UNIVERSITI PUTRA MALAYSIA

IMPORTANT CRITERIA FOR INDUSTRIALIZED BUILDING SYSTEMS FROM THE PRESPECTIVES OF MAJOR PROJECT PARTCIPANTS

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

IMPORTANT CRITERIA FOR INDUSTRIALIZED BUILDING SYSTEMS FROM THE PRESPECTIVES OF MAJOR PROJECT PARTCIPANTS

By

LIM JEE GIN

September 2002

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The revolution in the building industry has resulted in many new building systems being introduced. Consequently, the principal project participants are often faced with decision involving the selection of an appropriate building system. Hence, the research presented in the study focuses on the importance of criteria in selecting the most appropriate building system. It also presents a proposed evaluation model that serves as a guideline for professionals in the industry to perform an initial feasibility study on the selection of industrialized building system.

Based on the literature search, the relevant criteria were grouped into six categories: Project Objectives Criteria, Project Characteristics Criteria, Project Constraint Criteria, Technical Oriented Criteria, Performance Oriented Criteria, and Resources Oriented Criteria. The importances of these criteria were identified through a mailed questionnaire, which was employed as the research methodology.

From the importance or priorities of criteria obtained from the questionnaire survey, the relationship of criteria among principal project participants was analyzed. It has found that the criteria among Clients, Architects, and Engineers are strongly correlated, except the criteria of Contractor. In addition, it has also been found that the criteria among principal project participants are independent from methods of construction, methods of contracting and types of project.

The proposed evaluation model is set up based on the Analytical Hierarchy Procedure, which enables to set up complex problems involving attributes, subattributes, sub-subattributes, and so on, in an orderly, structured manner. Beside organizing the tangible and intangible decision criteria in a systematic manner, it also provides a structured yet relatively simple solution to the decision-making problems related to selection of an appropriate building system for implementation.

As a result of the research, there will be documented sources of information for the selection of an appropriate building system. Moreover, the selection of an appropriate building system can be performed in a systematic and effective method.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KRITERIA PENTING UNTUK SISTEM BINAAN BERINDUSTRI DARIPADA PEKSPEKTIF PROFESSIONAL UTAMA PROJEK

Oleh

LIM JEE GIN

September 2002

Pengerusi: Profesor Madya Ir. Dr. Mohd Razali Abdul Kadir

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Revolusi dalam industri pembangunan telah mengakibatkan banyak sistem binaan berindustri diperkenalkan. Akibatnya, pemaju, akitek dan jurutera perunding sentiasa menghadapi masalah untuk memilih suatu sistem binaan berindustri yang paling bersesuaian. Dengan demikian, penyelidikan ini telah dijalankan untuk memberi perhatian kepada kepentingan kriteria dalam pemilihan suatu sistem binaan berindustri yang paling bersesuaian. Selain itu, penyelidikan ini juga mencadangkan suatu model penilaian yang dapat digunakan sebagai panduan oleh profesional dalam industri pembangunan ini untuk melakukan penyelidikan kemungkinan dilaksanakan bagi sistem binaan berindustri berkenaan.

Berdasarkan kajian literatur yang dijalankan, kriteria yang berkenaan telah digolongkan kepada enam kumpulan, iaitu Kriteria Objektif Projek, Kriteria Sifat Projek, Kriteria Rintangan Projek, Kriteria Teknikal, Kriteria Prestasi, and Kriteria Sumber Projek. Kepentingan kriteria berkenaan ditentukan melalui sistem soal selidik pengiriman.

Berdasarkan kepentingan kriteria pemilihan berkenaan, hubungan kriteria pemilihan di antara profesional utama projek telah dianalisis. Adalah didapati bahawa kriteria pemilihan di antara Pemaju, Akitek dan Jurutera Perunding mempunyai hubungan yang linear kecuali kriteria pemilihan bagi Kontraktor. Selain itu, didapati juga kriteria di antara semua profesional utama projek adalah bebas daripada kaedah binaan, sistem kontrak dan jenis projek.

Model penilaian yang dicadangkan adalah berdasarkan Prosedur Hierarki Beranalisis, di mana kaedah ini mempunyai sifat keistimewaannya untuk mengatur masalah kompleks yang melibatkan atribut, subatribut, sub-subatribut, dan sebagainya dalam suatu struktur yang sistematik. Di samping pengaturan kriteria pemilihan secara sistematik, kaedah ini dapat memberi suatu penyelesaian yang mudah dalam pemilihan suatu sistem binaan berindustri yang paling bersesuaian.

Dengan siapnya penyelidikan ini, penyelidikan ini dapat memberi sumbangan ke arah sumber maklumat yang berguna dalam pemilihan sistem binaan berindustri. Tambahan pula, pemilihan sistem binaan berindustri yang paling bersesuaian dapat dilakukan dengan kaedah yang bersistematik dan berkesan.

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Last but not least, I would like to dedicate this work to my family members for their encouragement and never ending support throughout my research.

I certify that an Examination Committee met on 24th September 2002 to conduct the final examination of Lim Jee Gin on his Master of Science thesis entitled "Important Criteria for Industrialized Building Systems from the Perspectives of Major Project Participants" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

LIM JEE GIN

Date: 6/11/2002

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CHAPTER I

INTRODUCTION

Background

The revolution in the building technology causes many new improvements and methods being introduced to the construction industry over the past decade, which results in various types of industrialised building systems. This is due to rapid increase in world population, economics demands, facilities and others, especially in developed countries. Inefficiency of a building system can contribute to idle time, waste of money and low quality of products. Therefore, the success in the implementation of a project through adopting industrialised building system has led to an urgent search for a systematic and effective method in selecting an appropriate building system.

In the initial stages of project designs, construction owners and engineers are often faced with decision involving the pursuit of one of two options in project realisation: industrialised or conventional design and method of construction. However, the research presented in the study focuses on the decision support in selecting the most appropriate building system regardless of the conventional design or conventional method of construction.

Selection of an appropriate building system is an extremely complicated task where the number of decision attributes to be considered is large and complex. This is due to each building system has it advantages and disadvantages. Lack of information, time limitations, and the large number of system alternatives generally force the decision maker to rely on past experience and impractical judgement to make rapid alternative selection. If this natural, physical process of growth remains not guided by administrative means, it is likely that haphazard, uneconomical and unhealthy development will occur.

Prior to selection of an appropriate building system, the decision attributes in selecting an appropriate building system is to be identified. Subsequently, a decision making model is proposed that serves as a guideline for professionals in the industry to perform an initial feasibility study on the use of industrialized building system.

Problem Statements

Of all industrialised building system implemented in Malaysia, each has its own characteristics, features, advantages and disadvantages. Din (1984) stated that

> … while adopting modern innovations and techniques … not all industrialised building systems that is imported from foreign countries are suitable for practice in our country. Most of the developing countries have encountered big and costly mistakes on adopting modern industrialised building systems. Most systems chosen were found not compatible with the economy and cultural of the people in some countries.

Din (1984) also stated that

> … industrialised building systems had not achieved results as what was claimed to be ... There was not enough consideration given for the development of a true building industry … without detailed and minute planning and effective management, industrialised building techniques will certainly not lead to the desired result.

Thus, careful preparation and detailed planning are essential in order to obtain full advantages offered by industrialised building systems.

The significant element in adopting industrialised building systems depends very much on the proper management and co-ordination among the three principal project participants, i.e., clients, consultants and contractors, which our industry is still lack of (Lai, 1997). This is due to the physical implementation of a building involves many inter-related activities in the total delivery system before turning into the production of building which also involve various project participants.

Therefore, new building systems or components need to be evaluated before applying them (Murthy, 1984). However, many potential users (e.g. owners, contractors, etc) of innovative technologies currently have no formal system to evaluate innovative construction technologies for potential implementation into the construction programme (Lutz et al., 1990).

None of the building systems is universally applicable to all building situations. However, it has been suggested that there are a number of appropriate industrialised building systems, which are useful for a wide range of specific uses and situations.

To resolve the problem, a systematic evaluation system is required in order to select the most appropriate industrialised building systems. Prior to the development of a systematic evaluation system, decision criteria of building trade professionals – one of the most fundamental prerequisites has to be identified.

Apart from decision criteria, attention should also be given to choosing an appropriate contracting method for a proposed project because the success or failure of a project is very much dependent on the contracting method selected. It is believed there is a false impression that using industrialised building system is always quicker and simpler than traditional construction method. The type of contracting method selected does play an important role for a project adopting industrialised building system to be undertaken successfully.

According to Gordon (1994), certain contracting methods can shorten the project duration, provide flexibility for changes, reduce adversarial relationships, allow for contractors participation in design, provide cost saving incentives to the contractor, and provide alternative financing methods. Some methods are much more appropriate for some projects than others, an owner must first understand the various components of the contracting methods, the characteristics of the proposed project, and their own abilities in order to select an appropriate contracting method.

With respect to the aforementioned problem statements, this study compiles the knowledge for decision support that enables the decision-maker to perform a feasibility study on the selection of industrialised building system. The motivation of this effort has been twofold:

1. Due to the lack of documented sources of information about industrialisation decision support, there is a need to compile knowledge obtained from practitioners in the field into a structured resource.
2. Due to the absence of a conceptual decision making framework to select an appropriate building system on a proposed project, there is a need to produce one.

Therefore, this study is carried out as a descriptive research to answer the following three research questions:

1. What are the decision criteria of principal project participants in selecting an appropriate building system?
2. To what extent are there similarities and differences in decision criteria between principal project participants?
3. To what extent are there similarities and differences in decision criteria in accordance to different types of contracting method, building system, and types of project?
4. How to select an appropriate building system?

Objectives

With respect to the aforementioned research questions, the objectives of this study are as follows:

1. to identify decision criteria that help in the selection of an appropriate building system;
2. to determine the relationship of decision criteria among principal project participants in selecting an appropriate building system in accordance with different types of contracting method, building systems, and types of project.; and
3. to propose an evaluation model in selecting an appropriate building system.

Justification

Industrialisation of building system is an inter-disciplinary field of activity and does not entirely rely on the technological aspects of the process. The success of that industrialised building system depends largely on the balanced combination between the "software" and "hardware" elements of industrialised building system (Syed Junid, 1986).

It can be noticed that it is not solely dependent on the "hardware" elements of building system. "Software" elements of building system do play a very important role. Software elements of building systems research utilises accumulated technical knowledge and best technical foresight, to improve building performance; to make

buildings more economical to own; to build them safely and safer for living; to build and use them with lesser resources waste and lesser environment pollution; and to improve the quality of private and public lives (Dulaimi, 1995). Hence, this study is essential towards the contribution of "software" elements of the building system's research.

The decision criteria of each principal project participant are the most fundamental prerequisites prior to the development of an evaluation system. As Lutz et al. (1990) stated, a technology evaluation system would place the project participants in a proactive mode rather than a reactive mode with regard to implementation of innovative construction technologies.

Therefore, this study identifies and investigates the decision criteria of principal project participants in selecting an appropriate building system. Additionally, this study also investigates the relationship between decision criteria and principal project participants in accordance with different types of contract. This is due to the belief that types of contract would have an influence on the criteria of each principal project participant.

The findings of this study should contribute to a better understanding of the relationship among decision criteria and principal project participants according to different types of contract, methods of construction and types of project. This would enable a decision-making framework to be proposed based on the decision criteria identified as to arrive at logical conclusions for application or extension of the relevant system.

Thesis Overview

This study consists of seven chapters. A schematic diagram of the thesis layout is presented in Figure 1.1 with the summary of each chapter is described below:

Chapter one initially introduces the background of the study. Then, it outlines the statement of the problems and research questions. Subsequently, the objectives of the study followed by justification of the study are specified. Finally, the overview of thesis is also presented.

Chapter two begins with some background information on this study, which involves the definition of some predominant terms covered in the study. Then, it focuses on the adoption of decision criteria of principal project participants. Subsequently, the classification of industrialised building systems is presented. In addition, relevant contracting methods are being reviewed. The chapter ends with the review of possible decision making process, evaluation methods and model building.

Chapter three presents a detailed discussion of the research methodology employed. Questionnaire development, pre-testing of the questionnaire, the sampling procedure, and data collection are presented. The chapter also presents the analytical methodology – data analysis.

Chapter four presents the outcome of analyses, result and discussion based on the respond of questionnaire survey. The chapter is divided into two parts. Part one presents a descriptive statistics, which includes the discussion of the profile of respondents, followed by a description of the priority of principal project participants' criteria and the correlation of decision criteria among principal project participants.

Part two of chapter four focuses on the inferential statistics. The findings pertaining to the similarities or differences of criteria of each principal project participant is presented. The chapter also examines how contracting methods, construction methods, and project types influence the criteria of each principal project participant.

Chapter five proposes an evaluation model for the selection of an appropriate building system.

Finally, chapter six presents a summary of the findings and conclusions drawn from the research. The chapter then outlines the recommendations for future research.

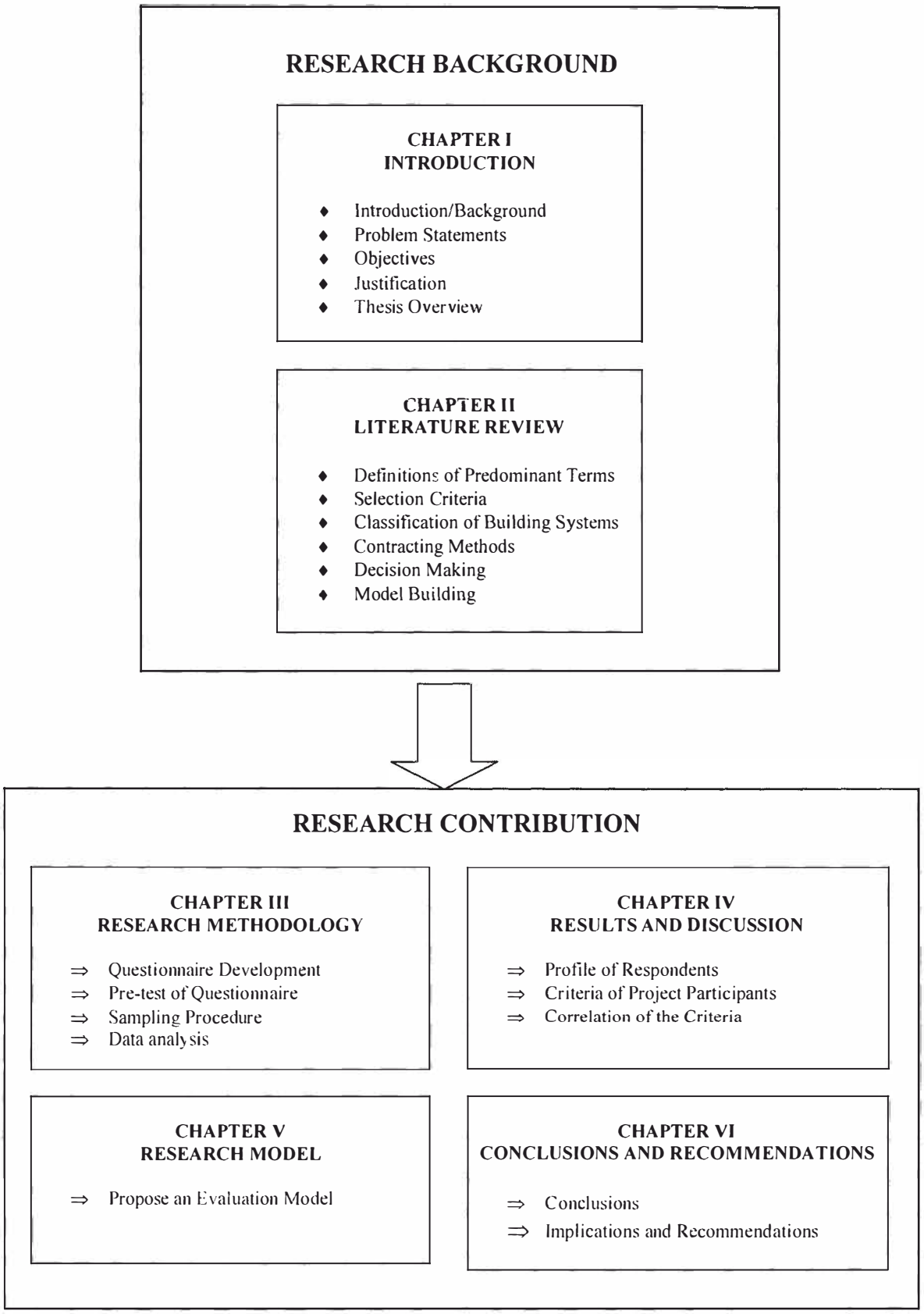

Figure 1.1: Thesis Layout