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ASSESSMENT OF THE POTENTIAL BENEFITS OF FOUR-DIMENSIONAL PLANNING AND SCHEDULING SOFTWARE IN CONSTRUCTION PROJECT

MOHD SYAH RIZAL BIN YAHYA

A project report submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Science in Construction Management

Faculty of Civil Engineering
Universiti Teknologi Malaysia

DECEMBER 2010

I declare that this project report entitled “Assessment of the Potential Benefits of Four-Dimensional Planning and Scheduling Software in Construction Project” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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To my beloved wife and children

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ABSTRACT

A construction schedule is used for managing, tracking, and controlling a construction project. Poor project planning and scheduling can be devastating to the project, resulting in delays and lost productivity. Today's, the needs for robust construction schedule is paramount. The advancement of information technology has resulted in the development of 4D planning and scheduling (4DPS). Therefore, the objectives of this study is to analyze the problems faced by the construction practitioners in current project planning and scheduling practice, to identify the effects due to current project planning and scheduling limitations, to identify and assess the benefits of using 4DPS software in construction project. A total of thirty nine factors and six groups that contributed to the problems in current planning and scheduling, the sixteen effects due to current planning and scheduling limitations and forty seven benefits of using 4DPS were identified based on literature review. The questionnaire survey was distributed to the targeted respondent in Selangor and Kuala Lumpur. The objectives of the study have been successfully achieved. The findings revealed the top ten most significant problems faced in current project planning and scheduling, the most common occurrence effects due to current project planning and scheduling limitations, and discovered twenty most importance benefits as believed by the construction practitioners that can reduces the problems in current project planning and scheduling practices.

ABSTRAK

Penjadualan pembinaan digunakan untuk mengurus, memantau dan mengawal projek pembinaan. Kelemahan dalam membuat perancangan dan penjadualan akan memberi kesan terhadap projek, menyebabkan kelewatan dan penurunan produktiviti. Pada masa kini, keperluan penjadualan yang baik adalah sangat penting. Kemajuan teknologi maklumat telah menghasilkan perancangan dan penjadualan 4-Dimensi (4DPS). Dengan itu, objektif kajian ini adalah untuk menganalisa masalah yang dihadapi oleh pengamal pembinaan dalam praktis perancangan dan penjadualan projek masa kini, mengenalpasti kesan yang disebabkan dari kekurangan perancangan dan penjadualan projek, mengenalpasti dan menilai kelebihan penggunaan perisian 4DPS dalam projek pembinaan. Sejumlah tiga puluh sembilan faktor dan enam kategori yang menyebabkan masalah dalam perancangan dan penjadualan, enam belas kesan disebabkan kekurangan perancangan dan penjadualan, dan empat puluh tujuh kelebihan penggunaan 4DPS dikenalpasti berdasarkan kajian literatur. Borang soal selidik telah diedarkan kepada sasaran responden di Selangor dan Kuala Lumpur. Objektif kajian telah dicapai dengan jayanya. Penemuan kajian membuktikan sepuluh masalah yang signifikan yang dihadapi dalam perancangan dan penjadualan projek, kesan yang sering berlaku disebabkan kekurangan dalam perancangan dan penjadualan, dan menemui dua puluh kelebihan yang paling penting yang dipercayai oleh pengamal pembinaan dapat mengurangkan masalah perancangan dan penjadualan masa kini.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

Σ	-	Sum of
X	-	Total Index
σ / SD	-	Standard Deviation
r	-	Correlation Value
Z	-	Confident Level
#	-	Number
3D	-	3-Dimensional
4DPS	-	4-Dimensional Planning and Scheduling
CAD	-	Computer Aided Design
CIDB	-	Construction Industry Development Board
CPM	-	Critical Path Method
LOB	-	Line of Balance
WBS	-	Work Breakdown Structure
P3	-	Primavera Project Planner
CM	-	Construction Management
GC	-	General Contractor

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1. Introduction

A construction schedule is used for managing, tracking, and controlling a construction project. It is also used as a medium of communication and collaboration within the project team (Benjaoran and Bhokha, 2009). Bar charts and network diagrams are typical means to represent and communicate construction schedules. Individuals having different background and being unfamiliar with these techniques find it difficult to evaluate and communicate the schedules. Even a good construction plan often gets misinterpreted by some of the project participants, which can lead to inefficient processes accomplishing the wrong thing (Dawood *et al.*, 2002).

Effective use of project scheduling can ensure the smooth running of construction project. The main scheduling techniques, which are used widely especially in big and medium size projects are the Bar Chart and Network techniques that incorporate the use of computer software such as Microsoft Project and Primavera Project Planner (Mohamad *et al*., 2006). Comprehensive planning

and the efficient layout of site facilities are important factors contributing to successful construction management (Chau *et al.,* 2004).

During the process of construction planning, construction professionals typically break the planned structure into workable packages and build a logical network among the work packages. Then they estimate the time duration to accomplish each package, identify the critical path in the network, and illustrate the construction schedule as a bar chart whose time line represents the sequence and duration of tasks. In most cases, successful construction planning and scheduling depends on a reasonable network between work packages. Any logical error in the network could be fatal to completing a successful project (Kang *at el*., 2007).

Nowadays, in most projects construction schedules are generated manually. This process is still extensive and time consuming (Tauscher *at el*., 2009). General and project specific data are communicated among project participants through design drawings in a 2D paper-based format. This paper-based exchange of large amount of information between participants usually leads to fragmentation and inefficiencies, and limits the ability of the project team to acquire and comprehend the information necessary for decision making. Another drawback of the manual approach is that planning functions are performed separately in isolation of each other. Due to the interdependence between the different elements and the large amount of information that needs to be manually processed, the current manual implementation approach is very difficult to undertake, and imposes a heavy burden on the project team to carry out the planning process (Waly, 2001).

The advancement of information technology has resulted in the development of new visualization and planning tools that offer major improvements when compared to the use of traditional planning tools (Marasin *et al.*, 2007). Visual 4D CAD planning and scheduling technique that combines static 3D CAD models with construction schedules has proven to be beneficial over traditional tools such as bar charts or network analyses (Ma Z.Y. *et al*., 2005). This new designed work

process that aims toward better, more efficient planning and execution of construction projects (Rischmoller and Alarcon, 2002).

1.2. Problem Statement

Time and money can easily be lost through poor project planning and scheduling of on-site labor, materials, and equipment. A lack of coordination in ensuring that materials and equipment are delivered to the site on time can be devastating to the project, resulting in delays and lost productivity (Hsieh, 2007).

Numerous researchers have also examined and identified the causes of delays in construction project. Causes related to construction planning and scheduling for example, conflicts in work schedules of subcontractors, improper project planning and scheduling, contractor-related factors include contractor experience in planning and controlling the projects, procurement programming, poor coordination, improper construction methods, poor materials planning, poor monitoring and control, and inefficient communication, poor labor planning, improper techniques and tools, equipment allocation problem, inaccurate time estimating and so forth.

A key problem is that it is very difficult to visualize the flow of the work in progress on a construction site (Sacks *et al*., 2009). Visualizing the chronology of construction is not an easy task with the current CPM schedules, which might lead to the planning process as being seen as one dimensional (i.e. taking into account only the time aspect) (Dixit, 2007). Besides that, the outputs of traditional planning techniques are very difficult to communicate and validate as the complexity of the project increases (Marasin *at el*., 2007). Therefore, more robust project schedule need to be provide to ensure the smooth running of the construction project. The

current study need to be carried out because many professionals unsure about the benefit and function of 4D software even to those who have used the software.

1.3. Aim and Objectives of the Study

The aim of this study is to investigate the potential benefits of using 4D planning and scheduling software in construction project in order to enhance its usage among the professionals. To achieve this aim, the following objectives have been identified:

- To analyze the problems faced by the construction practitioners in current project planning and scheduling practice;
- To identify the effects due to current project planning and scheduling limitations;
- To identify and assess the benefits of using 4D planning and scheduling software in construction project.

1.4. Scope of the Study

The scope of the study was mainly focus on literature review and questionnaire survey. Projects investigated in this study included Housing Scheme, Building School, Institution, Medical Centre, Hospital, Hotel, Business Center Building, Oil & Gas projects, Palace as well as Electrified Double Track Project.

The questionnaire survey was designed based on factors identified from literature review. A questionnaire was developed to assess the perceptions among construction practitioners related to the construction planning and scheduling. The respondents were selected randomly that represent the consultants and contractors. The developed questionnaire was distributed to the respondents in Selangor and Kuala Lumpur.

1.5. Research Methodology

The methodology of this study started from identifying the problem statement, a survey of literature, questionnaires survey, collecting data, interviews, analysis of results, discussion of results and conclusions. Figure 1.1 shows a flowchart of the research methodology in order to achieve the objectives of the study.

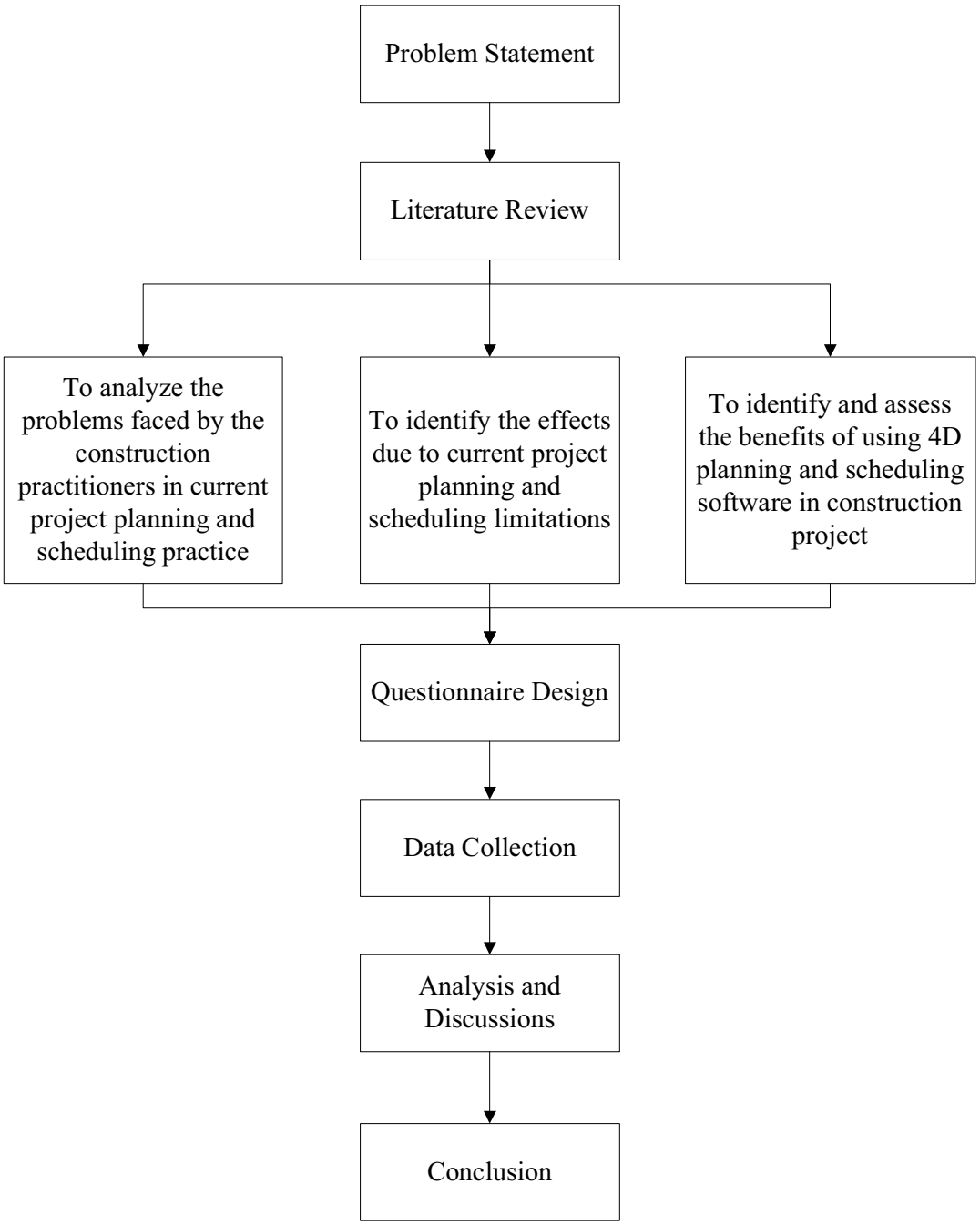

Figure 1.1: Flowchart of Research Methodology

CHAPTER 2

CURRENT AND ADVANCE CONSTRUCTION SCHEDULING: FOUR-DIMENSIONAL PLANNING AND SCHEDULING

2.1 Introduction

This chapter identifies the current planning and scheduling, today's construction planning and scheduling problems, introduces 4-Dimensional Planning and Scheduling (4DPS) and the benefits of 4DPS.

2.2 Current Planning and Scheduling

Currently, two-dimensional (2D) drawings have been used to illustrate a structure to be constructed. Conveying the consultant's intent to contractors through 2D drawings requires a good deal of education, acquired skill, and practical experience on both sides. Consultants decompose a 3D structure into multiple components and illustrate them on floor plans and sections, using 2D drawings to describe what they want to build. Contractors, in contrast, reverse the process.

They have to read the consultant's 2D drawing, i.e., floor plans and sections and assemble them mentally back into the 3D structure in order to understand what the consultant wants to build. Developing a construction schedule is even harder because project planner or schedulers need to disassemble the structure into workable packages, identify the relationships among these packages, and configure an order of implementing these packages step by step until the well planned schedule been produced.

Working without a plan is like *firing a gun before aiming at the target* (Mansur, 2004). Hence, well planned schedule is important to the project, for instance, Basu (2003) identified five reasons why CPM scheduling is important were includes; to demonstrate that there is a plan; to communicate and coordinate with others; to provide a baseline yardstick for progress and performance measurement; identify and assign risks and responsibilities; and to demonstrate the main contractor is organized for success.

According to Koo and Fischer (1998), project planners or schedulers rely on schedules generated from project management software to formalize and organize work activities. Schedules such as bar charts and CPM networks, generated from commercially available management software are an abstract, graphic representation of the logical sequence of how a building or structure is to be built.

When generating a schedule, project planners or schedulers must take into consideration an abundant amount of information relevant to the project. In addition to interpreting 2D drawings and specifications, they must also deal with constructability issues, optimum productivity evaluation, resource and equipment allocation, time-space conflicts at the site and so forth. Only after careful consideration to all details can a reliable and efficient schedule be generated. Even then it is difficult to completely detect all the conflicts that remain hidden.

In contrast to the extensive amount of information that was input in developing the schedule, the final schedule does not convey the thought processes or logic that went into generating it. Without prior knowledge and background of the logic in generating the schedule, it is difficult to understand the sequence of the schedule by itself. Incomplete comprehension of the logic of the schedule limits the ability to detect conflicts hidden in the schedule. In consequence, potential problems are only detected during actual construction in the field resulting in costly rework and revisions, which could have been minimized if they had been detected in the earlier planning stages.

2.2.1 Project Scheduling

Scheduling of construction work is usually done with the support of computer tools that use the network methods, especially the Critical Path Method (CPM). The tools have also presented a common platform for different parties involved in a construction project to communicate with one another. The ability to actually get work done at the construction work face depends on the availability of resources. The common resources can be categorised as labour, material, tools and equipment, which availability must be checked prior to starting the work.

However, in practice, many types of relevant resources namely, drawings, materials, equipment, available work-space and methods specifications, are not explicitly described in CPM schedules. It is very ideal if the project planner or schedulers really understands all works involved, which requires a separate mind-set and huge schedule size. If not, the project schedules are only useful for paper work purposes but not to those who are doing the work (Mansur, 2004).

2.2.2 Scheduling Methods for Construction

Two main methodologies for scheduling construction work can be identified which were activity-based scheduling and location-based scheduling (Jongeling and Olofsson, 2007).

2.2.2.1 Activity-Based Scheduling

Today's commonly used technique to schedule the construction process is the activity-based critical path method (CPM). Activity-based scheduling is the dominant scheduling method in construction. Generally, project planners or schedulers decompose a project into activities that they associate with one or more building components (e.g. casting of concrete floor 3) that make up the project. Each activity is included in a bar chart and a network that describe the proposed schedule of a project. This practice builds on the assumption that progressive subdivision of workscope eventually turns into specification of how construction tasks should be executed.

2.2.2.2 Location-Based Scheduling

Location-based scheduling is not a new concept and has been a research issue for many years. Practical use in construction has been limited, mainly due to the strong tradition of activity-based planning and the absence of software packages that support location-based planning. Jongeling and Olofsson (2007), mentioned that the research and development regarding the location-based scheduling method has been carried out since the 1940s and variations of the method appear in literature under different names, such as ‘Line-of-Balance’, ‘Flowline’, ‘Construction Planning Technique’, ‘Vertical Production Method’, ‘Time–Location