

**THE DEVELOPMENT OF AUTOMATED SYSTEM FOR EVALUATING
DESIGN CHANGES FEE USING BIM SUPPORT**

EHSAN SHOURANGIZ

Universiti Teknologi Malaysia

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EHSAN SHOURANGIZ

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requirements for the award of the degree of
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***TO MY BELOVED MOTHER FOR HER
ENDLESS LOVE AND SUPPORT***

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ABSTRACT

Traditional methods of evaluating design changes fee in construction projects often lead to dispute. Sometimes it leads to unacceptable claim because it is not easy for consultant engineers to justify the amount of changes they have performed. This study has been done with the aim to propose the new approach of evaluating the additional work done due to design changes by using BIM (Building information models) system. The methodologies used for this study are literature reviews and interviews with the construction professionals. In addition, a building model is simulated in “Autodesk Revit Structure” software to illustrate the process of automated system for evaluating design changes fee. The findings showed that the most current method practice in Malaysia is based on the Percentage of Construction Cost, Salary Cost Times Multiplier and Man-Hour. This study has developed an alternative method using BIM for assessing the additional design changes fee based on the construction cost which derived from BIM’s quantity take-offs automated system. The result of the benefit of the newly proposed system has been validated through interviews with expert panels. It is hope that this method will be more acceptable by Malaysian construction industry players in the future considering the benefit of this approach as establish in this study.

ABSTRAK

Kaedah tradisional dalam menilai kos perundingan tambahan akibat dari perubahan rekabentuk sering mendorong kepada perbalahan dan rasa tidak puas hati bagi mereka yang terlibat. Kadang-kadang ia tidak dapat diterima oleh perunding untuk nilai kerja yang telah mereka lakukan. Oleh itu kajian ini telah dijalankan dengan tujuan untuk memperkenalkan kaedah untuk menilai kos tambahan perubahan rekabentuk dengan menggunakan sistem berasaskan perisian *Building Information Models (BIM)*. Kaedah yang digunakan dalam kajian ini adalah dengan membuat kajian literatur dan temubual dengan professional dalam industri pembinaan. Sebagai tambahan satu model bangunan telah dibangunkan dan disimulasikan dengan menggunakan perisian *Autodesk Revit Structure* untuk menunjukkan bagaimana sistem pengiraan secara automatik boleh dibuat bagi menilai yuran tambahan akibat daripada perubahan rekabentuk asal bangunan. Hasil kajian telah menunjukkan bahawa di Malaysia kaedah yang digunakan untuk menilai tambahan yuran adalah dengan menggunakan kaedah peratausan dari kos projek, gaji yang didarabkan dengan multiplier dan penggunaan sistem jumlah jam kerja. Kajian ini telah mengemukakan prosidur penggunaan BIM sebagai asas pengiraan yuran tambahan. Dalam sistem ini pengiraan kuantiti kerja dibuat secara automatik oleh perisian yang digunakan. Kaedah ini telah validasi oleh panel pakar. Adalah diharap kaedah ini dapat diterima pakai di Malaysia.

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LIST OF ABBREVIATIONS

ACEM-	Association of Consulting Engineers Malaysia
BEM-	Board of Engineers Malaysia
BIM-	Building Information Modeling
POF-	Percentage of Original Fee

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In many construction projects frequent changes often result in time delays, cost overruns, quality defects and other negative impacts. Many researchers investigated the resources and effects of project change and more significantly the causes behind the changes from different perspectives. Design changes are classified as the changes resulting from a modification within or outside the original scope of work and require re-design and revision to the contract documents.

Changes are mostly caused by clients, in favour of getting new ideas, cost reduction on projects or have no adequate ability to visualize the drawing in design stages until they observe them in reality. Beside that Building Information Modelling (BIM) which is recently introduced to construction industry can be used to manage many issues related to design changes. It stores all information as an integrated parametric database and can be used for all aspects of life-cycle of project from design stage to operation and maintenance stage.

1.2 Problem Statement

When Design changes occur, it can lead to disputes among the construction project participants. These disputes can become time consuming and costly which may require litigation to resolve. Previous research on design changes reveals that “design changes increased construction cost by an average of 12.4 percent of the total cost of the projects in the United Kingdom” (Burati *et al*, 1992).

In Australia, (Bromilow, 1970) investigated 25 completed construction projects to find out the sources of design changes. It was concluded that the two largest sources by value were the clients (41 percent) and the design team (25 percent). (Amur, 2006) conducted a research in Oman construction industry and found that changes on the scope of the works which initiated by clients are the most common source of design changes. This is because; many clients have no sufficient ability to visualize the proposed works from detailed drawings until they see them in reality.

Moreover, lack of systematic or affective method to assess the additional design changes fee implemented by designers is the most common of disputation. This study reveals the limitations regarding current methods for evaluating additional design changes fee and how BIM could facilitate the process of evaluating design changes fee.

1.3 Aim and Objectives of the Study

Although many research conducted in design changes field but there is no practical and acceptable method yet to assess the fee of modifying the original design. The primary aim of this study work is to propose an automated system of evaluating additional fee for structural design changes using BIM platform. The result of this study will put forward practical way of preventing and resolving the disputes caused by the lack of proper method of assessing the fee of design changes through BIM support. The objectives of this study are as follows:

- i. To study the current methods of evaluating additional design changes fee and their limitations.
- ii. To develop an automated system of evaluating additional design change fee using BIM platform.
- iii. To evaluate the benefit of newly developed approach using BIM for construction industry.

1.5 Significance of the Study

Although many researches has been conducted regarding design changes but the need for investigating the behaviour and reaction of BIM in compliance with applying changes order is essential. In construction industry changes usually lead to dispute due to a lack of proper method or tools for evaluating additional design changes fee. However, using BIM as a new technology has been recently considered

among construction experts. This study is illustrated that introduction of BIM-based project as an automated system would facilitate structural engineers to apply changes order and justify the amount of changes more simply, clearly and rapidly.

1.6 Scope and Limitations of the Study

In this study, the scopes were carried out in Malaysia and only considered to Structural design changes for buildings. The building model for this study is a two-story school building with reinforced concrete structure and sloped roof. In addition, for simplicity only some of the structural elements such as; pile, column, beam, floor, roof and reinforcement was simulated, But there is no limitations regarding this newly developed method. In return, it is applicable to all other parts of structural, architectural or MEP elements.

1.7 Brief Methodology

The adopted methodology in order to identify the current methods of evaluating design changes fee in Malaysian construction industry was combination of literature reviews and interviews with construction professionals. In addition, a building model is simulated in “Autodesk Revit Structure” software to illustrate the process of automated system for evaluating design changes fee. The result of the benefit of the newly proposed system has been verified through interviews with expert panels. Figure 1.1 shows the flow chart adopted for the methodology used.

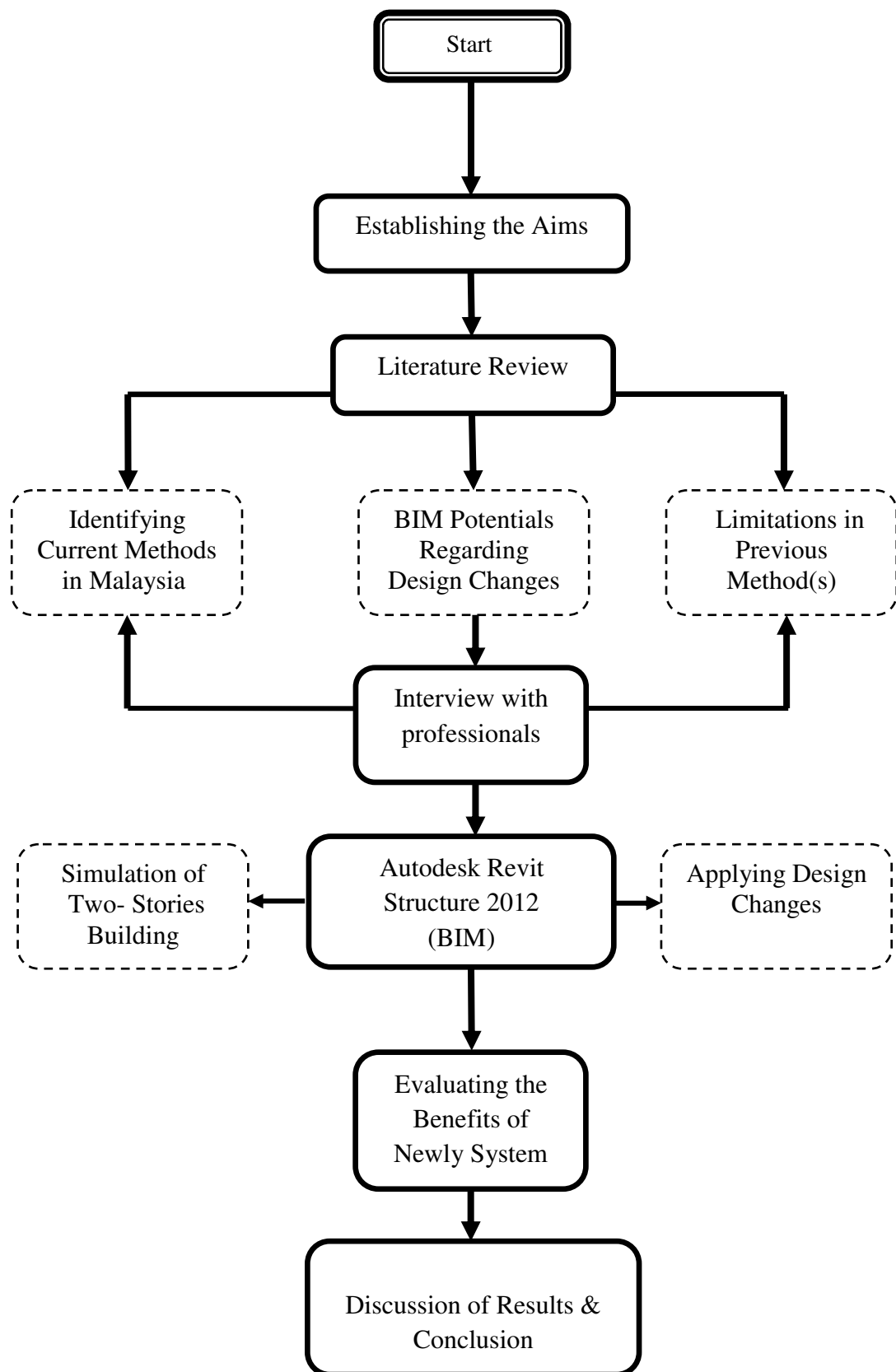


Figure1.1: Research Methodology Flow Chart

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