Temuramah dengan pakar-pakar dari industri dibuat untuk mengesahkan keputusan penyelidikan yang mana menjuruskan kepada pembentukan rangka kerja dan matriks prestasi. Kaedah analisis yang digunakan di dalam penyelidikan ini termasuk analisis faktor; indeks penting relatif; analisis diskriptif; analisis kekerapan; dan analisis kolerasi. Keputusan dari analisa telah mendapati enam faktor utama sebagai faktor yang mempengaruhi kejayaan sesebuah projek daripada 104 faktor yang dikenalpasti pada peringkat awal berdasarkan dari kajian literatur dan soal-selidik awal yang telah dijalankan. Ini termasuk masalah pengurusan kontraktor; masalah buruh; masalah sub-kontraktor dan pengalaman; masalah kewangan kontraktor; masalah mesin dan bahan; dan keadaaan cuaca. Penemuan ini telah membawa kepada pembangunan pemberat, skala dan mata nilai untuk setiap kriteria/faktor utama. Selain itu, rangka kerja juga telah dibangunkan untuk pengiraan jumlah skor bagi setiap tahap dan penemuan ini juga telah membawa kepada pembangunan prestasi matriks. Berikutan itu, pengesahan untuk indikasi pengukuran dijalankan dengan perbandingan antara skor pembinaaan dengan tempoh pembinaan sebenar projek dan keputusan analisa mencadangkan ketepatan indikasi pengukuran mencapai 77%. Kesimpulannya, penyelidikan ini telah berjaya membentuk prestasi matriks yang memberikan gambaran yang jelas tentang pengaruh prestasi kontraktor untuk kejayaan sesuatu projek. Penyelidikan ini juga memberikan kelebihan dan kekangan matriks prestasi dan cadangan untuk penyelidikan di masa depan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Today's construction industry is more complex and dynamic which requires clients and project managers to continuously face performance problems and uncertainties in the construction workplace. To gain a competitive edge in an extremely competitive and continuously changing construction environment, a project manager needs to make timely and informed decisions that will enable them to manage the project effectively. However, the successful completion of the project mainly depends on the contractor's performance. In many references, construction time performance has been identified along with cost and quality as one of three crucial success criteria for a construction project.

It is widely recognised that contractor's performance has significant influence on project time achievement. To ensure the project completes on time, contractor performance must be evaluated as early as the tender evaluation stage. The right contractor selected during tender evaluation has crucial effects on the project success. However, facing poor project performance during construction and project delays, clients of projects have now realised the importance of criteria during tender evaluation and the consequences of selecting a contractor solely based on the tender price. The lack of reliable assessment tools and prompt management action will increase the risk of the project delay. Although there are a numerous number of performance evaluation methods that use a common standard of scheduling and project control techniques available for today's project managers and their team to assist them in managing their projects, but it only concern on performance during the

construction stage and usually neglecting the impact of tender evaluation assessment stage. Thus, this research aims to complement the existing tool by proposing a measurement indicator and the assessment to support the process of predicting contractor's ability in completing the project on time. The measurement indicator is designed to evaluate the contractor performance during the tender evaluation and construction stage. In addition, it also predicts the likely performance of the contractor at the completion stage of a project. The measurement indicator utilise a simple assessment to obtain the score for tender evaluation performance, construction performance, and contractor performance at project completion. The scores were then emplyed to the performance evaluation matrix t in order to provide a quick overview of the project status by indicating the project performance at completion. In addition, the performance evaluation matrix which is suitable for small project such as school project is relatively simple to be used by any users in the project team. The performance evaluation matrix in a construction project is useful to the project manager to be able to predict the contractor performance as early as in the tender evaluation stage in which it is considered as an added advantage to support and complement for the existing performance evaluation methods.

Thus, this research focuses on the issues related to contractor performance that include: major criteria that influence contractor's selection during the tender evaluation; major factors that influence contractor's performance during the construction stage; measurement indicators for tender evaluation and construction stage; developing a performance evaluation matrix to predict the successful completion of a project.

The measurement indicators and performance evaluation matrix, once established, will be useful information to monitor the performance of a contractor in completing a project. It can help in selecting the right contractor and most importantly is able in predicting the contractor's performance of a project before it commences as well as during the construction stage.

1.2 Research Background and Justification of Research

The nature of construction projects and the environment in which they are executed have changed over time. In today's fast changing times, projects are becoming more complex, often larger and more dynamic which introduces numerous challenges to construction project managers and their organisations who are responsible for their project overall success, which includes meeting project goals (time, cost and quality). According to Navarre and Schaan (1990), a project success is measured by the project duration, monetary costs and project performance at the project level. However, Latham (1994) suggested that ensuring a timely delivery of projects is one of the important needs of clients of the construction industry. This is supported by Rwelamila and Hall (1995) who found that a timely completion of a project is frequently seen as a major criterion for project success.

In the construction industry, a contractor's performance has a crucial effect on the success of a project completion. Indeed, the majority of factors that lead to project delays are due to contractor performance. Othman *et al.* (2006) and Alaghbari (2005) found that major factors causing delays in Malaysian construction projects are factors due to contractors. Contractor performance can be defined as poor site management, lack of planning, delay of material, shortage of labour etc. Due to the delay, the client of the project may suffer an increase in project costs, operational cost which includes extra labour demands and disputes between parties. The delay may prolong for months if no immediate corrective action is taken by both parties.

The measurement indicators which are the key component of project success are able to measure the contractor performance and assist the project manager to take control of the project (Albert and Chan, 2004). Therefore, immediate action can be taken when the project is found lagging from its schedule. In current practice, Earned Value Management concept (Flemming and Koppleman, 1999; Kim *et al*., 2003; and Anbari, 2003) is commonly used in monitoring and controlling the contractor performance by variance in cost and schedule of the project performace and the planned S-curves method is used to model the results. The simplicity of the

above-mentioned methods explains why this method is widely used in the construction industry to measure the performance of projects. One of the advantages of this method is that it can identify any cost and schedule variances at the end of the project (Al-Jibouri, 2003). However, there is still a lacking within this method of providing the reliable factors that influence the construction performance. The needs of establishing the reliable factors in predicting the construction performance at completion are necessary for project managers in order to decide the suitable corrective action plans and the effect on the final construction performance (Attala and Hegazy, 2003). Therefore detail studies need to be undertaken to establish the factors contributing to contractors' performance and incorporating them in the planned S-Curves or Earned Value methods in determining the contractors' performance and thus, forecasting the project time completion.

Although there have been numerous studies undertaken by previous researchers such as Belassi and Tukel (1996); Hatush and Skitmore (1997); Walker (1995, 1996); De Wit (1988); Wright (1997); Arditi and Gunaydin (1997); Frimpong *et al.*, (2003); Williams (2003); and Luu *et al.* (2003) addressing the project delay issues in terms of the cost and schedule influences, little evidence is adduced from previous studies on issues related to major factors that affect contractors' performance and thus, will definitely lead to project delays. These major factors are fundamental in determining which factors contribute to the actual work percentage and whether these factors influence project success. Addressing these issues may also assist in establishing the important measurement indicator required by the contractor and the client to monitor and control the project during the construction stage. This research attempts to investigate and analyse the issues relating to the factors that effect the construction completion during the construction stage of a project.

Studies from the literature review such as Holt *et al.* (1994c) indicated that delays have different viewpoints from different project participants. There has been numerous research conducted on the relationships between client and contractor organization on identifying factors contributing to delays. Russel et al (1992) stated that many construction parties and researchers have argued on the commitment of

this relationship. Lim and Mohamed (1999) believed that project success should be viewed from different perspectives of the individual owner, developer, contractor, user, and the general public and so on. Mill (2005) and Holt *et al.* (1994c) stated that among the parties in contract there is a difference in opinion as to which indicator was best able to measure performance and also that there are several performance indicators including; cost, time quality, etc. Therefore, there is a need to study the perspective from client, consultant and contractor on several important issues in order to develop and establish the common factors which contribute to a project success and thus, establish the best measurement indicator to measure contractors' performance on site.

Since time is one of the major goals to project success, thus, it should not only be measured at the construction stage but also at the pre-tendering stage. The tender evaluation is one of the essential stages in achieving project success because the wrong decision in selecting an incapable contractor will lead to problematic contract execution, disputes and jeopardise the project completion. To select the best contractor, requires vast experience and knowledge to ensure that the chosen contractor is able to deliver the project according to client requirements. According to Khosrowshahi (1999); and Fong and Choi (2000) a high priority should be given to contractors' past performance during selection. In current practice, different clients use different sets of criteria during the tender evaluation process, but ultimately the lowest tender prices are still the main basis for contractor selection and competition in many countries (Hatush and Skitmore,1998). As Holt *et al.* (1994c) says that the public sector system of tender evaluation concentrating solely on tender price is one of the major causes of project delivery problems.

Most of the countries such as Australia, Saudi Arabia, Canada, U.S.A, Lithuania, Turkey, Iran and India adopt the procedure of selecting the lowest tender. In the case of Saudi Arabia, although the lowest tender is selected, the price should not be less than 70% of the client's cost estimates. Similarly, Canada, U.S.A and Lithuania also select the lowest tender but a tender bond of 10% of the tender price should be provided by the tenderer. Although these precaution steps were implemented on the lowest tenderer, it would not guarantee that the lowest tenderer

is capable of successfully completing the project. This also shows that although different countries use different procedures in tender evaluation, ultimately the lowest tender prices are still the sole basis for contractor selection and competition.

Thus, there are needs to study the major criteria that influence the tender evaluation process besides solely basing on the tender price. Although there is much research conducted in this area of delays, the number of occurrences in delays shows no reduction and therefore the need to establish the major criteria of delays gives the urge in conducting this research.

Today's measurement of contractor performance requires a method that is able to measure the accurate information from reliable criteria and integrate this information to predict project performance at completion (Abidali and Harris 1995; Tam and Harris 1996; Ng et al 1999; Lam et al 2000; and Wong and Holt 2001). Without such a system, the client as well as project participants will soon be lost during monitoring and controlling the project and unable to achieve the project goal.

In general, there are a numerous number of performance evaluation methods such as S-Curve, Earned Value method etc. that use a common standard of scheduling and project control techniques available for to today's project managers and their team to assist them in managing their projects and achieving success (Flemming and Koppleman, 2002; and Russell *et al.*, 1997). They are designed to perform as effectively as possible to collect and process data to produce information that project managers and their teams can use to manage their projects effectively and make a timely decision. This tool has been proven to be very valuable in assisting the project team with some of their core functions. However, according to Nasr (2005) many researchers and industry experts identified the following as areas that need immediate research and/or modifications to existing project evaluation methods to overcome their current limitations:

i. provide quick overview and review of project status
ii. detailed insight into reliable critical issue related to schedule performance

iii. effective integration of tender evaluation, construction and completion information
iv. quick identification and tractability of performance problem for different stages and analysis of their impact
v. meaningful analysis of performance trends and historical trends
vi. clear presentation of performance analysis and results
vii. simple, easy to use and does not require user with high level of mathematical background.

It is important to note that the above list neither comprehensive nor prioritised. However it identifies related improvements and /or modifications needed. Therefore, it requires improved project measurement tools which could assist the project managers and clients to monitor and control their contractor performance. This project attempts to develop a performance evaluation matrix that will be able to integrate tender evaluation analysis and contractor performance during the construction stage. By integrating the results from the aforementioned stages in the performance evaluation matrix, the project manager may be able to predict the contractor performance at the project completion. The performance evaluation matrix provides a quick overview of the project status by indicating the project performance at completion. In addition, the performance evaluation matrix is relatively simple to be used by any users in the project team. Adopting the performance evaluation matrix in a construction project may be useful to the project manager to be able to predict the contractor performance as early as in the tender evaluation stage in which it is considered as an added advantage for the existing performance evaluation methods.

1.3 Research Aims and Objectives

The aim of this research is to establish the measurement indicators for both tender and construction stages which has led to the development of the performance evaluation matrix. The review and investigations were carried out with the following objectives:

i. to identify and establish the measurement indicators of the major criteria for tender evaluation;
ii. to identify the major factors that influence the construction performance during the construction stage;
iii. to identify and establish the measurement indicators of the major factor for performance at the construction stage;
iv. to develop the performance evaluation matrix of contractors at the completion stage.

1.4 Research Scope and Limitations

The work reported in the thesis involved the identification of major criteria/factors and its respective measurement indicators during the tender evaluation and the construction stage. These were then used to develop a performance evaluation matrix in order to predict the successful completion of the project.

The research involved public school projects that were managed by the PWD in the 8th and 9th Malaysian Plan. During the 8th and 9th Malaysian Plans, there were only additional blocks that were tendered and constructed. Since the project involved public school projects, the design and project scope were similar from one to another in terms of the design, structure, materials used and floor areas. However, this research excludes the smart school projects which was dissimilar in design from the public school project and were also managed by the Ministry of Education.

The respondents for the questionnaire survey involved PWD states and districts throughout Malaysia. Also, the questionnaires were posted to selected contractors who have completed the public school projects. The list of these contractors was obtained from the PWD and consists of various classes of contractor i.e. contractor from Class B to Class D.

Approval for data collection was granted from PWD Headquarter. However, the data were limited for projects which were managed by the PWD Federal Territory. Thus, the data collected for this research was from projects located within the Klang Valley areas.

1.5 Brief Research Methodology

This section briefly presents the research methodology in an attempt to realise the aims of this research. In achieving the aims and objectives, a research methodology is designed and as shown in Figure 1.1. The research consists of four essential stages of conducting this research which includes: literature review; stage 1 data collection, stage 2 data collection; project data collection; analysis of data; and conclusion.

An extensive literature review was conducted to identify/establish the following information:

i. criteria that influence contractor selection during tender evaluation;
ii. factors that influence contractor performance during construction stage;
iii. methods to establish measurement indicators for tender evaluation stage, construction stage and completion stage; and
iv. performance evaluation matrix of contractors at the completion stage.

The data collection for this research consists of two stages. The first stage of data collection for this research was conducted via questionnaire surveys and interviews to identify the major criteria for tender evaluation and major factors for the construction stage. Similarly, for the second stage, the questionnaire survey was conducted to establish the measurement indicators for all three stages (i.e. tender stage, construction stage and completion stage). Finally, the project data was collected from the completed project managed by the Public Work Department (PWD). The administration of the questionnaire and interview is discussed in detail in Chapter 4.

Discussions with the experts were conducted as a follow up to the stage 1 and stage 2 data analysis in order to confirm on the results and the proposed frameworks. The project data collected from the PWD office was used to validate the performance evaluation matrix. The findings and conclusion were derived based on the analysis, and the performance evaluation matrix was also developed to predict the contractor performance at completion.

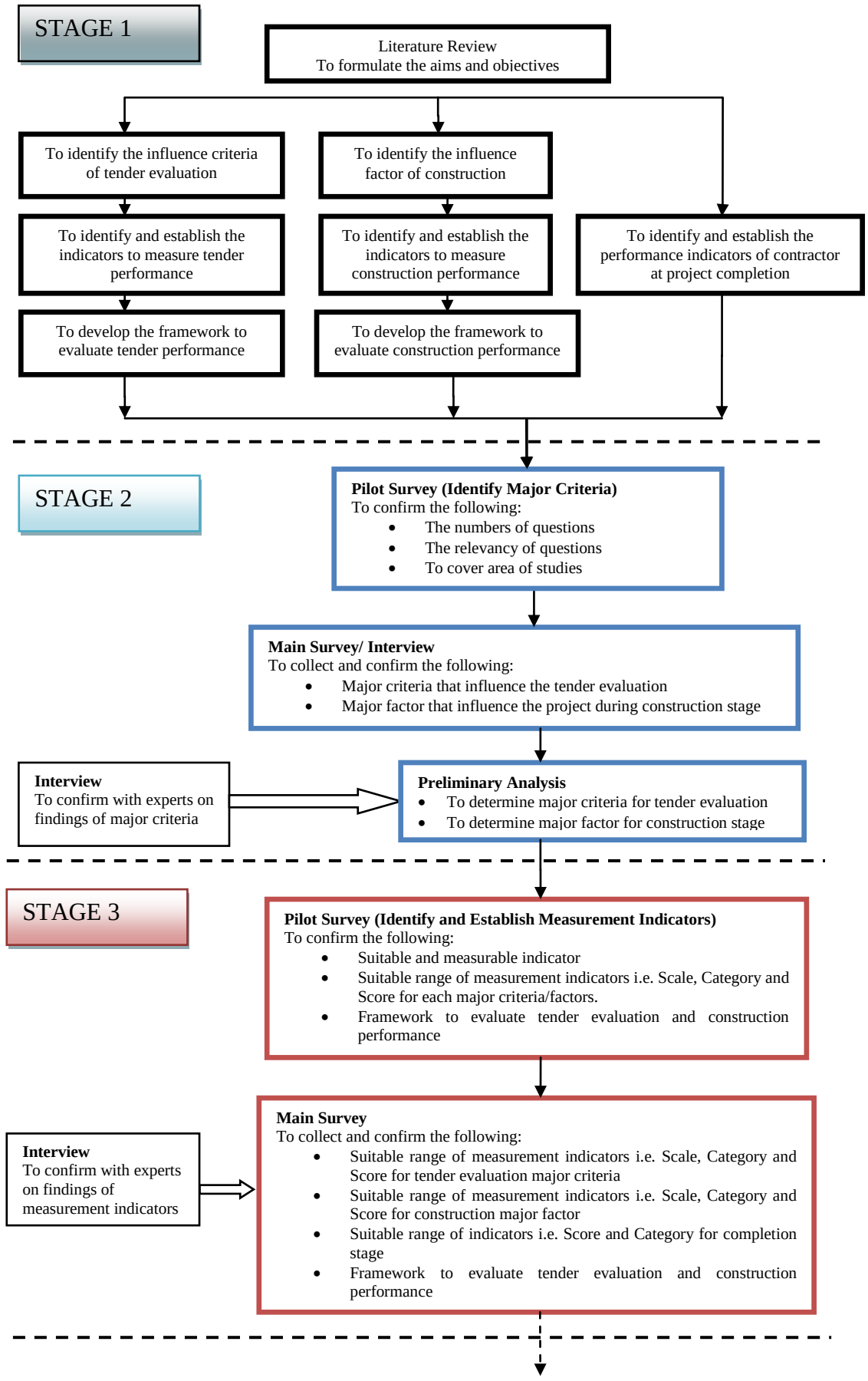

Figure 1.1 : Procedure of data collection

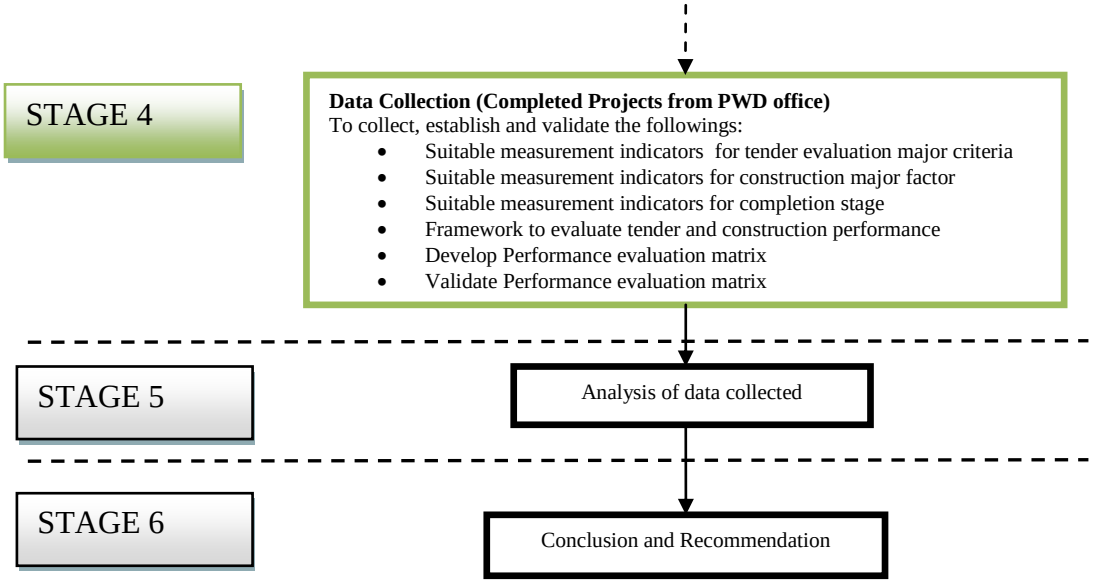

Figure 1.1 : Procedure of data collection (continued)

1.6 Summary of Findings

The investigation of issue related to contractor performance from the analysis discussed in Section 5.0 has achieved the research objectives and the summary of findings is as follows:

The lists of the major criteria that influence tender selection and major factors that influence construction performance were determined. The findings revealed that 6 major criteria during tender evaluation and 6 major factors for construction stage were the most influenced criteria/factors that influenced project success. The 12 major criteria/factors were then used in establishing the measurement indicators.

The measurement indicators were established based on the 12 major criteria/factors and each of the criteria/factor consists of weights, scale, categories and scores.

i. The weights were established using Relative Important Index (RII) and were assigned to each of the criteria/factors. The weights represent the rank-order among the criteria/factor and have assisted in distributing the scores more appropriately and sensibly.

ii. The scales, categories and scores for each major criteria/factor were also determined based on the survey conducted and completed project data. The findings were confirmed by the experts as suitable scales, categories and scores to be used in evaluating the contractor performance for public school projects.

The measurement indicators were developed to integrate the 3 important stages which include the tender evaluation stage, the construction stage and the completion stage. The measurement indicator score calculation was established using Equation 2.1 in order to evaluate the contractor performance at the tender stage and construction stages. The measurement indicator score for all the criteria in the tender stage represents the degree of potential to which the contractor will be selected for the project. The tender measurement indicator is useful for the clients to expedite the tender evaluation process and selecting the suitable and right contractor for the project. Similarly, the measurement indicator score for all the factors for the construction stage represents the probability of the successful completion of the project. Unlike the tender and construction measurement indicators scores, the completion measurement indicator score was established based on the actual completion duration of the project. Therefore, the completion measurement indicator was used to validate the findings.

The main contribution of this research to the body of knowledge is the establishment of the framework to measure the tender evaluation performance and construction performance; and the development of performance evaluation matrix that integrates the 3 important project stages which include: tender stage, construction stage and completion stage. The performance evaluation matrix is useful for the project manager or the client to predict the successful completion of the project.

1.7 Organisation of the Thesis

The thesis is organised into the following chapters:

Chapter 2 provides a comprehensive literature review of the tender evaluation criteria, tender evaluation framework, tender evaluation measurement indicators and the PWD current practice of tender evaluation. It classifies them according to their employed concepts and methods and identifies their capabilities and limitation of each component in addressing effective tender evaluation.

Chapter 3 provides a comprehensive literature review of project success and its influence factors. It describes the major factors influence the project success and its measurement indicators. It also explains on the methods of measuring the indicators.

Chapter 4 describes the methodology involved in identifying the major criteria/factors and its respective measurement indicators. A detailed description on the methodology used to identify major criteria for tender evaluation and major factors for contractor performance during construction stage are provided, followed by a detailed description of the methodology used in establishing its respective measurement indicators. Also described are the methods in developing the frameworks and performance evaluation matrix. The chapter ends by describing various methods employed for data analysis in this study.

Chapter 5 describes the results of the analysis. A detailed description on how the major criteria/factors were identified and their respective measurement indicators were selected for this research. Then, it is followed by a detailed description of the measurement indicators measuring method which involved the three main stages: tender evaluation, construction and completion. A detailed description of the framework to evaluate tender and construction performance is provided. Finally, a detail description on developing the performance evaluation matrix of the contractors at the completion stage is discussed.

Chapter 6 describes the conclusion of this research, highlighting its limitations and contributions as well as suggestions for future work.

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