

## **Critical Path Method (CPM) Software in Malaysian Constructions**

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### **Abstract**

Critical Path Method (CPM) is a well known scheduling method and it is currently a necessary tool in middle and big construction projects in Malaysia. This study investigates the utilization of CPM software among Malaysian contractors and its relations toward their perception of project performance. 110 questionnaires were distributed among contractors as participants of Construction Industry Development Board (CIDB) training programs within two weeks of time frame and the data analyzed. The result shows that Malaysian contractors have yet to fully adopt the CPM software in their work. Most of them (49.1%) use the CPM software for planning, scheduling and monitoring activities but they still did not highly use the software for their project. However, 77.3% of the contractors' perceived that the use of CPM software helps to increase their projects' performance.

### **Keywords**

Critical Path Method (CPM), construction, scheduling, utilization, performance

### **1. Introduction**

The construction industry is an important part of the Malaysian economy. Although relatively small, it is extensively linked with many other aspects of the economy, in particular with the related industries such as those for basic metal products and electrical machinery. Therefore, construction can be described as some kind of an economic engine for Malaysia. Due to its significant contribution to the country's economic growth, special development attention has been given by Malaysian government. For instance, in the 2010 Malaysian Budget (Ministry of Finance, 2009), an allocation of RM9 billion (0.05% of total budget) was provided for construction.

The construction process is complex and unique where each project is different and no project is similar to the previous one (Enshassi et al., 2006; Hanid et al., 2008; Lin and Lin, 2006). Construction is also often characterized by as an activity with a high degree of uncertainty in terms of physical features of the facility to be constructed, working environment, resource allocation, and activity constraints (Song et al., 2005). Its slow adoption of emerging technologies is due to its diverse and complex nature (Turk, 2006; Frits, 2007).

The application of technology has been found to be among the factors that affect project performance (Megat Rus Kamarani, 2002; Hicks, 2007; Gaith et al., 2009) and the use of technology has been perceived as a success factor by many construction businesses (Gaith et al., 2009). Current use of computer-based tools (technology) are being leveraged to meet the demands placed on the construction industry by way of improved management of information, and improved execution of tasks such as planning, scheduling, estimating and project control (Songer et al., 2001). Songer et. al., (2001) conclude that the integration of the technologies is one of the greatest contemporary challenges facing the construction industry.

Technology is defined as the usage and knowledge of tools, techniques, and crafts, or is systems or methods of organization, or is a material product (en.wikipedia.org/wiki). One of the technological systems that are widely used in construction industry is scheduling software. By using computer for scheduling, the scheduling effort can be performed faster and less of the tedious work. Scheduling is a major technique for monitoring and managing projects (Waly et al., 1999) and it involves planning and controlling the time aspect of construction projects while also considering the cost (Anton et al., 2007). Mohamad Zin et al., (2008) state that the purpose of having work schedule is for monitoring work progress, costs, materials and work sequence. There are many techniques of scheduling such as bar charts, line of balance (LOB) and critical path method (CPM) which provide a means for capturing the uncertainty with the goal of preparing a more accurate schedule. Among the techniques, CPM is the most popular scheduling technique in the construction industry (Galloway, 2006; Okmen & Oztas, 2008; Phillip, 2009). Phillip (2009) acknowledges that most construction schedules use CPM, a graphical network showing the relationship between the various construction activities and the sum of which constitutes the completed construction project. Clough et al., (2000) describes CPM as having three-elements; planning, scheduling, and time monitoring. Planning is about determining what activities must be done, how logically and, efficient the activities are together to complete the project. Scheduling involves determining how long an activity is likely to take and between what dates. Monitoring involves comparing actual progress with the completed schedule.

## **2. Construction Scheduling and scheduling software**

Schedules are key documents in the management of construction projects (Baki, 1998; Anton et al., 2007). A project schedule establishes the start date, duration, completion date, and resource needs for each activity in the project. Mistakes in the schedule may cause the project team to allocate resources to the inappropriate place or may cause the parties to inaccurately assess whether the project is ahead of or behind schedule (Ackley et al. 2007). Knowing precisely when an activity is going to begin also has substantial cost implications. For example, rental of a large crane can cost more if the duration of a project is miscalculated, contractors can quickly consume rental charges reducing profit they might hope to earn from a job. In addition, the contractor's overhead is dependent on duration the project is expected to take (Gould 2005).

Scheduling the construction process is essential not only to ensure that projects can be completed profitably and on time, but also that any delays can be evaluated in order to prove entitlement to time and cost compensation. If problems are encountered, the schedule helps project managers to rearrange project tasks and resources so that they can meet the primary objectives of time, cost, and quality under limited resource and budget constraints. Although bar charts (Gantt charts) have been used as a simple scheduling method, network schedules that employ the critical path method (CPM) provide more usefulness and are widely used (Galloway, 2006). This is because of the fact that network analysis can show which activities are critical and which are not. Almost all project management software is therefore based on critical path analysis, which is the focus of this research. Examples of scheduling software that popularly available in market are Primavera Project Planner, Microsoft Project and Suretrax (Galloway, 2005; 2006).

### 3. Problem statement

In Malaysia, construction bodies such as Contractor Services Centre under Ministry of Works, Construction Industries Development Board (CIDB) and Professional Services Development Corporation (PSDC) provide training, with special financial discounts and facilities to help develop and modernize Malaysian contractors in line with the development of Malaysian country. Large sums of money have been spent to ensure contractors understand and are well developed.

Numerous training programs have been offered by Malaysian construction bodies, amongst the many is the application of CPM software in construction scheduling. According to Mohamad Zin et al., (2008), CPM scheduling is widely used only by big and medium category contractors with the majority of them using CPM software such as Primavera and Microsoft Project. However, no research has revealed CPM software usage level among contractors nor indicate for what purpose the contractors use the CPM.

According to CIDB (2010), 6.5% of small size contractors attending the CPM training course in year 2010, followed by middle size contractors (17.2%) and most of the participants are big size (G7) contractors (61.5%). This shows that small and middle size contractors are still far behind big size contractors in terms of attending CPM course. However, the reason is small size contractors are not appropriate with the software and this is due to their project time frame that are too short and their project cost are small. Even though most of the participants are big size contractors, their usage level is not necessarily known. This research would be useful to know whether Malaysian contractors fully use the CPM software or not and what is the usage level of CPM software among the contractors. The research also is to understand the impact of CPM software towards work performance of Malaysian contractors.

### 4. Objectives of the Study

The above-mentioned problems and the gaps in the present literature point to the purpose of this research. The aim of this study is to identify the usage of technology (i.e. CPM software) among contractors in the Malaysian Construction Industry. In short, this study attempts to specifically identify the following:

1. To identify the extent of CPM software usage among contractors.
2. To identify the common CPM software used among contractors.
3. To determine whether the use of CPM software increase the contractors performance

### 5. Scope of the Study

This study focuses on the usage of CPM software among contractors in construction industry. The contractors consist of seven grades G1, G2, G3, G4, G5, G6 and G7. Below is the classification of contractors based on the capital and project cost:

**Table 1: Construction Industry Development Board of Malaysia's contractors classification**

Registration Grade	Minimum paid up Capital (RM)	Maximum project cost (RM)	Contractor categories (size)
Grade 1	5000	Not more than 100000	Small
Grade 2	25000	Not more than 500000	Small
Grade 3	50000	Not more than 1000000	Small
Grade 4	150000	Not more than 3000000	Medium
Grade 5	250000	Not more than 5000000	Medium
Grade 6	500000	Not more than 10000000	Medium
Grade 7	750000	No limit	Large

The study is only focused on CPM software namely Microsoft Project and Primavera software used by Malaysian contractors. The respondents of this research consist of general managers, assistant general managers, project managers, site managers and executives. They are directly involved in the management of projects and thus know much about the activities of project management.

## **6. Data Collection Procedure**

The data for the study was gathered using a questionnaire survey. The purpose of the study and confidentiality of the data gathered were explained in the cover letter of the questionnaire. The participants were told that the study was conducted to explore their perceptions on CPM software usage. The respondents were provided the telephone number and e-mail address for contacting the researcher to make inquiries or to obtain the results of the study.

The questionnaire survey consisted of mostly questions related to demographics of the respondents. Among the questions asked were gender, age, race, academic qualification, position, classification of contractor, type of software used, extensiveness of use of CPM software, purpose of CPM software used and performance. The questionnaires were given by to contractors during training programs organized by CIDB. The data collection period was approximately two weeks.

## **7. The Sample and Sampling method**

There are 64,593 registered contractors in Malaysia and they are divided into 7 groups based on capital and project cost, which are G1 (less than RM100 thousands), G2 (RM100 – 500 thousands), G3 (RM500 thousands – RM1 millions), G4 (RM1 - 3 millions), G5 (RM3 – 5 millions), G6 (RM5 – 10 millions) and G7 (more than RM10 millions).

The sample size was determined using Roscoe's (1975) rules of thumb: Sample sizes larger than 30 and less than 500 are appropriate for most research. As a rule of thumb, 120 questionnaires were prepared and distributed to contractors who were the research respondents. The respondents were top contractor company officials - general managers, senior managers, project managers, site managers and project executives.

A non random sampling which is classified as convenient method was used to get the samples from the contractors identified attended the training organized by CIDB. There were three CIDB training programs in two weeks time from 22 November till 3 December 2010. This sampling method is used because it is easy and convenient by the researcher to manage the sampling of the study.

## **8. Results and Discussion**

According to Zikmund (1994), the choice of the method for statistical analysis depends on the type of questions to be answered, the number of variables and the scale of measurement. In this research, all data will be coded and analyzed using frequency tool in the statistical software, namely, Statistical Package of Social Science (SPSS) 13.0. The descriptive statistics are explained below:

### 8.1 Gender of respondents

From the survey, 93 contractors (84.5%) were male and only 17 of them (15.5%) were female. This is illustrated as the table below:

**Table 2: Gender**

Gender	Frequency	Percent
Male	93	84.5
Female	17	15.5
Total	110	100.0

### 8.2 Age of respondents

In terms of age, majority of contractors who attended the programs were between 20 to 30 years old (41.8%), followed by 31 to 40 years (25.5%), 41 to 50 years (19.1%) and above 51 years (13.6%).

**Table 3: Age**

Age	Frequency	Percent
20-30 years	46	41.8
31-40 years	28	25.5
41-50 years	21	19.1
51 above	15	13.6
Total	110	100.0

### 8.3 Type of races

Most of contractors were Malay (70.9%) and 28.2% were Chinese. The table below shows the finding:

**Table 4: Race**

Race	Frequency	Percent
Malay	78	70.9
Chinese	31	28.2
India	1	0.9
Total	110	100.0

### 8.4 Academic qualification of respondents

In terms of academic qualification, most of the contractors hold degree (39.1%) and diploma (37.3%) qualification.

**Table 5: Academic**

Academic	Frequency	Percent
Diploma	41	37.3
Degree	43	39.1
Master	6	5.5
Others	20	18.2
Total	110	100.0

### 8.5 Positions in organizations

Majority of the respondents were executives (39.1%), follows by engineers (20%), site managers (19.1%), project managers (14.5%) and others (7.3%).

**Table 6: Position**

Position	Frequency	Percent
Engineer	22	20.0
Site manager	21	19.1
Project manager	16	14.5
Executive	43	39.1
Others	8	7.3
Total	110	100.0

### 8.6 Classification of contractors

The biggest or 44.5% of the samples was from group G7, follows by group G5 (20%) and G4 (13.6%). The group G2 had the lowest participants (0.9%).

**Table 7: Contractor's Grade**

Grade	Frequency	Percent
G1	10	9.1
G2	1	0.9
G3	8	7.3
G4	15	13.6
G5	22	20.0
G6	5	4.5
G7	49	44.5
Total	110	100.0

### 8.7 Type of software used

Most (72.7%) of the contractors claimed they used Microsoft Project whilst 23.6% of the contractors claimed they did not use any computer CPM software in managing construction project. Primavera software has a small percentage of 1.8% since it is suitable for a complex projects with cost more than RM50 millions and this software is used normally by some of big size contractors.

**Table 8: CPM software**

CPM software	Frequency	Percent
Microsoft Project	80	72.7
Primavera	2	1.8
Others	2	1.8
Not used yet	26	23.6
Total	110	100.0

### 8.8 Extensiveness of use of computer CPM software

In terms of the extension of the use of CPM software, majority of contractors (41.8%) were moderately used the CPM software, 20% low usage and only 14.5% were highly used the software. The result shows that even though CPM software is widely used by Malaysian contractors, they still do not fully apply the software in their works.

**Table 9: Usage level**

Usage level	Frequency	Percent
Not used	26	23.6
Low	22	20.0
Moderate	46	41.8

High	16	14.5
Total	110	100.0

### 8.9 Purpose of use of computer CPM software

From those who used the CPM software, majority (49.1%) used them for planning, scheduling and monitoring, 20.9% used for planning and scheduling and 5.5% used only for planning.

**Table 10: Purpose of use**

Purpose of use	Frequency	Percent
Planning	6	5.5
Planning and scheduling	23	20.9
Planning, scheduling and monitoring	54	49.1
Others	27	24.5
Total	110	100.0

### 8.10 CPM software and project performance

Most of the respondents (77.3%) agreed that CPM software had increased their work performance. However 20% of respondents could not provide a definite answer. The result indicates that CPM software gives a positive impact to performance and is crucial for managing construction activities.

**Table 11: Increase work performance**

Performance	Frequency	Percent
Strongly disagree	1	0.9
Disagree	2	1.8
Neither agree nor disagree	22	20.0
Agree	65	59.1
Strongly agree	20	18.2
Total	110	100.0

## 9. Conclusions

Malaysian contractors have yet to fully adopt the CPM software in their work, especially small and middle size contractors. Most of them who use CPM software are big size contractors grade G7. They apply it for planning, scheduling and monitoring activities even though they are still not highly using the software for their project. However, most of the contractors' (77.3%) perceive that the use of CPM software helps to increase their projects' performance.

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