

INTEGRATING CONSTRUCTABILITY INTO THE DESIGN PROCESS

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To my beloved mother and father

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ABSTRACT

Constructability is an important element in building project's design phase, where designers' personnel play a prominent role to enhance it. Several researchers found that failure of design professional to consider constructability during the design phase can result design reworks, contract changes, delay, increase of cost, and even legal entanglement and claims. The focus of this study is establishment and integration of constructability principles into the current building's design process. Therefore, the objectives of this study are to determine the local construction industry's current design process, in order to propose an integration of design constructability review process to that existing design process model, and develop a building design constructability checklist. There are three distinct phases of this study: phase 1 involves literature review and preliminary interview; phase 2 consists of structured interviewing with design professional experts and design process models development; phase 3 comprises of constructability principles integration and the checklist development. The data flow diagram (DFD) is adopted in this study to model those design process flow. Finally, the outcomes of this study are establishment of general building design process model, constructability integrated building design process model and constructability checklist. This checklist acts as a tool, where it is integrated with constructability principles, used for constructability enhancement of the design. However, due to the limitation of time, only a foundation design constructability checklist is developed.

ABSTRAK

Kebolehbinaan merupakan salah satu elemen yang penting pada peringkat rekabentuk suatu projek bangunan, di mana para pereka memainkan peranan yang penting untuk meningkatkan kebolehbinaan rekabentuk itu. Beberapa ahli penyelidikan mendapati bahawa kegagalan pereka mempertimbangkan kebolehbinaan pada fasa rekabentuk suatu projek boleh menyebabkan perulangan kerja, perubahan kontrak, penundaan, pengingkatan kos, kekusutan undang-undang dan penuntutan ganti rugi. Fokus kajian ini ialah menubuhkan dan mengintegrasikan prinsip-prinsip kebolehbinaan ke dalam proses rekabentuk bangunan. Maka, objektif kajian ini adalah mengenalpastikan proses rekabentuk bangunan tempatan yang semasa ini, supaya ia dapat dicadangkan untuk diintegrasikan dengan proses penilaian kebolehbinaan rekabentuk dan membangunkan satu senarai semakan kebolehbinaan rekabentuk. Kajian ini dilaksanakan dengan melalui tiga fasa yang utama, iaitu: fasa 1 melibatkan kajian literatur dan temuramah awalan; fasa 2 merangkumi temuramah berstruktur dengan pakar profesional dan pembangunan model proses rekabentuk; fasa 3 terdiri daripada integrasi prinsip-prinsip kebolehbinaan dan pembangunan senarai semakan kebolehbinaan rekabentuk. *Data flow diagram* (DFD) dipakai dalam kajian ini untuk memodelkan aliran-aliran proses rekabentuk itu. Akhirnya, hasil keputusan bagi kajian ini ialah pembangunan satu model am bagi proses rekabentuk bangunan, model proses rekabentuk bangunan yang telah diintegrasikan dan senarai semakan kebolehbinaan rekabentuk. Senarai semakan ini bertindak sebagai satu alat untuk mempertingkatkan kebolehbinaan suatu rekabentuk. Oleh sebab kesuntukan masa, hanya satu senarai semakan kebolehbinaan rekabentuk dibangunkan dalam kajian ini.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the late of 1970s, the constructability concept emerged and evolved from studies into how improvement can be achieved to increase cost efficiency and quality in the construction industry. Nowadays, constructability concept has been extensively being developed and applied in the USA, UK and later in Australia, where their studies have demonstrated that improved constructability has lead to significant savings in both cost and time required for completing construction projects (Russel *et al.*, 1992a; Jergeas and Van der Put, 2001).

However, according to Nima *et al.* (2001), in Malaysia there are neither reliable documentation nor available sources that detail those constructability concepts and guide their application. Therefore, for those who has site experience certainly has heard the words “how is this going to fit” or “how am I suppose to build this thing”. Such of these on site frustration can often be traced back to design decisions that lacked of knowledge regarding on how the object would be built. It seems that the design process should include constructability input and critiques. However, there still a little or surprisingly no explicit constructability input is provided to the design phase that always leads to frustration mentioned above, slower and more costly construction period and changes. Hence, Malaysian engineers have a disadvantage by not knowing what, when and how they shall enhance the project

constructability in design stage, when compared with the engineers in more developed countries.

1.2 Problem Statement

In the construction process of a traditional contracting system, it is the A/E's responsibility to develop a design that able to produce a project that, when it is implemented by the contractor, meets the client's needs and expectation. However, by the A/E's very nature, A/Es are not exactly expert in construction means and methods. According to Glavinich (1995), most design drawings and specifications that produced by the design engineers are tend to be performance oriented, specifying an end result and materials, while leaves the means and methods for constructing the work to the contractor. As a result, the reality of construction is that most of the problems encountered in the field are often compounded by inherent design flaws that generated in the design phase. Therefore, it is important to emphasis constructability during the early stage of a design. Besides, many studies (Paulson, 1976; Glavinich, 1995; Mendelsohn, 1997; Nima *et al.*, 1999; Nima *et al.*, 2004) found that integrating constructability knowledge into design processes is the best time to influence project costs, decrease the likelihood of delays, contract change orders due to unforeseen site conditions and legal entanglement and claims.

In Malaysia, a study about the implementation of constructability in the Malaysian construction industry has been carried out by Nima *et al.* (2001). In this study, it was found that there is an acceptance of the majority constructability concepts by the Malaysian engineers from the theoretical point of view. However, they generally did not apply these concepts in their practices, especially during the design phase. One of the reasons is due to current design practice which does not incorporate constructability as part of the design process. Therefore, it is needed to predetermine the current local design process of a building design, before proposing any further design process improvement that integrates constructability concepts.

Constructability concept can be implemented in design on several ways. Several researchers have developed develop tools that can be use and to enhance the constructability of project designs (Anderson *et al.*, 2000; Arditi *et al.*, 2002; Navon *et al.*, 2000; Soibelman *et al.*, 2003; Pulaski and Horman, 2005). However, the level of formality of those methods is varied. It is because some of them are very formal as they incorporated the constructability concepts, such as specifying constructability objectives, forming a constructability team and identifying means to obtain constructability input. While, several methods incorporate constructability only through standard design procedures. Nonetheless, constructability improvement tool in the form of checklist is considered to be comprehensive in term of the concepts covered (Rosli, 2004). Suitable constructability checklist for the local construction industry is currently unavailable, therefore, as initially, it is essential to develop a constructability checklist that able to check a design work.

1.3 The Objectives

The following are the objectives of this study:

- a) To determine the local construction industry's current building design process.
- b) To propose a model that integrates constructability to the general building design process.
- c) To develop a building design constructability checklist.

1.4 Scope of Study

In this study, three case studies of building projects that are carried under the local traditional contracting system, where its design stage is significantly separated from the construction stage, will be the type of project investigated.

Although the constructability concepts can be implemented through the entire project life cycle: i.e. from conceptual planning until construction, however, the study will only focus on the constructability improvement at the design phase.

In order to develop the building design constructability checklist, the design phase's constructability principles identified by Rosli (2004) will be used. Therefore, those principles will not be formulated by the writer in this study. Besides, due to limitation of time, only a sample of building design constructability checklist for foundation assessment I developed for reviewing and checking the design work.

1.5 Research Methodology

Research methodology is a framework for the researcher on how a study is carried out, such as process of collecting, analyzing, interpreting observations. Therefore, Figure 1.1 outlined the research methodology of this study. It is divided into three phases: Phase 1 encompasses literature review and preliminary interview with experts in local construction industry; Phase 2 involves the case studies of current designs process and its constructability issue. After that, a current design process model is developed based on the case studies and lastly, Phase 3 consists of design process improvement by integrating constructability concepts and development of a design review checklist based on a selected work.

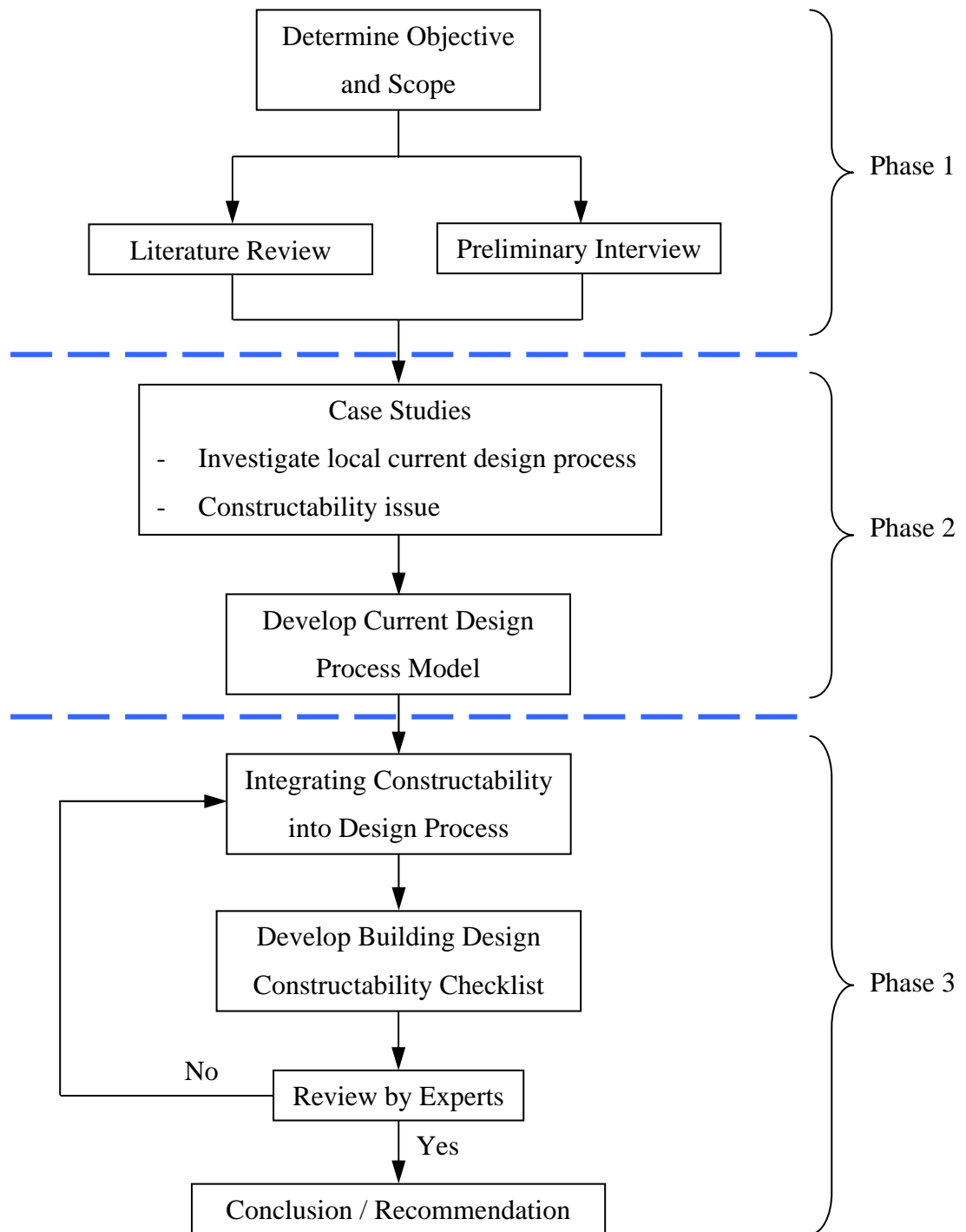


Figure 1.1 : Schematic of research methodology

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