CHAPTER 4

RESEARCH DESIGN AND METHODS

4.1 Introduction

This chapter describes the research approach and methods that are used to accomplish the research objectives. The chapter begins with an overview of the research design process. The quantitative and qualitative data collection and statistical analysis techniques are also discussed later in this chapter.

4.2 Research Design

A research design is a comprehensive and structured programme that guides the researcher to achieve research aim and objectives [66]. The aim of this study is to investigate the applications of Earned Value Management (EVM) method for the Malaysian construction industry which involve study on different aspects pertaining to the construction industry. Therefore, the design of the proposed study is based on a mixed methodology that incorporates both quantitative and qualitative methods. Mixed methods allow researcher to combine one or more research methods, e.g. survey and case studies, in a single study in order to provide greater flexibility to investigate the research intentions [67]. The proposed study is designed into three phases. The first part is based on a quantitative survey that aims to obtain a perception and understanding of EVM method among Malaysian construction industry. The mail survey provides a number of advantages, such as, low cost, easy access and minimum resource requirement. It also allows sufficient time for the

respondent to compose thoughtful answers and provide anonymity to the respondent and make them feel more comfortable about divulging important information [68]. The second part will employ qualitative data collection and analysis of EVM applications through case studies. These case studies provide in-depth examples of how and why organizations can implement EVM system in their current monitoring practices. During this phase, collection of data from multiple sources of information i.e. interviews, document analysis, reports, etc. investigate the advantages that can be achieved by the implementation of EVM method in the different project scenarios. Four case studies (i.e. infrastructure, housing, revamping/upgradation and building projects) were selected that helps to generate more general EVM results. The final part of this research includes a discussion from the senior officials of participating organizations. The interviews were carried out mainly in a semi-structured format in which data is first collected on the background of each company and the role of senior management in project implementation. The participants were asked to provide their views and opinions about the existing time and cost monitoring practices in Malaysia, its limitations with respect to EVM method and the possible advantages of EVM that were replicated through the analysis of case studies. Figure 4.1 shows the research design process flow chart.

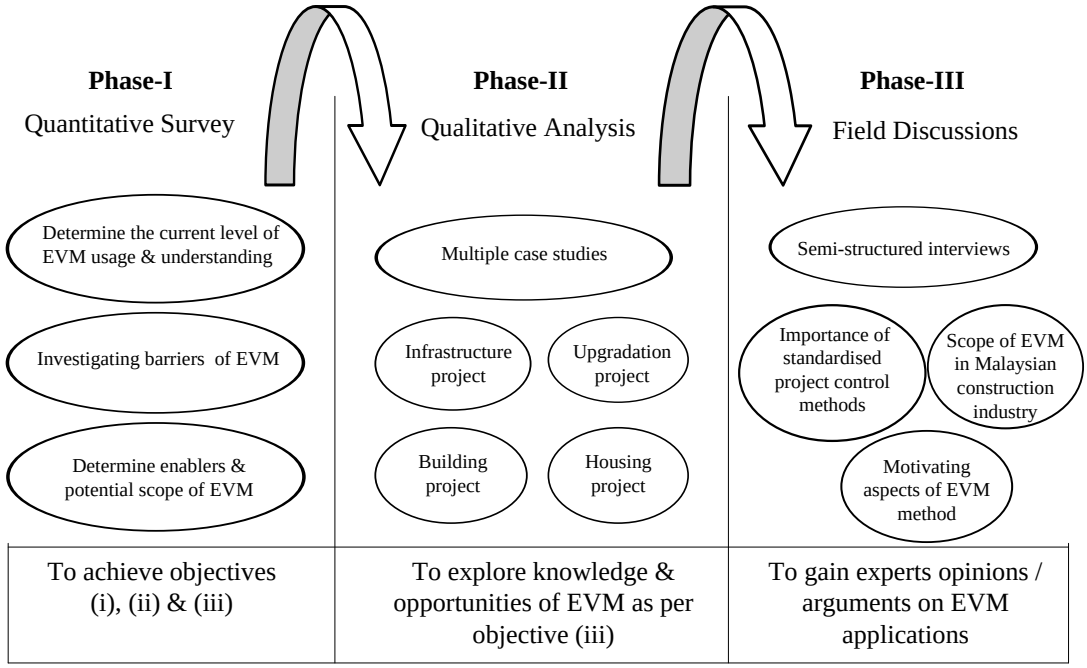

Figure 4.1: Research Design Process Flow.

4.3 Research Methods

This section describes the details of research methods which are used in carrying out the study. These methods are as follows;

4.3.1 Questionnaire Survey

The primary data required for this study was collected through questionnaire survey. For the purpose of achieving the desired research objectives, a structured or close-ended questionnaire was designed to gain the views from the industry practioners. The information that elicited from the questionnaire is primarily a form of descriptive survey. Its main concern was to explore the existing usage of EVM method in Malaysian construction industry, its enablers and barriers, and the perception about its implementation among the practitioners.

4.3.1.1 Structure

A four-page structured questionnaire was developed to meet the initial research objectives. The format consists of two sections i.e. Section A comprises of general information about the responder and his associated organization whereas Section B focuses on understanding and usage of EVM method. The sample of the questionnaire is attached in Appendix A.

4.3.1.2 Rating Scale

A five-point Likert scale is used for rating the respondent's feedbacks. For example:

Table 4.1: Likert Scale

Attributes	**Very Difficult**	**Quite Difficult**	**Neutral**	**Quite Easy**	**Very Easy**
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Ratings	1	2	3	4	5

4.3.1.3 Pilot Test

A pilot test was conducted prior to carrying out the final questionnaire survey. Its main purpose is to refine the contents and reduce the ambiguity that overall effect the validity of data. The pilot tests were conducted on three senior faculty member of the Civil Engineering Department, two post graduate students and three Engineering Procurement Construction (EPC) contractors. The recommendations solicited from the pilot test are summarized below;

- It is appropriate to send the survey form to a broader category of respondents which may include Executive/Senior Management, Contract Manager, Quantity Surveyor, Procurement Manager, financial Manager, Estimator, Scheduler/Controller and Earned Value Specialist rather than only Project Managers. This is due to the fact that not all the targeted organizations possessed the post of Project Manager or in most of the cases some of them were not available and reachable.

- Numbering sequence of the survey questions needs to be reordered for logical sequencing.

- For closed-ended with ordered response questions, affix Likert scale rating with every choice.

- In the questionnaire form, modified open-ended choices with the closed-ended in order to make the coding easier for data processing.

4.3.1.4 Sampling

The respondents were identified through purposive sampling technique. A purposeful sample is a group of individuals or organizations that can best inform the researcher about the phenomenon under study [67]. It is therefore considered that usually in large organizations better and innovative tools for schedule and cost management exist and also they have well established project management approach. Due to this reason, a group of large construction companies of Grade G7 (as classified by CIDB Malaysia) based in Kuala Lumpur city were selected due to their direct involvement

in infrastructure development and key construction projects in Malaysia. According to CIDB data of 2007 – 2008, a total number of 819 building contractor were registered in the Level A category of Grade G7 [71]. The proposed sample size (i.e. N = 106) for private sector organizations was randomly selected from this total population based on their high financial rankings as indexed by Malaysia Top Corporate Directory [72]. The second group of respondents from the public sector include Government ministries / agencies and having a sample size (i.e. N = 24) [73]. In this regard, a total number of 130 questionnaires were sent to these two groups of respondents which include public and private sector organizations. The questionnaires were sent to the targeted respondents by using postal, fax and electronic-mail. After repeated follow-ups and personal contacts a total of 30 completed questionnaires were received out of 130 giving an overall response rate of 23%. The private sector organizations are concerned with heavy/civil engineering, industrial, general/commercial buildings, housing and expressways construction. The respondents include senior managers, project managers, contract managers, quantity surveyors, procurement managers, financial managers and estimators. The majority of them have experience of more than 15 years in the industry.

4.3.2 Analysis Techniques

The data collected in this research was analyzed by using SPSS version 12 and several types of statistical analysis were applied such as frequency analysis, cross-tabulation, average index analysis, Spearman's correlation and Kendall's coefficient of concordance to establish findings. A brief description of these are given below;

4.3.2.1 Frequency Analysis

The frequency analysis statistical tool is used for respondents feedback analysis in order to provide the basic information pertaining to organization, background of the respondents and others. The results have been arranged in the form of frequency number and percentage according to total number of feedbacks received and represented in the form of pie chart and histogram.

4.3.2.2 Cross Tabulation

Cross-tabulation is a statistical tool that allows the researcher to examine frequencies of observations that belong to specific categories on more than one variable. By examining these frequencies, it can be possible to identify relations between cross-tabulated variables.

4.3.2.3 Average Index Analysis

It has been used to further analyze the ranking data of five-point Likert scale. As in this part of the questionnaire, the respondents have been asked to assign a rating stating with 1 for very difficult / strongly disagree to 5 for very easy / strongly agree. The Average Index formula is given by:

$$AverageIndex = \frac{\sum iX_i}{\sum X_i} \tag{4.1}$$

The Average Index Assessment Scale is given in Table 4.2.

Table 4.2: Average Index Assessment Scale [69]

S.No.	Scale	Indicator
1	0.00 – 1.50	Very Low
2	1.51 – 2.50	Low
3	2.51 – 3.50	Average
4	3.50 – 4.50	High
5	> 4.50	Very High

4.3.2.4 Spearman's Correlation Analysis

The Spearman rank order correlation coefficient is non-parametric and determines the strength and direction of association that exists between two variables measured on at least an ordinal scale. It is denoted by the symbol r_s (or the Greek letter ρ, pronounced rho).

4.3.2.5 Kendall's Coefficient of Concordance Analysis

Kendall's coefficient of concordance (*w)* analysis is a measure of degree of agreement of the respondents within a category on their ranking. If Kendall's coefficient of concordance (*w*) is significant at the 5% level than it shows an acceptable degree of consensus to the ranking of the factors existing among the respondents in that category [70].

4.3.3 Case Studies

The questionnaire survey cannot provide detailed examples of how and why organizations can utilize EVM method in their particular project scenarios nor its interrelationship between existing project management practices. These deeper insights can only be ascertained through the use of some qualitative means. Therefore, in order to achieve the research objectives, the method of descriptive case studies was used to demonstrate the practical applications of EVM method in construction projects. This approach provides an effective way to describe the theories where insufficient information is available [74]. The key rationale for this part of the study is to collect and analyze project data in order to gain insights of the project monitoring by using EVM approach. For this research, four different case studies from building, housing, infrastructure and upgradation projects were selected that helps to generate more general EVM results. These case studies discuss the core EVM process and extend its application for time and cost monitoring of civil projects in Malaysian construction industry.

4.3.4 Semi-structured Interviews

After the case studies, two semi-structured interviews were also conducted from a client and a contractor. Formal requests were sent to the participating organizations who were involved in case studies. The request explained the purpose of interviews, the intent, and the ethical considerations. The aim of these interviews was to get the feedbacks and substantial arguments from the industry professionals regarding the scope, anticipated usage and the extended advantages of EVM methodology in Malaysian construction industry. In this perspective, the interviews were conducted from the senior officials of Public Works Department Malaysia, Perak (as a client) and Malaysian Resource Corporation Berhad (as a contractor). During the session open-ended questions were discussed with the interviewees. The discussions in these interviews were recorded as a series of field notes, subsequently transcribed and then verified with the participants for accuracy. The subject of discussion and findings are included in the Chapter 5 of the thesis.

4.4 Summary

This chapter has described the design of research study in order to effectively achieve the intended aims and objectives. In this research, quantitative and qualitative methods were used. The primary and secondary data were colleted through questionnaire and literature survey respectively. The questionnaire was designed to get the demographic information of respondents primary job function, role, category and organizational project management experience. The survey also enquired the associated questions on the details of understanding and usage of EVM method in Malaysia. The questionnaire data analysis was conducted by using SPSS version 12 and several tools of statistics were selected to establish findings. In the qualitative analysis, the use of multiple case studies helps to find the details of EVM applications and to understand the different aspects of its implementation procedures. Furthermore, two interviews (from a client and a contractor) were also conducted in a semi-structured format in order to get the insights and comments of experts regarding the applications of EVM method for local construction industry.