CHAPTER 1

INTRODUCTION

1.1 Introduction

Construction projects are one-time and largely unique efforts of limited duration, which involve work of a non-standardised and variable nature. Field construction works can be greatly affected and influenced by events that are difficult to anticipate. High cost requirements and limited time to adjust can seriously worsen the situation. Proper co-ordination and communication can have significant effect on productivity and quality of construction projects (Sadri, 1994). This makes skilled and unremitting management efforts become not only desirable but also imperative for a satisfactory result. There is just too much risk to undertake a construction project without a well-thought plan. The risks can emerge in the forms of time variation, cost variation or litigations.

Productivity is one of the most important basic variables governing economic production activities (Alby, 1994). However, despite being so important, productivity has sometimes been relegated to second rank, neglected or ignored. In recent years, the pressures of an increasingly global economy have compelled companies in all industries including construction to focus on strategies for productivity improvements. Unfortunately, issues related to productivity measurement or assessment have not received adequate attention by the relevant parties. The main reasons that made productivity assessment become complicated were (Belcher and John, 1984; Alby, 1994; Sudit, 1995):

- *Methodology*: Improvements in the methodology of productivity assessment were diversified and not performed as a whole.
- *Operational*: The implementations of productivity assessment procedures in most firms were not adequate.

Nevertheless, many construction development bodies have shown interest in the study of productivity in the construction industry. Over the past several years, the Construction Industry Institute of America (CII) has funded a number of research projects focused on productivity (CII, 1990a; CII, 1992; CII, 1994a; CII, 1994b). Findings from these investigations have somehow changed the degree of awareness of project management professionals toward the importance and benefits of productivity assessment.

There are two common problems related to the productivity issues. The first common problem faced by clients and contractors is project delay (Finke, 1999; Kartam, 1999; Al-Hammad, 2000). A project delay means a project that cannot be completed, partially or as a whole, on or before the scheduled completion date. There are many factors that can delay works and the project completion, such as unexpected events, hidden conditions or even additional work assigned during construction. In order to bring the project back on schedule, the contractor's rate of performing the remaining activities must be increased because there is more work to be finished in a limited time. Even though the whole project schedule may look the same, the contractor's individual schedule may have to be compressed.

The second problem, which usually troubles the contractor, is when the client decides to move in or use a facility earlier than planned, which makes the whole project schedule needs to be completed early (AGC, 1994; Al-Khalil and Al-Ghafly, 1999). This may involve shortening or compressing the overall schedule duration by revising the project plan. Schedule compression can be performed during the planning process before the start of construction or anytime in between the construction period (CII, 1988a & 1990b). The usual goal of schedule compression to the client is to shorten the overall schedule duration by the necessary amount at the least cost (AGC, 1994).

In both cases, productivity aspects of the project must be understood, so that productivity can be increased and effective methods of schedule compression can be applied in order to complete a construction project at the required time with least costs (CII, 1990b). Measuring project performance alone will not be very effective because the sources of improving performance come from productivity control and improvement, which cannot be done without productivity assessment (Allmon *et al*., 2000). In general, productivity assessment can provide an objective source of information about operating trends, draw attention to problems of performance and inspire a useful exchange of ideas.

1.2 Background of the Problem

It is the norm that all project participants would attempt to perform well when a construction project is first undertaken (McKim *et al.*, 2000). However, construction projects must go through many complex steps, difficult site conditions and different individuals, which have caused some unavoidable delays, such as changing of the planned concepts or even rescheduling the project details (Faniran *et al.*, 1999). It is highly desirable for contractors to deal with productivity objectively (Paulonis and Cox, 2003). Project managers and participants should implement techniques that are aimed at “doing things right the first time” and able to find, analyse and make corrections while the job is under way (Daffenbaugh, 1993; Jahren and Federle, 1999; Deming, 1986). Thus, there must be some appropriate ways to monitor tasks from deviations and to bring the schedule back on track when problems occur or delays happen.

An extensive literature review was performed on related topics, such as pre-project planning (Gibson and Hamilton, 1994; Gibson *et al.*, 1993; Gibson *et al.*, 1994; CII, 1995; CII, 1997), productivity (Motwani *et al*., 1995; Thomas and Zavrski, 1999; Allmon *et al.*, 2000; Rojas and Aramvareekul, 2003a; Rojas and Aramvareekul, 2003b; Goodrum and Hass, 2004), schedule compression (Moselhi, 1993; Noyce and Hanna, 1998; CII, 1988, 1990 & 1998; Hanna *et al*., 1999a & 1999b) and project success (Chan *et al*., 2001; Griffith *et al*., 1999; Chua, 1999; Griffith and Gibson, 2001; Gao *et al*., 2002). The findings were used to provide background and support in developing the problem statement and methodology used in this study.

According to a study by CII (1994c), pre-project and project planning are very important in determining the success of a project. The better it is performed, the better the overall outcome of the project would be. In other words, there is a positive, quantifiable relationship between effort expended during the pre-project planning phase and the ultimate success of a project (Ottoman *et al.*, 1999; McKim *et al*., 2000; Cox *et al.*, 2003). By establishing lower third, middle third and upper third pre-project planning effort groups within the sample and evaluating each group against success variables, some broad conclusions can be made. At least, various parties involved in construction projects should understand the implications of pre-project planning in terms of project execution and the contracting environment that currently exists in the industry.

Many public and private sectors are investing significantly less money into preventive maintenance programmes in the construction industry. This lack of financial commitment towards construction projects is because of construction productivity and quality has not improved as much as in other industries and is regarded as low-priority investment (Christian and Hachey, 1995). However, the practice of giving low commitment to productivity and quality improvement should not be continued further because a successful project implementation should be accepted as a big return of an investment too.

1.3 Statement of the Problem

Delays in construction projects are very common, but not something that are unavoidable (Finke, 1999; Kartam, 1999; Carr, 2000). When delay happens, work output or productivity must be increased so that the initial schedule can be achieved. Although there are many methods suggested and commonly used to accelerate work productivity or to compress construction schedules, there is no clear and definitive answer on the effects of these method on certain important characteristics of a project, such as the capability of increasing the productivity rate of labour, reducing the schedule duration and whether the methods selected will increase the project costs (Christian and Hachey, 1995; Motwani, 1995; Noyce and Hanna, 1998; Crockett, 2000; Allmon *et al.*, 2000, Marsh, 2002; Rojas and Aramvareekul, 2003a). For example, the initial reaction for most cases is probably to use more labour, increase the work period into overtime or use an additional shift (Noyce and Hanna, 1998). Yet, it is not clear if these methods will in fact reduce the duration and what the overall impact on cost will be. On the other hand, there are also many other schedule compression methods that are not commonly considered as equally or more effective in reducing the impacts on the financial status of contractors during schedule compression period (CII 1990).

However, there have been many studies performed and models developed by researchers in other countries that can be used as guides to this research (Perera, 1982; Coskunogula, 1984; Vrat and Kriengkrairut, 1986; Ritchie, 1990; CII, 1990; Moselhi, 1993; Senouci and Hanna, 1995; Noyce and Hanna, 1998). Some of the major problems with those existing models are that they have to be specially tailored or customised to the project local needs before they can be applied effectively (Hancher and Abd-ElKhalek, 1998). They can also be too complex to be understood and applied by general construction parties because they generally lack the emphasis and accountability on practical and effective concepts or the methods used in compressing the construction schedule itself (Thomas *et al.*, 1999; Han and Diekmann, 2001).

Contractors and clients must be able to identify their resource constraints and apply the appropriate management decision process in the selection of the schedule compression approach or technique (Leu *et al.*, 1999; Chelaka *et al.*, 2001; Hegazy and Ersahin, 2001). There is a need to assess and evaluate the current or expected level of productivity and to identify the most effective methods of getting a project back on track. The need is to develop an improvised model of productivity assessment and schedule compression methods that is simple to understand and easy to apply, so that contractors and clients can be guided and informed about how to increase productivity and compress a schedule effectively with very little time to prepare and anticipate. The primary purpose of this study is to develop a practical tool or index that can be used by Malaysian project planning teams, including contractors and clients.

1.4 Aim and Objectives

The aim of the research is to develop a project management tool that combines productivity assessment and schedule compression methods for reporting productivity status and evaluating project performance. The objectives of this research are:

1. To establish the level of implementation of:
    a. Project planning.
    b. Productivity assessment.
    c. Schedule compression methods.

2. To identify elements of the followings that are relevant to the local building construction projects:
    a. Factors affecting productivity.
    b. Schedule compression methods.
3. To determine the correlations between factors affecting productivity, schedule compression methods and project time performance.

4. To perform productivity assessment and performance evaluation using single planning tool.
5. To compare estimated risks involved with and without productivity assessment tool.

1.5 Scope of Research

The chance of achieving a project success can be increased by performing assessment on project productivity and on the effectiveness of schedule compression methods. This is done by forecasting the probability in which certain construction activity will finish on time and the capability of compressing the project schedule. Because of insufficient project data and the requirement of additional planning costs, pre-project planning was typically not given enough emphasis in building construction projects in Malaysia. Therefore, an inexpensive management or planning tool that can be applied during pre-project and construction stage can be very useful, especially the one that is user-friendly, accurate and reliable.

In developing such a tool, a study was conducted to gather data on general building projects in Peninsular Malaysia that were completed within the last five years. The tool was developed and intended to be used in general building construction projects, such as schools, offices, shop-houses, hotels, residential, mosques and institutional buildings. In order to avoid significant discrepancies, the tool should be limited from being applied in other types of projects or in other countries.

1.6 Methodology of the Research

Figure 1.1 represents the methodology of the research, which was performed over a three years and six months period. The study was divided into stages, namely, the first, second and third stage. The first stage involved collecting data from literature review, setting research aims and objectives, and conducting a pilot survey. The second stage involved two rounds of survey, model fitting and data analyses. The third stage involved model validation, risk prediction, conclusion and recommendations for future research.

The initial steps in the first stage was identifying the importance and optimum level of project planning, the differences between productivity and performance, fundamentals of productivity assessments, Factors Affecting Productivity (FAP) and Schedule Compression Methods (SCM) from previous research found in the literature review. This was followed by a pilot survey, which objective was to determine the relevance, suitability and applicability of the information obtained from literature review to the local building construction industry using index of importance method.

In the second stage, the objective of the first round survey were to obtain the minimum and maximum limit for FAP and SCM elements weighting process, and develop the questionnaire for second round survey. The objective of the second round survey was to obtain historical data from completed projects. The data were analysed to determine the correlations between FAP, SCM and TPR. Once the correlations were determined, a prediction table for predicted TPR values was produced using fuzzy inference system. The table of predicted TPR values can be referred to as the project performance index table.

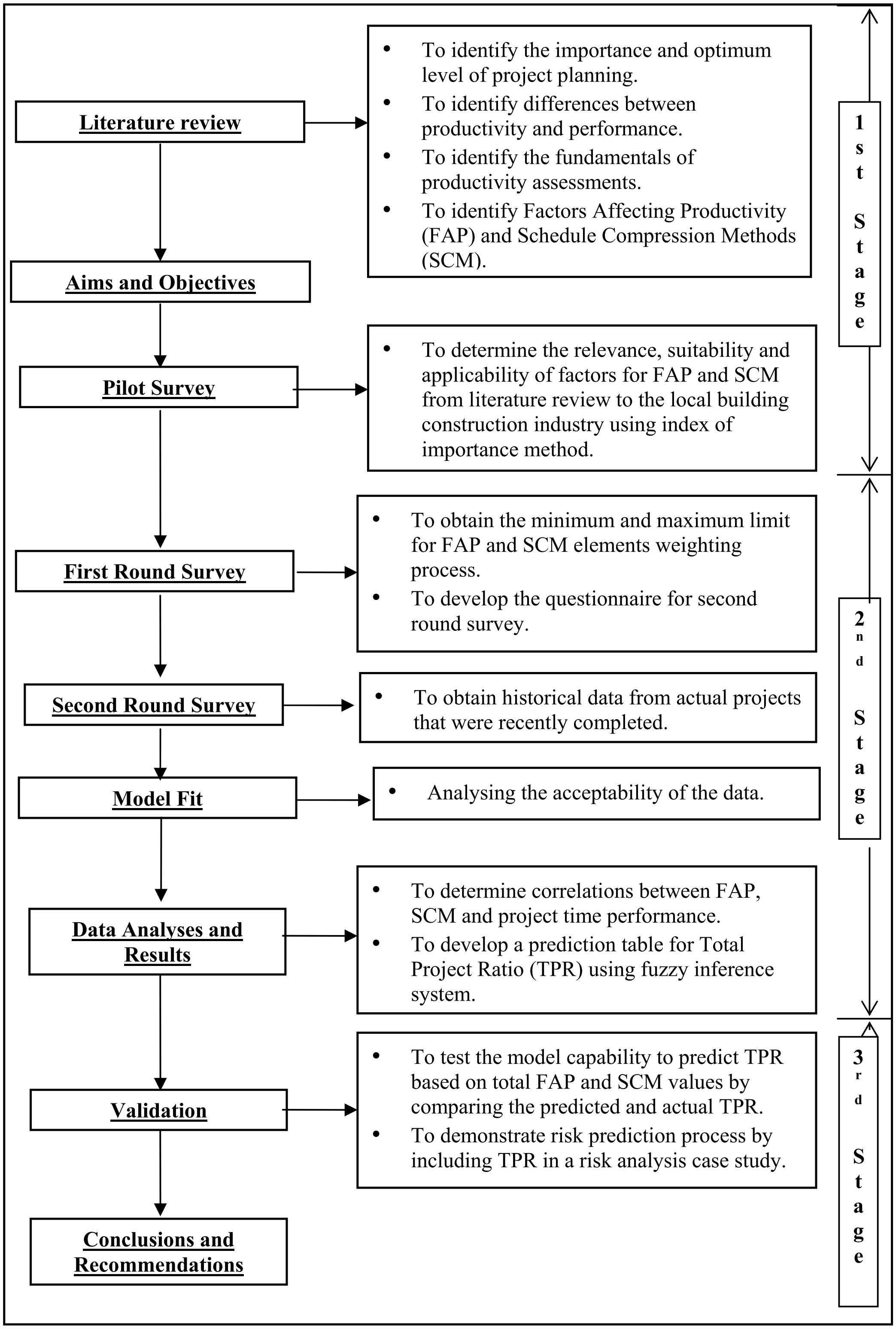

Figure 1.1 : Methodology of the research

In the third stage, validation of the data was performed to test their accuracy and consistency. The predicted TPR values were validated using completed project data. An application of risk analysis was also demonstrated for an on-going project at the time of the research, as a case study. Lastly, conclusions of the research and recommendations for future research were made. More details on the research methodology can be found in Chapter 6.

1.7 Organisation of the Thesis

This thesis is divided into ten chapters. Chapter 1 gives the introduction and background to the existing problems, describes the research objectives and the research methodology.

Chapter 2 provides the overview of project planning. The importance of implementing and finding the correct level of planning are discussed. The existing planning models are identified.

Chapter 3 highlights the difference between productivity and performance. Existing performance measurement and performance indicators are identified.

Chapter 4 focuses on productivity assessment process. Methodologies for direct and indirect productivity assessment are identified. Factors affecting productivity are also identified, which are important to the development of the research.

Chapter 5 identifies productivity and schedule compression methods that have been developed and implemented in previous research. The strengths and limitations of the models are described.

Chapter 6 discusses in detail the methodology of the research. The research was discussed in accordance to stages of the research. Identification of survey elements, questionnaire development, data collection process and method of analysis are the main topics described in the chapter.

Chapter 7 describes the analyses that were performed on the data collected from different stages of the research. The results are displayed, analysed and discussed in order to obtain significant findings and fulfill the research objectives.

Chapter 8 discusses the data validation process. The model capabilities in performing productivity assessment and performance evaluation are demonstrated using data from completed projects. Actual project data were compared to the predicted values produced in this research.

Chapter 9 demonstrates the application of the research findings in predicting and reducing project risks. The demonstration is performed on a selected project as a case study.

Chapter 10 finally summarises the research work, provides the conclusions of this research and recommendations for future research.