MITIGATION MEASURES FOR CONTROLLING TIME AND COST OVERRUN FACTORS

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ABSTRACT

Achieving completion of projects on time and staying within budget are fundamental criteria of successful construction. Hence, it is vital to evaluate time and cost performance at the early stage and take corrective actions. There have been a lot of studies worldwide focusing on mitigation measures, but not much information has highlighted the effectiveness of these measures. A study in Malaysia has recommended procedures to mitigate or even recover the time and cost overrun, where more than one measures can be applied at the same time depending on the nature of the problem/s that cause the time and cost overrun. However, the mitigation measures were not critically reviewed and discussed in relation to the effectiveness since only general recommendations or suggestions were provided. Thus, this study focused on investigating the effective mitigation measures for controlling critical factors of time and cost overrun throughout four phases of project life cycle, i.e., planning phase, design phase, construction phase and finishing phase. Twelve critical factors and the corresponding mitigation measures were recognised from literature review, which were categorized into the four phases of project life cycle. Two rounds of Delphi survey were applied to achieve consensus among the respondents. The effectiveness level of the mitigation measures were determined by Average Index. The findings of this study show that the most effective mitigation measures for controlling time overrun was through implementation of realistic planning and scheduling of the project, while for cost overrun was development of a comprehensive financial plan and cash flow. The mitigation measures for controlling time and cost overrun in accordance to the phases of project life cycle were successfully investigated their effectiveness for potential application by the construction practitioners in the Malaysian construction industry.

Keywords: *time overrun, cost overrun, factors, mitigation measures*

ABSTRAK

Menyiapkan projek pada masa dan kos yang telah ditetapkan adalah kriteria pembinaan yang berjaya. Oleh itu, masa dan prestasi kos pada peringkat awal perlu dinilai dan pembetulan yang sesuai perlu dilakukan. Kajian mengenai langkah-langkah kawalan untuk mengawal kelewatan masa dan kos berlebihan telah dijalankan di seluruh dunia, tetapi tidak banyak maklumat yang menekankan keberkesanan langkah kawalan ini. Kajian di Malaysia telah mencadangkan prosedur untuk mengurangkan kelewatan masa dan kos berlebihan dimana lebih daripada satu penyelesaian boleh digunakan pada masa yang sama bergantung kepada jenis masalah yang dihadapi. Walau bagaimanapun, langkah-langkah kawalan tersebut hanya dinyatakan secara umum, tidak dikaji secara kritikal dan tidak dibincangkan keberkesanannya. Oleh itu, kajian ini bertujuan menentukan langkah-langkah kawalan yang berkesan untuk mengawal faktor kelewatan masa dan kos berlebihan sepanjang empat fasa (kitar hayat projek) iaitu fasa perancangan, fasa reka bentuk, fasa pembinaan dan fasa kemasan. Dua belas faktor yang kritikal dan langkah-langkah kawalan telah dikenal pasti melalui kajian literatur, yang dikategorikan kepada empat fasa kitaran hayat projek. Dalam kajian ini, dua pusingan kajian Delphi dijalankan untuk mencapai kesepakatan di kalangan responden. Tahap keberkesanan langkah-langkah kawalan tersebut ditentukan menggunakan kaedah Indeks Purata. Dapatan kajian ini menunjukkan bahawa langkah-langkah kawalan yang paling berkesan untuk mengawal kelewatan masa ialah perlaksanaan perancangan dan penjadualan projek yang realistik, manakala bagi kos berlebihan ialah pembangunan pelan kewangan dan aliran tunai yang komprehensif. Tahap keberkesanan langkah-langkah kawalan untuk mengawal kelewatan masa dan kos berlebihan mengikut fasa kitar hayat projek yang berpotensi untuk di aplikasi oleh pengamal pembinaan di industri pembinaan Malaysia telah berjaya dikaji.

***Kata kunci**: kelewatan masa, kos berlebihan, faktor, langkah-langkah kawalan*

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LIST OF SYMBOLS AND ABBREVIATIONS

9th MP	-	Ninth Malaysia Plan
AI	-	Average Index
BIM	-	Building Information System
CCB	-	Change Control Boards
CPM	-	Critical Path Method
EE	-	Extremely Effective
EoT	-	Extension of Time
KLIA 2	-	Kuala Lumpur International Airport 2
MARA	-	Majlis Amanah Rakyat
ME	-	Moderately Effective
NE	-	Not Effective
PMIS	-	Project Management Information System
PWD	-	Public Works Department
RC	-	Risk in Cost
RT	-	Risk in Time
SD	-	Standard Deviation
SS	-	Slightly Effective
VE	-	Very Effective
WBS	-	Work Breakdown Structure

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The construction industry plays a significant role in the economy of a country. Construction is an important part of development and modernization. While it is closely correlated to economic growth, it does not follow that providing incentives and increasing spending on projects necessarily lead to economic growth. As studied by Ameh, Soyingbe & Odusami (2010), the construction sector deals mainly with the provision of capital infrastructure, which has an impact on economic growth. The delivery of such infrastructure creates significant employment through the multiplier effect (Ameh *et al.*, 2010).

Projects are reportedly failing across all the key performance measures including cost, time and quality performances. Understanding the fundamental factors affecting all these key performance measures is still an area of investigation in Malaysia. Hence, it is essential that the projects must completed successfully, that is, they must be completed on time and within financial budgets by managing any risks that could jeopardize success. Besides taking into consideration the criteria for successfully completed projects, the needs of the construction practitioners involved in the project who will be impacted by the changes brought about by the construction project should also be considered. Frimpong, Oluwoye & Crawford (2003) highlighted that a successful construction project is the one that achieves its objectives as specified in the project plan. On the other hand, Gunduz, Nielsen & Ozdemir (2013) mentioned that if the project meets the time target, stays within the estimated cost, is in accordance with specifications, and achieves stakeholder

satisfaction, it is regarded as a successful construction project. Al-Tmeemy, Rahman & Harun (2011) argued that for the success of projects, it is a fundamental criterion that the projects adhere to the quality targets within the stipulated schedule and budget.

Meanwhile, every construction project is unique in nature and differs in terms of the operation of the organization in having specific objectives to meet the requirements of the client, differing in duration of the project, and also may use different methods and approaches to complete them (The Department for Business Innovation and Skills, 2010). In addition, almost every construction project varies from another project in terms of scope, period, purposes, uncertainty, difficulty, deadlines and some other measurements. It involves a large number of activities that may create several constraints such as material constraints, organizational constraints, professional constraints, stage constraints, as well as work package constraints (Antoniadis *et al.*, 2008). Due to these constraints, the construction industry is always facing chronic problems such as time overrun, cost overrun, low quality of construction, low productivity, and construction waste (Memon, Rahman & Azis, 2011). Among these, time and cost overrun are serious issues faced by the construction industry globally, although the magnitude of these time and cost overruns varies considerably among the projects (Enshassi, Al-Najjar & Kumaraswamy, 2009a; Le-Hoai, Lee & Nguyen, 2013; Nawaz, Shareef & Ikram, 2013).

Tumi, Omran, & Pakir, (2009) highlighted time overrun as one of the biggest problems that the construction industry faces while a study by Ali & Kamaruzzaman (2010) mentioned that many countries are facing many severe problems on cost overrun. Flyvbjerg (2003) mentioned that the issue of cost overrun has not improved for the last 70 years, where about 90% of projects worldwide face overrun in cost. For all projects, the average cost overrun is 28% worldwide (Flybjerg, 2003). These problems of time and cost overrun have adversely affected the construction industry in many countries. For example, time overrun problem in construction projects in Egypt has led to disputes and litigation cases (Marzouk & El-Rasas, 2014).

Malaysia is also facing problems of time and cost overrun in construction projects (Sambasivan & Soon, 2007; Toh, Ali & Aliagha, 2011). Ramanathan *et al.* (2012) have reported that many construction projects in Malaysia have suffered from either cost and/or time overruns. As a result of this situation, the construction

industry, its clients and stakeholders, are continuously experiencing financial waste, losses in quality and other inconveniences associated with delays. A survey by Memon *et al.* (2012) found that, a quite small number of responses (11%) mentioned that the projects were completed within the estimated time and cost. If project costs or schedules exceed their planned targets, it will affect not only the client satisfaction but also the funding from stakeholders. For example, according to the Tenth Malaysia Plan, there are 238 delayed development projects worth RM4.48 billion (The Economic Planning Unit, 2010). Hence, serious attention and in-depth research on issues of time and cost overruns with proper solutions is a serious concern for practitioners in the construction industry.

1.2 Problem Statement

The Malaysian construction industry is also facing a lot of challenges in completing construction projects within the estimated time and cost (Ibrahim *et al.*, 2010; Sambasivan & Soon, 2007). Abdullah (2010) reported that more than 90% of large MARA construction projects have been experiencing delay since 1984. Endut *et al.* (2009) studied time and cost performances of 359 projects, which comprise of 301 new constructions and 58 refurbishment projects in Malaysia. Of these 301 projects, 250 were public projects and 51 private projects. The study found that only 18.2% of public sector projects and 29.45% of private sector projects were completed on time and more than 50% of projects face cost overrun. Since completion of projects on time and staying within budget are fundamental criteria of successful construction, it is vital to evaluate time and cost performance at the early stage and take necessary corrective actions.

A study in Malaysia by Rahman *et al.* (2006) recommended procedures to mitigate or even recover the delays, where more than one solution can be applied at the same time. This depends on the nature of the problems that cause the delay and the uniqueness of the project. However, previous researchers only provide recommendations and suggestions in general, and they did not match the mitigation measures with the corresponding factors. Then, this study also shows that there are three common methods used as tools for planning and controlling the quality of performance, and many projects use more than one technique (Rahman *et al.*, 2006). There were 25.6% of respondents who cited that they used bar charts, while 22.7%

depended on holding site meetings regularly with all functional groups involved, followed by 20.8% who conducted inspections on works during construction, and another 8.2% who used milestone monitoring. CPM scheduling, network analysis and detailed work procedure were used by 7.7% of the respondents and another 6.28% used work tables and follow-through method. This is an indicator that they were satisfied with what they were using then or that planning is done in a nonconventional way.

As stated by Olawale & Sun (2010), in order to improve project control, it is essential to understand the key factors that influence the performance of time and cost. This shows that, for effective control of time and cost overrun, control should focus on factors of time and cost overrun. Even though Olawale & Sun (2010) have suggested the mitigating measures for the factors, they only focused on 5 factors, namely design changes, risk or uncertainties, inaccurate evaluation of project time/duration, complexities and non-performances of subcontractors. This is because they were found to be the same leading factors for cost and time control during the survey of the research. However, these factors and their numbers may vary for other types of organizations or in different countries.

Besides that, there have been a lot of studies focusing on mitigation measures since 1996, but not much information has highlighted the effectiveness of these measures. Then, a study by Memon *et al.* (2012) also developed 13 mitigation measures to improve time performance and 15 measures to improve cost performance of construction projects in Malaysia. However, this study did not critically review and discuss the effectiveness of the mitigation measures since they just provided general recommendations or suggestions that are not specific for the factors at the end of the study. The suggested controlling measures were not verified whether they were suitable or not to mitigate the factors. Furthermore, some mitigation measures are relevant to reduce the possibility of the common factors of time and cost overrun in the civil construction industry. However, their effectiveness will not be certain until they are actually applied by civil construction practitioners.

According to Memon *et al.* (2014), the construction industry today is facing a major risk in completing projects within the estimated time and budget. The study by Ismail *et al.* (2013) found that 85% of factors have been reported as causes of time and cost overrun in the construction phase. In the design phase, 28% of factors are likely to cause time and cost overrun. This is followed by finishing phase and finally

planning phase, where 22% and 17% of factors respectively can possibly occur. This shows that time and cost overrun occur throughout the project lifecycle, which is in the planning phase, design phase, construction phase and finishing phase. To solve the problems, the causative factors and corresponding mitigation measures of time and cost overrun on project success throughout the lifecycle of the construction process need to be assessed.

This study focuses on suggesting effective mitigation measures to control critical factors causing time and cost overrun throughout four phases (planning, design, construction and finishing) of project life cycle in the Malaysian construction industry.

1.3 Research Aim and Objectives

The aim of this study is to investigate the suitable mitigation measures for controlling time and cost overrun factors throughout the project life cycle. In achieving this target, the objectives are:

(i) To determine the critical level of time and cost overrun factors to be overcome through appropriate mitigation measures;

(ii) To determine the relevancy of factors and mitigation measures in controlling time and cost overrun; and

(iii) To determine the effectiveness level of mitigation measures in controlling time and cost overrun throughout the project life cycle.

1.4 Significance of the Research

In achieving a successful completion project, it is very crucial to control time and cost overrun of construction projects. However, nowadays, the construction industry is facing a major risk in achieving completion of the project within estimated time and cost (Memon *et al.,* 2014). Various factors cause this risk. There is still a significant gap in emerging knowledge on the establishment of a reference to improve time and cost overrun performance in construction projects. Even though in recent years numerous previous researchers have attempted to identify the factors of time and cost overrun, there is still lack of research in identifying the effective mitigation measures for controlling the factors.

This study presents a solution in controlling the critical problem of time and cost overrun faced by the construction industry in the Malaysian perspective. Time and cost overrun are global concerns and are associated to almost every project (Memon *et al.*, 2014). This research will help practitioners in Malaysia to implement the mitigation measure throughout four phases of project life cycle, i.e., planning phase, design phase, construction phase and finishing phase, in order to achieve successful construction projects.

These measures are by no means exhaustive as there will obviously be numerous practices out there that have not made the list. It is also worth noting that the measures may seem obvious to the experienced practitioner and will be useful to people who are new and inexperienced in the project management profession.

Finally, this research will provide opportunities to other researchers to establish the basis for future research to explore the mitigation measures for controlling time and cost overrun.

1.5 Research Scope

This scope of the research is limited to the construction industry in Selangor, Negeri Sembilan, Melaka and Johor. In conducting the questionnaire survey, the Delphi technique was adopted. The respondents involved in data collection are limited to the construction practitioners who have more than ten years of experience in the construction industry. Besides that, the participants involved in this study are consultants, clients, and contractors, including main contractors and sub-contractors, as well as local authorities.

A total of 35 factors contributing to time and cost overrun were considered in this study, which were clustered in four phases of project life cycle, namely planning, design, construction and finishing. The factors and their allocation over the project life cycle were adopted from Ismail, Memon & Rahman (2013). These 35 factors were identified through literature and interviews with the experts of the construction industry as laid out by Ismail *et al.* (2013). Furthermore, this study identifies the expert opinion on risk level for factors affecting time and cost overrun along the project life cycle in Malaysian construction projects. Since the aim of this study is to identify the effectiveness of mitigation measures for controlling time and cost

overrun in the Malaysian construction industry, these 35 factors are applicable in order to investigate the suitable mitigation measures for the factors.

1.6 Organization of Thesis

The thesis is divided into five chapters as follows:

Chapter 1 – Introduction:
This section contains background of the study, problem statement, aim and objectives, significance of the study and also the scope and limitations of the study.

Chapter 2 – Literature Review
This chapter discusses the review of previous researches on the factors affecting time and cost overrun and also mitigation measures for controlling the factors. Factors and mitigation measures in the construction industry are presented in detail. Gaps are identified, and how this research is positioned to fill in these gaps is discussed.

Chapter 3 – Research Methodology
The chapter explains the methodology used in this study. It includes details of the method of data collection and analysis. The rationale of the methods chosen for data collection is also presented. In addition, this chapter presents the data analysis techniques and the statistical software packages used in this study.

Chapter 4 – Data Analysis and Research Findings
This chapter focuses on the analysis of gathering and analyzing data in suggesting suitable mitigation measures for controlling time and cost overrun factors. Besides that, it describes the analysis of the data. Data is presented, and the results are tabulated. The interpretation of the results is also discussed.

Chapter 5 – Conclusion and Recommendation
This final chapter comprises of the findings of this research. It also highlights the limitations and recommendations for future studies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is conducted for the purpose of exploring mitigation measures for controlling time and cost overrun. This literature review starts by exploring the concept and issues of time and cost overrun in the construction industry. It also discusses various factors causing time and cost overrun in the construction project. Subsequently, the mitigation measures for controlling time and cost overrun factors are identified from comprehensive literature review and explained in this chapter.

2.2 Concept of Time and Cost Overrun

Numerous projects are experiencing time and cost overrun caused by exceeding schedule and budget of the projects as this is one of the challenges faced by the construction industry (Sweis *et al.*, 2008). Construction projects in Malaysia experienced 92% of overrun and thereby exceeded initial time and cost estimates, and only 8% of the projects achieved the completion within the schedule baseline (Rahman *et al.*, 2012). Hence, it is imperative to avoid time and cost overrun problems in the projects. Thus, it is essential to understand the concept of time and cost overrun. This subtopic focuses on explaining this concept for better understanding.

2.2.1 Time Overrun Definition

Many literatures and actual projects indicate that construction cost overrun is a common problem in the construction field (Cheng, 2014). Time in the construction industry is usually measured by schedule (González *et al.,* 2014). Besides, a schedule of a construction project can be defined as the duration from the date of approval of the project and its expected date of completion (Danso & Antwi, 2012). If the project does not complete on time within planned schedule, it is commonly known as time overrun or delay (Tumi *et al*., 2009; Kaliba, Muya & Mumba, 2009; Kaming *et al.*, 1997; Memon *et al.*, 2012). As stated by Danso & Antwi (2012), the ratio of the time overrun and the execution phase of the project, multiplied by one hundred is defined as time overrun and expressed in percentage.

According to Tumi *et al.* (2009) time delay has two categories which are inexcusable delays and excusable delays. The excusable delays are divided into two categories that are non-compensable delays and compensable delays. Inexcusable delays are caused by the fault of the contractors or suppliers. The carelessness of the contractor leads to many cases of project delays which have caused penalty payments. On the other hand, the compensable delays result from acts or omissions of the owner or the owner's agents. It is usually caused by an extension of the schedule and exposes financial damages to the owner. Non-compensable delays are caused by incidents that are beyond the control of any parties or occurrences typically by acts of God such as unusual weather, fires, etc.

Every company has their plans to complete the construction work on time as an integral part of the contract (Kaliba *et al.,* 2009). Hence, a common requirement is construction projects need to be completed on the schedule.. Unfortunately, in reality many projects suffer from time overrun which require effective project time control (Olawale & Sun, 2013).

In this study, time overrun can be defined as the extension of time in the completion of project. In short, time overrun means failure to complete project in targeted time as agreed in contract (Danso & Antwi, 2012).

2.2.2 Cost Overrun Definition

Most countries worldwide are facing many problems on cost performance such as Malaysia, Gaza, Nigeria, Pakistan, Egypt, Greek and India. Cost overrun on a construction project is one of the major issues which describes inability to complete the project within the limited or specified cost (Rahman, Memon & Karim, 2013). This issue of cost overrun in Malaysia is considered as significant in the construction industry (Ali & Kamaruzzaman, 2010).

Cost overrun is also known as cost escalation where actual cost exceeds the approved cost or original budget for construction of the project (Danso & Antwi, 2012; Kaliba *et al.*, 2009; Memon *et al.*, 2012). Uncontrolled cost overrun may lead to the increase in construction cost and affect the decision-making for investment. National finance will be wasted which might result in corruption or offense (Ali & Kamaruzzaman, 2010). Hence, to ensure successful projects, it is essential to find the solution for effective project cost control (Olawale & Sun, 2013).

In this study, cost overrun occurs when the final cost of the project exceeds the original contract value at the time of completion (Danso & Antwi, 2012). The difference between the original cost and the actual cost when the project is completed is cost overrun.

2.3 Issues of Time and Cost Overrun

A serious challenge of time and cost overrun in the construction industry is experienced globally. The common requirement for the success of all construction projects are being completed on-time and within budget (Olawale & Sun, 2013). Unfortunately, in reality there are many projects incur time and cost overrun. Time and cost overrun is common in various construction projects and they cause considerable losses to project parties. Besides that, client satisfaction would be compromised if the project time and cost exceed their planned targets.

According to Flyvbjerg *et al.*, (2003) cost overrun is a worldwide phenomenon, across 20 nations. Estimation of cost does not improve, and the cost overrun does not decrease over the past 70 years. From the study in transportation, infrastructure projects show that the average cost overrun for rail is 45%, for tunnels

and bridges 34%, and 20% for roads. The perspective of respondents towards time and/or cost overrun in various countries is summarized in Table 2.1.

Table 2.1: Perspective of respondents towards time and/or cost overrun

Country	Perspective of Respondents towards Time and/or Cost Overrun	References
Vietnam	The construction projects encountered time overrun as; Often = 72% Rarely = 4% Always = 24% The average of time overrun of the original construction duration as; 10%-20% = 46% More than 20% = 24%	Luu *et al.* (2009)
Zambia	A significant number of projects experienced time overrun: Many projects = 60% Quite a few projects = 30% Negligible = 10% A significant number of projects experienced cost overrunt: Many projects = 40% Quite a few projects = 30% Negligible = 30%	Kaliba *et al.* (2009)
Indonesia	The average of time overrun of the original construction duration as: Completed more than 90% = 55% Completed less than 70% = 30% Completed between 70%-90% = 15% The average of cost overrun of the original construction duration as: Completed more than 90% = 20% Completed less than 70% = 28% Completed between 70%-90% = 52%	Kaming *et al.* (2010)
Ghana	The average of time overrun of the original construction duration as: 82% time overrun on the average of 35% to 55% The average of cost overrun of the original construction duration as: 40% faced cost overrun on average 25% to 35%	Danso & Antwi (2012)

In recent years, there have been numerous studies on project time and cost overruns worldwide. Table 2.2 shows the projects experiencing time and/or cost overrun.

Table 2.2: Projects experiencing time and/or cost overrun

Country	Projects Experiencing Time and/or Cost Overrun	References
Saudi Arabia	59% projects are experiencing time overrun	Assaf & Al-Hejji (2006)
Pakistan	More than 90% of project delays in Pakistan get over budgeted	Nawaz *et al.* (2013)
India	57% projects in India are experiencing time overrun	Salunkhe & Patil (2014)

In Nigeria, time overrun is found to be the most significant effect of delay on building project delivery followed by cost overrun. When an activity on the critical path starts late, this will lead to the delay of completion. Hence, this will cause overall time schedule slippage of the project. Next, the delay of the project will cause additional costs to be borne. According to Aibinu & Jagboro (2002), It is not a surprise that cost overrun is the most common effect of delays in Nigerian projects.

These aforementioned studies show that time and cost overrun is a common issue in the construction industry. Although numerous models and methodologies dealing with the cost estimation and managing escalations in projects have been developed over the past years, there is still a significant knowledge gap in establishing a reference for the practices across the industry.

2.4 Example of Time and Cost Overrun in Malaysia

Construction industry is an extremely dynamic sector which is growing fast and plays an imperative role in the development of Malaysia. . However, the construction industry in Malaysia is facing chronic problems including poor performance of time and cost, construction waste, poor productivity and over-dependent on foreign workers (Memon *et al*., 2012). As a consequence, most of the projects face a tremendous amount of time and cost overrun (Sambasivan & Soon, 2007).

Issues of cost performance in Malaysia are considered significant to the construction industry. There are many factors that contribute to cost overrun in Malaysia's construction projects. The factors might become risky and lead to adverse effects on the projects (Ali & Kamaruzzaman, 2010).

According to the research by Abdullah *et al.* (2011), ranking of time and cost overrun are significant effects of delay. Besides, time overrun may lead to cost overrun. It is due to the extension of time on the projects which affects the payment of additional labour salaries, utility bills etc. result in the increase of cost.

Besides that, various reports published by National Audit Department of Malaysia and national newspapers have highlighted different case studies of projects facing time and cost overrun. According to the National Audit Department (2012), the construction of market, bus and taxi stations in Labuan had experienced delays. The construction of the landfill was delayed for about 40 months. The construction of the bus and taxi stations experienced a delay for about three years and 8 months in which the projects should had been completed on 12 August 2009 but they were only completed on 15 March 2013. The delay in the market construction was due to the unqualified contractors with no experience in building construction and who were facing financial problems. The construction work by the contractors were also unsatisfying. Besides that, the cost of construction in the market had increased by 34.8% that it had increased from RM24.89 million to RM33.54 million. Payments were made to the original contractor amounted to RM8.55 million for the construction of the market and RM2.72 million for the construction of the bus and taxi stations. It can be summarized that the construction of market, bus and taxi stations in Labuan did not meet the required time and cost performance. It faced overrun of time by more than 30% while cost had increased by about 34.8% from the planned cost.

Besides that, the University Malaysia Kelantan (UMK) Campus had also experienced delays between 176 to 445 days (The National Audit Department, 2012). This happened due to the contractor's delay in applying for the extension of time and the delay by the Kelantan State Public Work Department (PWD) in approving the extension, therefore, the monitoring of the construction project was also ineffective (The National Audit Department, 2012).

The construction of the new Kuantan Court Complex was delayed for 560 days, with a cost overrun of RM19.56 million as stated by The National Audit Department (2013). The Complex construction project started on 8 July 2009 with a contract period of 78 weeks and cost RM157.34 million. However, the project was only completed on 17 July 2013, with a cost of RM158 million. Furthermore, the audit revealed that the construction of Banting Polytechnic, Selangor was delayed

too (The National Audit Department, 2013). However, the construction was completed within the approved time when the extension of time was granted. Even though the construction of polytechnic was satisfactory, the delay was a sign of weakness.

The Kuala Lumpur International Airport 2 (KLIA 2) is built to be an international airport centre that allows seamless connectivity for both local and international low-cost and full-service carriers. In the beginning stage, the KLIA 2 measured about 150,000 sqm, and it was designed to cater for 30 million passengers a year. In the schedule, KLIA 2 was planned to be completed in April 2012 with the cost of RM2 billion. However, during the construction phase, the KLIA 2 was revised to 257,000 sqm with an increase of 71% . The capacity was also increased to cater for over 45 million passengers. It was rescheduled to open in May 2014, and the cost had risen to 3.6 billion Malaysian Ringgit. The completion of the airport had been delayed five times. Delays were caused by the difficulties in building the structure on reclaimed land. The land, consisting mostly of former palm oil plantations, had to be drained and levelled, which was a time-consuming process (Kaur and Najib, 2013). In essence, the KLIA 2 was facing time and cost overrun. The construction was delayed for about one year from the scheduled plan. Other than that, the cost had also increased from 2 billion Ringgit Malaysia to 3.6 billion Ringgit Malaysia.

Besides, the delays in the completion of the aquatic complex situated in the Tuanku Syed Sirajuddin Putra Sports Complex, had caused swimming and diving events for Malaysian Games (SUKMA) to be delayed as reported by the The News Straits Times (2014). The delay was due to the late approval by the authority to build the sports complex (Pillai, 2014). Hence, the delays had resulted in the aquatics competition starting a day late.

This indicates that time and cost performance of Malaysian construction industry is not satisfactory. It is necessary to assess time and cost performance on construction projects. The poor time and cost performance in construction projects is a result of various factors and it is very important to uncover these factors. These factors are also investigated and mitigation measures are proposed to control these factors.

2.5 Common Factors of Time and Cost Overrun

Several studies have been carried out to determine the factors of time and cost overrun in construction projects. Various researchers have identified the factors of time and cost overrun such as inaccurate time and cost estimates, mistakes during construction, inadequate monitoring and control, cash flow and financial difficulties faced by contractors, poor financial control on site, and others (Danso & Antwi, 2012; Kaliba *et al.*, 2009; Kaming *et al.*, 1997; Lo *et al.*, 2006).

Table 2.3: Time and cost overrun factors (Ismail *et al.*, 2013)

No	Factors
1	Poor site management and supervision
2	Incompetent subcontractors
3	Schedule delay
4	Inadequate planning and scheduling
5	Lack of experience
6	Inaccurate time and cost estimates
7	Mistakes during construction
8	Inadequate monitoring and control
9	Frequent design changes
10	Mistakes and errors in design
11	Incomplete design at the time of tender
12	Poor design and delays in Design
13	Delay Preparation and approval of drawings
14	Cash flow and financial difficulties faced by contractors
15	Poor financial control on site
16	Financial difficulties of owner
17	Delay in progress payment by owner
18	Delay payment to supplier /subcontractor
19	Contractual claims, such as, extension of time with cost claims
20	Lack of coordination between parties
21	Slow information flow between parties
22	Lack of communication between parties
23	Labour productivity
24	Shortage of site workers
25	Shortage of technical personnel (skilled labour)
26	High cost of labour
27	Labour absenteeism
28	Fluctuation of prices of materials
29	Shortages of materials
30	Late delivery of materials and equipment
31	Equipment availability and failure
32	Poor project management
33	Change in the scope of the project
34	Delays in decisions making
35	Inaccurate quantity take-off

This study is an extension of the research work carried out by Ismail *et al.* (2013) regarding identifying significant factors contributing to cost overrun. Ismail *et al.* (2013) has identified a total of 35 factors of cost overrun. The 35 factors are selected because of their importance and the fact that they are common for both cost and time control. Time and cost overrun are directly related to each other and it is difficult to separate the factors causing overrun between time and cost as the reasons for cost increase are normally also the reason for time extension (Aibinu & Jagboro, 2002; Memon *et al.*, 2010a). Hence, in this study the same factors are considered as contributing factors for both time and cost overrun. Table 2.3 presents 35 factors that cause time and cost overrun.

2.6 Project Life Cycle of Construction Projects

Every construction project has a life cycle phase which undergoes through several processes. Each phase involves various parties and activities that are interrelated and overlapped (Memon *et al.*, 2014). The project's life cycle has identifiable start and end points which can be associated with time scale (Saad, 2011). All the processes in project life cycle need coordination, team work, decision making, technical capabilities, benchmarking and scheduling techniques.

A project passes through several distinct phases as it matures, as a study by Saad (2011), showed the sequence of five phases of a project life cycle. The phases are; Phase 1: Conceptual Planning and Economics (Feasibility Study) Phase; Phase 2: Engineering and Functional Design Phase; Phase 3: This phase includes three sub-phases: 3-1 Preparing Drawings and Specifications, 3-2 Tender and Award 3-3 Procurement; Phase 4: Construction and Completion of the Project (Implementation) Phase; and Phase 5: Operation and Utilization Phase.

Another research by Memon *et al.* (2014) classified project life cycle into four phases. The first phase of any project is the project initiation which is the beginning phase to start up a new project. This phase focuses on examining the feasibility of the project. Once the feasibility study is accomplished, the project enters the planning phase. Planning phase focuses on preparing details of the project, activity planning and designing the working mechanism. Furthermore, the objectives and scope of the project are properly defined; project cost and benefits are documented clearly. Besides that, the project team is formed, and every member of

the team is assigned the duties and the project office is established. A complete list of work items and required resources are prepared, and the system for monitoring, controlling the resources and work schedule is devised. Third phase of the project life cycle is the actual project execution, where concentration is given to communication between the parties involved so that quick decision can be made to ensure the project run smoothly. Work in execution phase follows the schedule of items prepared in the planning phase. Actual execution work is undertaken by the contractors while the consultants are responsible for monitoring the work progress to achieve better quality, verify the work done to process the monthly payments of the contractors and so on. The final phase of the project is the closure which deals with the hand over and taking over process so that contractually the project can be finished (Memon *et al.*, 2014).

In this study, as this study is an extension work from Ismail *et al.*, (2013) there are four basic phases that contribute to transform a project from an idea into reality. Mainly, a project life cycle contains four basic phases as shown in Figure 2.1.

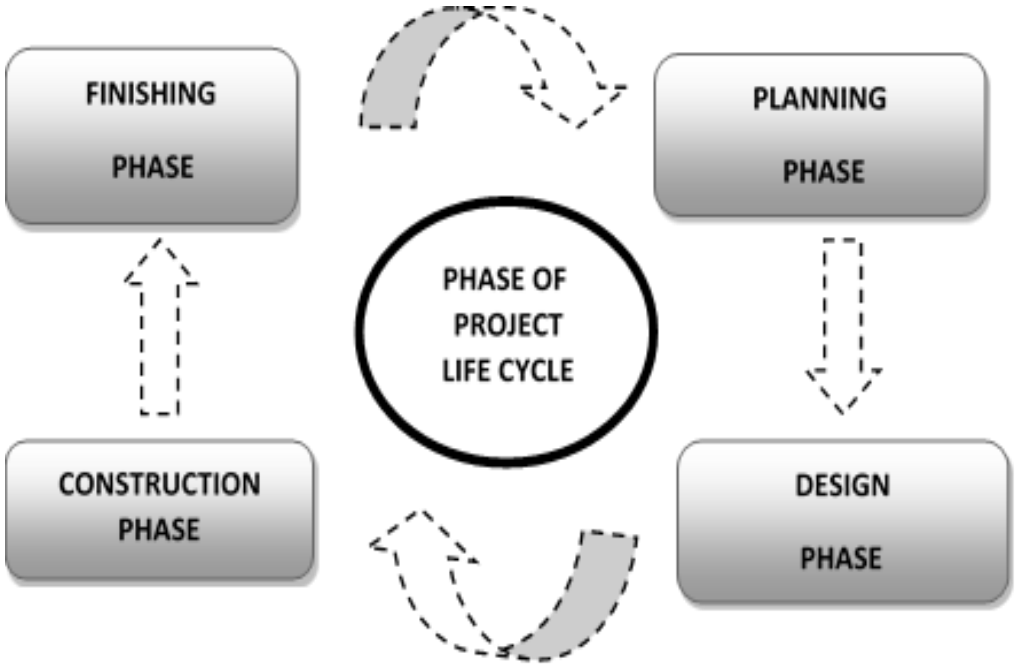

Figure 2.1: Project life cycle phases (Ismail *et al.*, 2013)

A study by Ismail *et al.* (2013) identified the factors of time and cost overrun in accordance with their occurrence at various stages and phases of project life cycle i.e. planning phase, design phase, construction phase and finishing phase. Hence, the definition of each phase is;

- Planning phase:

  The planning phase emphasizes complete and detailed plan as necessary to meet the objective requirement of a project. At this stage, it needs to identify the project's task and resource requirements, along with the strategy for the project. This is also known as scope management. A project plan is created to outline the activities, tasks, dependencies and timeframes. The preparation of the budget is also in this phase as the cost estimates for the labour, equipment and material costs are determined at this stage.

- Design phase:

  The next phase, the design phase, is where the project preparation of detailed plan and drawings. A sufficient number of drawings are then completed to communicate the preliminary design concepts. The number of drawings required is strictly dependent upon the size and complexity of the project. Construction practitioners involved in this phase are responsible for providing drawings according to the owner's requirements, and any changes can be made before the project is approved.

- Construction phase:

  The third phase i.e. construction phase, means the project plan is put into motion and performs the work of the project. It is important to maintain control and communication as needed during this phase. Progress is continuously monitored, and appropriate adjustments are made and recorded as variances from the original plan. During construction phase, the construction practitioners involved in the projects carry out the tasks and progress information is reported through regular team meetings.

- Finishing phase:

  Finishing phase is the concluding stage of a construction work. It is actually the emphasis on the construction of architectural finishing work. The architectural finishing works are simple and complex finishing works for floors and walls, decorative interior and exterior paints, floor coverings, instalment of doors, windows, ceilings and others.

2.7 Effectiveness of Mitigation Measures for Controlling Time and Cost Overrun

Construction project delay and over budget have been a major setback in the last decades and is an even more serious issue in developing nations. Awareness regarding this phenomenon seems high while tremendous effort has been placed in identifying its contributors and mitigation plans but time and cost overrun still remains an important topic within the industry (Riazi, Riazi, & Fiona, 2013).

Keeping construction projects within estimated costs and schedules requires sound strategies, good practices, and careful judgment. There are, however, steps that can be taken to minimise their causes and effects of time and cost overrun, the major one is using efficient project management tools and practices. Thus, previous researchers have given recommendations or suggestions to help accomplishing time and cost overrun reduction in construction projects.

A study by Abdul Rahman *et al.* (2006) recommended procedures to overcome or mitigate the effect of delay. All of the interviewees agreed that site meetings are essential in solving the problems with the condition that it should not be too frequent because then it will be a waste of time, and those attending should be seniors and are authorized to make decisions. This form of communication method confirmed the importance of site meetings to the top management view in the questionnaire findings. From the survey, recommended procedures to increase the productivity were by working overtime or working by shifts (29.2%) followed by asking for extension of time (24%). If the problem was the shortage of resources, 32.3% suggested rescheduling the activities within the available resources, 27.8% by using more general and skilled labours and 12.8% by using subcontractors. This means that there are no specific procedures to mitigate or overcome delays in projects but it depends mainly on the causes, the nature of the problem, and the

availability of resources. However, this study showed that the controlling measures are not related to the specific factors or causes of the delays. Hence, this important research leaves a gap which the current study seeks to fill, namely to find the specific mitigation measures for the factors of time and cost overrun in construction projects.

Then, the study of construction delays in Hong Kong was investigating the suggestions as stated in the report of the Construction Industry Review Committee (CIRC). The Committee comprises members with good standing and knowledge in the construction and related fields as well as those from other professions who are responsible for examining the current state of the construction industry in terms of its output quantity, the quality of work, its environmental friendliness, site safety, its workforce and the system of supervision are applicable to and effective at mitigating the corresponding delays (Lo *et al.,* 2006). Hence, this study revealed that although some mitigation measures have been suggested in the CIRC report, the respondents' perceptions of their effectiveness are not totally in line with the significance of the corresponding causes of construction delay.

Table 2.4: Most significant causes of construction delay and corresponding mitigation measures as stated in the CIRC report in 2001 (Lo *et al.,* 2006)

Causes of delay	Corresponding mitigation measures as stated in CIRC report
Unforeseen ground conditions	To reconsider the recommendations of the consultancy study on the General Conditions of Contract for Public Works Projects with the objective of achieving a more equitable allocation of risks between contracting parties
Poor site management and supervision by consultants	Clients to enforce acceptance standards and to consider designated site supervision proposals as a critical criterion for tender evaluation. For consultant- managed projects, clients to require consultants to demonstrate that they have satisfactorily carried out their supervisory role in all project activities
Client variations	Clients to exercise robust change control, with particular emphasis on comprehensive project planning of scope and risk assessment at the project outset
Environmental restrictions	Environment and Food Bureau and Environmental Protection Department to conduct a regulatory impact assessment on the cumulative impact of the environmental legislation on the construction industry

As shown in Table 2.4, the respondents thought that the recommended delay mitigation measures corresponding to the causes of delay were relatively less effective and even ranked out of the top ten (Lo *et al.,*2006). This shows that these suggestions are not effective enough to mitigate the corresponding delay problem.

Nevertheless, the CIRC report is considered to be a good starting point for tackling the delay problem in the Hong Kong construction industry.

In addition, there have been a lot of researches that focused on mitigation, but not much information to emphasize the effectiveness of these measures. There is no critical review of the mitigation measures, meanwhile they only give general recommendations or suggestions for effectiveness rather than specific factors and the corresponding mitigation measures. The recommended control measures have not been verified whether they are suitable to mitigate the factors. Furthermore, a number of mitigation measures are possible to reduce the time and cost overruns in the civil construction industry. However, until they are actually applied by the civil construction, practitioners will not be able to determine their effectiveness.

Since there have been a lot of studies focusing on mitigation measures, a comprehensive literature review consisting of 21 published articles have been used in identifying 58 mitigation measures related to control time and cost overrun issues as summarized in Table 2.5.

Table 2.5: Mapping of mitigation measures from previous studies

No	Mitigation Measures	Chan *et al.* (1996)	Al-Tabtabai (2002)	Frimpong *et al.* (2003)	Koushki *et al.* (2005)	Assaf & Al-Hejii (2006)	Le-Hoai *et al.* (2008)	Kaliba *et al.* (2009)	Enshassi *et al.* (2009)	Ali & Kamaruzzaman (2010)	Ameh, *et al.* (2010)	Olawale & Sun (2010)	Doloi *et al.* (2012)	Memon *et al.* (2012)	Danso & Antwi (2012)	Gunduz *et al.* (2013)	Aziz (2013)	Pai & Bharat (2013)	Memon *et al.* (2013a)	Nawaz *et al.* (2013)	Gunduz *et al.* (2013)	Marzouk & El-Rasas (2014)
1	Accurate cost estimation									x												
2	Allocate adequate contingency allowances	x		x					x	x												
3	Adopt clear information and communication channel													x								
4	Adopt effective and efficient material procurement systems			x													x					
5	Allocate sufficient time and money				x		x															
6	Application of professional construction management (CM)		x																			
7	Appoint competent site managers					x																
8	Appropriate scope definition							x		x												
9	Approval project from relevant parties								x													x
10	Assess materials available with the contractors								x													
11	Choose experienced subcontractors with good reputation																x					
12	Close monitoring													x	x							
13	Competent designer									x												
14	Competent project manager												x									
15	Comprehensive contract administration													x								
16	Conducting a process mapping exercise											x										
17	Contractors should improve their project management skills and articulate their resources																			x		
18	Control the design changes																x					

Table 2.5 (continued)

19	Design changes should be adequately highlighted and updated on all relevant project documentations											x										
20	Designing the project to a great detail at the outset whenever possible											x										
21	Developed strategy for solving the identified risk											x										
22	Developing project programme based on experiences planners											x										
23	Development of a comprehensive financial plan and cash flow																			x		
24	Development of a cost monitoring and periodical reporting of critical and long lead items		x																			
25	Development of a good monitoring and controlling system																					x
26	Development of a proper system of site management and supervision																					x
27	Develops realistic planning and scheduling for the project																					x
28	Effective coordination								x					x					x			
29	Effective financial management and control																		x			
30	Effective planning and scheduling							x						x			x		x			
31	Enough number of labour																	x				
32	Ensure there are adequate time to complete the work											x										
33	Ensuring design changes are reasonably timed when possible											x										
34	Ensuring prompt resolution to design change queries, issues and authorisation requests											x										
35	Ensuring the time and cost implication of a design change is always determined and agreed											x										
36	Having a design manager to responsible for the design changes											x										
37	Having enough resources to deal with the complexity											x										
38	Hire competent labour																x				x	
39	Incentive schemes					x																
40	Making sure the risk register is a live document that is updated regularly											x										
41	Must ensure the timely availability of required finance				x																	
42	Owners are recommended to review and improve bid documents																		x			
43	Permission from law enforcement agencies should be sought in advance to beef up on site security										x											
44	Plan a time schedule for material delivery process																					
45	Producing design documents on time																	x				
46	Progress payments to sub-contractor/supplier must be made on time																					

Table 2.5 (continued)

47	Promote open communication	x																		x		
48	Promote team building communication processes							x														
49	Prompt progress payments from clients															x						
50	Proper motivation and safety systems								x													
51	Provide training to unskilled workers based on their scope of work								x								x					
52	Quick design approvals																		x			
53	Quickly informed the relevant parties when unforeseen circumstances affect the programme/lead-in times										x											
54	Reliable contractor				x					x						x	x					x
55	Safety and health program																		x			
56	Select experienced and capable subcontractors										x											
57	Selecting a consultant who has sufficient experience in similar nature of works and has a good reputation										x											
58	Subcontractor has capability to deal with the complexity										x							x				x

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