STRUCTURAL MODELLING OF COST OVERRUN FACTORS IN CONSTRUCTION INDUSTRY

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ABSTRACT

Construction industry contributes significantly in improving socio-economic growth of a country. However, this industry usually faces chronic problems such as time overrun, cost overrun, poor quality and others. Of all these, cost overrun is a major problem that occurs globally including Malaysia. Cost overrun is resulted from various factors which are essential to identify for improving cost performance in construction project. Hence, this study focused on identifying and modelling the factors of cost overrun for construction projects in Malaysia. Data collection was done through structured questionnaire, which was designed based on 78 factors found from the literature. Qualitative pilot study was done based on the opinions of 15 experts in the construction industry to improve the questionnaire by reducing the factors to 58. The questionnaire survey was carried out among clients, consultants and contractors. A total of 231 questionnaires were collected of which 213 responses were found valid. Partial Least Square Structural Equation (PLS-SEM) model was developed based on 8 categories/constructs generated through factor analysis test and found that Global Fit Index (GOF) of the model to be 0.37. The findings from the model indicate that all the 8 categories have significant effect on the cost overrun. The most significant category is contractor's site management related issues with path co-efficient value of 0.448. The developed model was validated statistically (using power analysis and predictive relevancy) and through interviewing 21 experienced practitioners. Statistical validation tests showed that the developed model had achieved substantial power in explaining cost overrun problem. All the experts agreed with the factors and also categories of the model have significant impact to cost overrun.
ABSTRAK

Industri pembinaan menyumbang secara ketara dalam meningkatkan pertumbuhan sosio-ekonomi sesebuah negara. Walau bagaimanapun, industri ini sentiasa menghadapi pelbagai masalah kronik seperti lebihan masa, lebihan kos, kualiti yang rendah dan lain-lain. Dari semua ini, lebihan kos adalah masalah utama yang berlaku di seluruh dunia termasuk Malaysia. Lebihan kos adalah hasil dari pelbagai faktor yang penting untuk dikenal pasti bagi meningkatkan prestasi kos dalam projek pembinaan. Oleh itu, kajian ini mengfokuskan kepada mengenal pasti faktor serta membina model lebihan kos untuk projek pembinaan di Malaysia. Pengumpulan data dilakukan melalui borang soal selidik berstruktur yang direkabentuk berdasarkan 78 faktor hasil kajian literatur. Kajian rintis berbentuk kualitatif dilaksanakan berdasarkan pendapat 15 pakar dalam industri pembinaan bagi memperbaiki borang soal selidik dan hasilnya bilangan faktor menjadi 58 sahaja. Soal selidik sepenuhnya dijalankan di kalangan klien, perunding dan kontraktor. Sebanyak 231 borang soal selidik telah dipulangkan dan hanya 213 borang adalah sah. Model Partial Least Square Structural Equation (PLS-SEM) dibangunkan berdasarkan 8 kategori / konstruk dijana melalui ujian analisis factor dan didapati Global Fit Indeks (GoF) model tersebut adalah 0.37. Penemuan menunjukkan bahawa semua 8 kategori mempunyai kesan ketara terhadap lebihan kos. Kategori yang paling ketara adalah isu berkaitan pengurusan kontraktor di tapakbina dengan nilai angkali 0.448. Model yang dibangunkan telah disahkan melalui statistik dan melalui temuramah dengan 21 pakar pembinaan yang berpengalaman. Pengesahan statistik menunjukkan model yang dibangunkan telah mencapai kuasa yang ketara dalam menjelaskan masalah lebihan kos. Semua pakar bersetuju bahawa faktor dan kategori yang terdapat dalam model mempunyai impak yang ketara terhadap lebihan kos.
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CHAPTER 1

INTRODUCTION

1.1 Background

Construction industry is a very important industry that plays a vital role in the socio-economic growth of a country. Economically, it contributes significantly in the improvement to the overall GDP of a country. It also improves the quality of life by providing necessary infrastructure such as roads, hospitals, schools and other basic and enhanced facilities. Hence, it is fundamentally crucial to make the construction projects complete successfully within the time, budget and quality expected. However, being a complex, fragmented and schedule driven industry it is always facing chronic problems such as low quality, low productivity, cost overrun, time overrun, construction waste etc. Of these, cost overrun is the major problem as money is always of high importance.

Cost overrun is a global phenomenon in the construction industry and very rarely projects are finished within the budgeted cost. The issue of cost overrun in construction projects is very dominant in both developed and developing countries but this trend is very severe in developing countries where these overruns sometimes exceed 100% of the anticipated cost (Azhar, Farooqui, & Ahmed, 2008).

Flyvbjerg, Holm, & Buhl (2003) in their global study of construction project performance concluded that cost overrun is a major problem in the construction industry where 9 of 10 projects are faced by these overruns which commonly range between 50 to 100%. In developed countries like UK also construction industry is affected by this problem (Olawale & Sun, 2010) and nearly one third of the client’s complaint that their projects generally overrun the allocated budget (Jackson, 2002).
1.2 Problem Statement

Like other developing countries, Malaysia also facing a serious issue of cost overrun in construction industry (Ali & Kamaruzzaman, 2010, Sambasivan & Soon, 2007, Abdullah et al., 2009 and Ibrahim et al., 2010). This is confirmed with a research conducted by Endut, Akintoye, & Kelly (2009) showing that only 46.8% of public sector and 37.2% of private sector projects were completed within the stipulated budget. The issue of cost overrun has become a serious concern of the investors, which needs a serious attention and in-depth research to put forward with solution to this issue.

According to Toh, Ali, & Aliagha, (2011), Malaysia needs more research works by academia and practitioners regarding construction cost factors. Since construction cost is the most dominant component of project’s life cycle, thus it is important to evaluate it before it is too late so that poor cost performance can be prevented (Cha & Shin, 2011). The impact of poor cost performance could lead to cost overrun which is an additional burden over the budgeted cost of project and this cost overrun can never be recovered. These overruns are resulted from various factors, thus it is important to identify and to control these responsible factors.

Further, there was no study done on assessing causal relationships among factors of cost overrun (Toh et al., 2011) and this give an opportunity to the author adopting Structural Equation Modelling (SEM) approach to assess and also to model the factors. SEM is a graphical equivalent of a mathematical representation (Byrne, 2010) with features of advance multivariate tool to determine the strength of the relationships between the factors (Jackson, Dezee, Douglas, & Shimeall, 2005; Hair, Anderson, Tatham, & Black, 1998). It is becoming very popular in analyzing cause–effect relations between factors (Hair, Ringle, & Sarstedt, 2011).

Hence, this study focuses on identifying major factors causing cost overrun run and developing a structural model in representing the factors affecting cost overrun for Malaysian construction industry.
1.3 Aim and Objectives

The aim of this study is to model the factors contributing to cost overrun in Malaysian construction industry. To achieve this aim, various objectives were set which include:

- Identifying the common factors causing cost overrun
- Assessing hierarchically the causative factors of cost overrun in Malaysian construction industry
- Developing Structural Equation Model (SEM) to assess significance of causative factors to cost overrun
- Validating the results of SEM

1.4 Scope of the Research

This study adopted quantitative approach in identifying and assessing the significant factors causing overrun. The data samples are collected through questionnaire survey amongst the clients, consultants and contractors involved in construction industry. Contractors were selected from “list of approved contractors” in Construction Industry Development Board (CIDB) Malaysia registered under category from G3 to G7.

1.5 Research Methodology

This study is based on three research methods which include literature review, interviews and questionnaires. These three methods acted as supplement to each other which made the data collection more comprehensive and meaningful. Basically, literature review focused on gaining a better understanding of cost performance and causative factors affecting cost overrun in construction projects. These factors were analyzed in conformance to represent the problems of cost overrun in prevailing construction industry of Malaysia through interviewing the experience personnel
involved in handling construction projects. Questionnaire survey was conducted to understand the perception of clients, consultants and contractors towards the factors causing cost overrun. Gathered data was analyzed with statistical tools in order to draw the conclusion in determining the current situation of cost overrun problem and factors contributing to this overrun.

1.6 Thesis Layout/Organization

This study focused on modelling the causative factors of cost overrun to propose the guidelines for controlling cost overrun problem in construction industry of Malaysia. The thesis for this study is divided into 6 chapters as follows:

Chapter One: This chapter discusses about the need of this study. It contains background of the study and problem statement to outline the primary objectives, scope of the study with introductory remarks.

Chapter Two: This chapter contains the review of published research works for related study on cost overrun issues and factors of cost overrun.

Chapter Three: This chapter illustrates the methodology adopted for this study. It provides details of various analyzing approaches used for data analysis together with the data collection strategy used.

Chapter Four: This chapter explains the descriptive analysis results including the hierarchal assessment of causative factors of cost overrun and comparison of findings with similar studies carried out in other countries.

Chapter Five: It discusses the structural equation modelling (SEM) analysis and achieved results of causal relationships. It also explains the course of validating the results and prosing the mitigation measure and guidelines to help the practitioners in controlling causative factors of cost overrun at source.

Chapter Six: The final chapter discusses about the conclusion achieved from this study with counsel for probable advancement and line of action for future works to provide more benefits in achieving cost control of construction projects.
CHAPTER 2

LITERATURE REVIEW

2.1 Construction Industry in Malaysia

Construction industry is necessary in every country to provide physical developments which help in improving social and economic needs of country (Abedi, Mohamad, & Fathi, 2011). Hence, construction industry has been growing rapidly worldwide.

Construction industry in Malaysia developed since its independence. The industry is generally classified into two areas namely general construction and special trade works (Ibrahim et al., 2010). General construction focuses on residential and non-residential constructions and also general civil engineering works. For special trade works, the activities involved are metal works, electrical works, plumbing, sewerage and sanitary works, refrigeration and air-conditioning work, painting work, carpentry, tiling and flooring work, and glass work. Figure 2.1 and 2.2 show the example of construction work of apartment complex and tunnel construction in Kuala Lumpur.

Construction industry has been an important drive in Malaysian economy (Ali & Kamaruzzaman, 2010). However, the volatile global economy between 2008 and 2009 constituted an overall decline in revenue stream in Malaysia’s construction market. It was a challenging period for the construction industry facing that economic crisis. According to (Rashid & Morledge, 1998) construction industry is considered in crisis if its growth is less than 5.4% of the Growth Domestic Product (GDP). Despite of these crises Malaysian construction industry has remained stable (Leung & Tam, 2004) and registered a strong growth of 5.8% in 2009. The industry
growth subsequently increased to 8.7% in 2010 as against that overall (GDP) growth of 10.1%. Realizing the huge impact on the economy, the government had allocated huge amount of the budget for construction development in Malaysia under 10th Malaysian Plan with a total sum of RM230 billion (Mansor, 2010).

**Figure 2.1:** Construction work on an apartment complex in Kuala Lumpur  
Source: Richter & Scheid (2011)

**Figure 2.2:** The construction of the tunnel at Bukit Berapit in Kuala Lumpur  
Source: Railway-Technology.com (2011)

In Malaysian construction industry, it is mandatory for the contractors to register with the Construction Industry Development Board (CIDB) before they are eligible to participate in any construction activities for both public and private
projects. A total of 66,904 contractors are currently registered with CIDB as classified in 7 categories ranging from grade G1 to grade G7 (CIDB, 2012) as shown in table 2.1.

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<th>Grade G3</th>
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<td>468</td>
<td>429</td>
<td>94</td>
<td>126</td>
<td>52</td>
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<tr>
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<td>500</td>
<td>557</td>
<td>185</td>
<td>152</td>
<td>59</td>
<td>128</td>
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<tr>
<td>Perak</td>
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<td>641</td>
<td>178</td>
<td>178</td>
<td>71</td>
<td>123</td>
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<tr>
<td>Perlis</td>
<td>925</td>
<td>92</td>
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<td>22</td>
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<td>418</td>
<td>141</td>
<td>164</td>
<td>89</td>
<td>367</td>
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<td>2,251</td>
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<td>816</td>
<td>283</td>
<td>1,005</td>
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<td>Terengganu</td>
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<td>356</td>
<td>147</td>
<td>209</td>
<td>76</td>
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<td>Wilayah Persekutuan</td>
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<td>870</td>
<td>2,325</td>
<td>529</td>
<td>1,106</td>
<td>368</td>
<td>1,448</td>
<td>8,469</td>
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<tr>
<td><strong>Total</strong></td>
<td>33,991</td>
<td>8,780</td>
<td>11,183</td>
<td>2,793</td>
<td>3,930</td>
<td>1,454</td>
<td>4,773</td>
<td>66,904</td>
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</table>

Source: (CIDB, 2012)

Table 2.1 shows that large group of contractors are in G1 grade which means that these contractors are entitled to participate in tendering for project with worth of maximum contract sum of not exceeding than MR 100,000. G2 contractors are suitable to participate in tendering for projects of contract sum not exceeding MR 500,000. Similarly, G3 and G4 contractors are qualified for tendering in project with maximum tender values of not exceeding than RM 1 million and RM 3 million respectively. G5 contractors can participate in tendering process of project of value not exceeding than RM 5 Million. Abdullah et al., (2009) stated that in Malaysia projects with contract value equal to or less than RM 5 Million are regarded as small projects. This means the contractors registered under grades G1 to G5 are eligible to
take part for tendering only in small projects. While, contractors registered in G6 and G7 grades are able to tender for small and large projects. However, grade G6 contractors are limited to tender up to RM 10 million project and G7 contractors have no limitation.

2.2 Problems in Construction Industry

Construction industry is considered as a locomotive of physical developments which bring substantial and significant impacts to the country’s economy (Kumaraswamy, 2006). However, it also contributes to negative implications especially to the environment and social aspect of a country. In addition, the industry is always facing chronic problems such as time overrun, cost overrun, waste generation (Hussin, Rahman, & Memon, 2012a), poor safety (Nahmens & Ikuma, 2009), poor quality, excessive resource consumption and threat to environment (Hussin, Rahman, & Memon, 2012b).

2.2.1 Time Overrun

Achieving completion of construction projects on time is a basic requirement. However, seldom projects are completed on time. This has become a worldwide problem. A study showed that the Vietnamese government has acknowledged this issue as a serious concern, especially with government-related funded projects (Le-Hoai, Lee, & Lee, 2008). In Nigeria, out of 3,407 projects only 24 projects were completed on time, while 1517 were delayed and 1812 were abandoned (Amu & Adesanya, 2011). Omorogie & Radford (2006) reported that the minimum average percentage escalation period of projects in Nigeria was found to be 188%. A similar research was conducted in Bosnia and Herzegovina on 177 projects and found that the contracted date was not met in 51.40 % of the projects (Zujo, Car-Pusic, & Brkan-Vežovic, 2010). Al-Momani (2000) conducted a survey on 130 public projects in Jordan and found delays occurred in 106 (82%) of the projects. Frimpong,
Oluwoye, & Crawford (2003) found that 33 (70%) out of 47 projects in Ghana were delayed. Whilst, in Saudi Arabia 70% of projects faced time delay with average time delay of 10% to 30% of the original duration of the project (Assaf & Al-Hejjii, 2006).

Likewise in Malaysia also, the construction industry is facing the same critical problem of time overrun (Alaghbari, Kadir, Salim, & Ernawati, 2007; Ibrahim et al., 2010; Sambasivan & Soon, 2007). Abdullah (2010) reported that more than 90% of large MARA construction projects experienced delay since 1984. Endut et al. (2009) studied on time performance of 359 projects (301 new constructions while 58 refurbishment projects) in Malaysia. Of these 301 were public projects and 51 private projects. The study found that only 18.2% of the public sector projects and 29.45% of private sector projects had 0% time deviation (no delays) while the average percentage of time overrun for other projects was 49.71%. Time Delay can be due to one or more reasons including problems of financing and payment for completed works. As an example, Yogeswaran, Kumaraswamy, & Miller (1998) scrutinized 67 civil engineering projects in Hong Kong and found at least 15–20% of time overrun was due to inclement weather.

### 2.2.2 Cost Overrun

Cost is one of the major considerations throughout the lifecycle of a project. Unfortunately, most of the projects failed to achieve project completion with the estimated cost. Besides time overrun, cost overrun is also a serious problem in the construction industry. This is a major problem both in developed and developing countries. The trend is more severe in developing countries where these overruns sometimes exceeds 100% of the anticipated cost of the project (Azhar et al. 2008).

The history of the construction industry worldwide is full of projects that were completed with significant amount of cost overruns. Despite the wide availability and use of different project management methods and software packages, many construction projects still suffer cost overruns (Olawale & Sun, 2010). Developed countries have lessons to learn as well since cost overrun in the construction industry is a worldwide phenomenon (Ameh, Soyingbe, & Odusami, 2010). Approximately 90% of projects worldwide have cost overrun ranging from 50
to 100% of project cost (Flyvbjerg et al., 2003). Like other countries, Malaysian
construction industry is also facing a lot of challenges in completing the construction
projects within the estimated cost (Ibrahim et al., 2010; Toh et al., 2011) and more
than 50% of projects face cost overrun (Endut et al., 2009).

2.2.3 Construction Waste

Waste is another serious problem in construction projects. Waste has direct impact
on the productivity, material loss and completion time of project resulting in loss of a
significant amount of revenue. Forsberg & Saukkoriipi, (2007) stated that the amount
of waste contributed is around 30-35% of a project’s production cost. The amount of
construction materials wasted on the site is relatively high and equals 9% by weight
of the purchased materials (Bossink & Brouwers, 1996). They investigated material
waste generated in a Dutch construction project and found that the average waste per
house was 6,860 kg which consisted of 4,480 kg of construction debris and 2,380 kg
of other types of solid waste.

In Malaysia also construction waste generation is becoming an important
issue (Begum, Satari, & Pereira, 2010; Nagapan, Rahman, Azis, Memon, & Zin,
2012). The high quantity of construction waste generated in the country is due to the
rapid development of the construction industry. Demand of houses and major
infrastructure projects contributed to the increase of construction waste (Nasaruddin,
studied the economic feasibility of waste minimization in Malaysian construction
project and concluded that by adopting waste minimization strategy like recycling
and reusing materials, it can save 2.5% of the total budget.

The major impact of increased construction waste generation has caused
illegal dumping and has swelled rapidly in Malaysia (Yahaya & Larsen, 2008). A
study done in Johor district alone indicated that 42% of 46 illegal dumping sites are
of construction waste (Rahmat & Ibrahim, 2007). Furthermore, a study in Seberang
Perai, Pulau Pinang also discovered more illegal dump site along the roadside
(Faridah, Hasmanie, & Hasnain, 2004). Recent news had highlighted that almost 30
tons of construction wastes was dumped illegally in tropical mangrove swamp near
Bandar Hilir, Malacca (Murali, 2011) and construction debris problem near roadside at Section 17, Petaling Jaya, Selangor (Tan, 2012) as shown in figures 2.3 and 2.4.

![Figure 2.3: Construction waste illegally dumped in mangrove swamp. Source: Murali (2011)](image1)

![Figure 2.4: Construction debris along roadside. Source: Tan (2012)](image2)

These illegal dumping has caused a risk to human health and environment (Faridah et al., 2004; Rahmat & Ibrahim, 2007). The issues of illegal dumping arise is due to the cost and location of the project (Seow & Mohamad, 2007). The contractors intended to maximise profit by avoiding transportation cost and payment charge to the gazetted landfill. Distance between the project location and the landfill site also hinders the contractor to dispose in legal landfill. A study conducted at 30 construction sites in Malaysia identified six types of waste materials which includes concrete (12.32%), metals (9.62%), bricks (6.54%), plastics (0.43%), timber (69.10%) and other wastes (2%) (Faridah et al., 2004). Hence, it is timely for Malaysia to adopt a systematic and efficient waste management strategy which would minimise the generation of waste at different level. Advanced techniques such as lean construction can help in reducing waste at source and can minimised the waste produced during the operation by re-using and re-cycling.

### 2.2.4 Poor Safety

The construction industry is notoriously known for its poor safety record as compared with other industries (Mohamed, 2002). Poor safety resulted to accidents and fatality which affect significantly on efficiency and cost of the project. Accident
data prepared by the Occupational Safety and Health Branch of the Labour Department, Hong Kong as summarized by (Rachel, 2006) shows that accident rates in the construction industry are much worse than all other industries for many years: for 1000 workers, the accident rates are on an average 3 times more than that of all industries, whereas the fatality rates are on an average 5 times more than other industries. Bureau of Labor Statistics USA (in Nahmens & Ikuma, 2009) reported that in USA total injury and illness incidence rates are 9.5 to 14.3 per 100 workers in prefabricated wood manufacturing while in the residential construction, incidence rate is approximately 5 per 100 workers.

Koskela (1992) mentioned that cost incurred because of poor safety practices in construction industry is approximately 6% of total project cost. In a research, Everett and Frank (1996) found that the total costs of construction accidents accounted for 7.9% to 15% of the total costs of projects. UK Health and Safety Executive reported that the total losses due to accidents in the UK were equal to about 8.5% of the tender price (Rowlinson, 2003). These accidents may be caused by different factors. Kartam (1997) stated that accidents are directly attributed to unsafe design and site practices while Baxendale & Jones (2000) stated that most of the accidents are caused due to poor management and control.

2.2.5 Poor Quality

Another problem faced by construction industry is poor quality standards. It is very common and serious problem as the expected quality is not complied in the construction projects (Kometa & Olomolaiye, 1997). Failure in achieving required quality has also significant impact of project cost. Koskela (1992) stated that quality cost (non-conformance) in construction industry of USA contributed to 12% of total project cost. Burati, Farrington, & Ledbetter (1992); Ledbetter (1994) and Love (2002) studying quality performance of construction projects through case studies as summarized in Marosszeky, Thomas, Karim, Davis, & McGeorge (2002) showed that quality failures had resulted in rework which incurred extra cost approximately 2% to 12% of project cost while Marosszeky et al (2002) stated that quality rectification problems contributed to approximately 3.4% to 6.2% of project cost.
2.2.6 Excessive Resources Consumption

Built environment has significant impact on resources where it accounts for one-sixth of the world’s freshwater withdrawals, one-quarter of its wood harvest and two-fifths of its material and energy flows. The structures also have impact areas beyond their immediate location, affecting the watersheds, air quality, and transportation patterns of communities (Rodman & Lenssen, 1994). Buildings built without due consideration to energy, environmental impact and natural resources conservation will result in detrimental wastage affecting our ecological integrity (Shen & Tam, 2002).

Excessive resource and energy use and a growing demand for raw materials are largely responsible for the depletion of natural resources worldwide and the acceleration of global warming. About 40% of the world's resource and energy used is linked to the construction and maintenance of buildings. This contributes to one-tenth of the global economy (Rodman & Lenssen, 1994). Other studies indicate that more than half of all resources consumed globally are used in construction, and 45 per cent of energy generated across the world is used to heat, light and ventilate our buildings, with a further 5 per cent arising from constructing those (Edwards, 2001). As an example, in the European Union, buildings are responsible for more than 40% of the total energy consumption and the construction sector is estimated to generate approximately 40% of all man-made wastes. In addition, the construction sector is the Union’s largest industrial sector, contributing approximately 11% to the GNP and having more than 25 million people directly and indirectly engaged (CIB, 1999).

2.2.7 Threat To Environment

Built environment is considered the most environmental unfriendly human activity because it consumes large amounts of natural resources and produces a huge amount of pollutants. The environmental impact of the construction industry is extensive and readily identifiable (Rodman & Lenssen, 1994). Most people are not serious about environmental protection in construction sites. They assume that a construction site
is only a temporary setup lasting for two to three years. In fact, the industry is a major source of urban air pollutants (Chan, 2000).

The emission of CO$_2$ by buildings contributed to the global warming and extreme weather change all over the world. The harvest of timber leads to the loss of natural forests. Other impacts of constructing a new building include quarrying to provide aggregates, production of cement, the wasteful use of water and the widespread use of toxic chemicals in materials (Kin-sun, 2004).

2.3 Construction Cost Overrun

Among the problems faced by construction industry, one of the most critical issues is cost overrun problem. Cost overrun has become a global phenomenon and rarely projects are completed within the budgeted cost. While, achieving completion within the budgetary cost is the fundamental requirement of any construction project (Olawale & Sun, 2010). Cost overrun normally experiences in construction projects (Azhar et al., 2008). However, the magnitude of these cost overruns varies considerably from project to project which are subjected to various causes. Thus Sohail, Miles, & Cotton (2002) suggested that construction professionals should pay more attention to cost performance of projects as cited by (Olawale & Sun, 2010) and unearth the causes affecting it which can be shared amongst construction community.

2.3.1 Concept

Cost overrun is also called “cost escalation,” “cost increase,” or “budget overrun” (Zhu & Lin, 2004 in Enshassi, Al-Najjar, & Kumaraswamy, 2009). Cost overrun is the excess of actual cost over budgeted cost which occurs when the final cost of the project exceeds the original estimates (Avots, 1983; Azhar et al., 2008). Cost overrun has become a universal phenomenon (Endut et al., 2009) which adds pressure to investment decision (Ali & Kamaruzzaman, 2010).
Cost overrun is measured as a percentage of actual costs over the estimated costs of the project (Cantarelli, 2009; Choudhury & Phatak, 2004) as shown in expression 2.1:

\[
\text{Cost Overrun} = \frac{\text{Actual Cost} - \text{Estimated Cost}}{\text{Estimated Cost}}
\] (2.1)

Actual costs are defined as real and accounted construction costs determined at the time of project completion. Estimated costs are defined as budgeted or forecasted construction costs determined at the start of projects (Cantarelli, 2009).

2.3.2 Cost Performance

The success of any project can be measured by various norms like time performance, cost performance, quality standards, achieving safety and health, etc. Atkinson (1999) stated that cost, time and quality serve as Iron Triangle for success of any project. Of these, cost performance is the most important indicator of project success (Frimpong et al., 2003; Olawale & Sun, 2010). It presents not only the firm’s profitability but also the productivity of organizations at any point during the construction processes. It can be seen easily in the project account and is always used to measure project performance against the estimated target.

Unfortunately, construction industry has been experiencing poor cost performance which described its inability to complete projects within budget. This chronic issue is experienced worldwide and becoming more critical as been revealed in World Bank report in 1990. The report pointed out that 63% of the 1778 financed construction projects faced poor performance with overrun in budget at an average of 40% as cited by (Ameh et al., 2010; Zujo et al., 2010). For worldwide scenario, Flyvbjerg et al. (2003) had studied 258 projects in 20 nations which approximately US$90 billion worth of project with size ranging from US$1.5 million to $8.5 billion. They found that cost escalation happened to almost 9 out of 10 projects with an average of 28% higher than forecasted costs. The study concluded that cost performance has not improved over the time and its magnitude has not changed for the past 70 years. Other study conducted by Odeck (2004) shows that average cost
overrun was rather small with approximately 7.9% of project cost. The problem of cost overrun is common issue in both developing and developed countries (Angelo & Reina, 2002) However, it is more severe in developing countries where actual cost exceeded 100% of the anticipated cost of the projects (Azhar et al., 2008).

2.3.2.1 Developed Countries

Numerous project control methods and software packages, such as Gantt Bar Chart, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM), Microsoft Project, Asta Power Project, Primavera, etc. have been used to control cost overrun. Despite that, many construction projects in developed countries still suffer cost overruns (Olawale & Sun, 2010) as discussed below:

- **UK Scenario:** A research conducted by Barrick (1995) showed that nearly one third of the clients in UK complaints that their projects generally overran budget. Further, Department of Environment, Transport and the Regions (DETR, 2000) reported that approximately 55% of projects face the problem of cost overrun with huge amount as cited by (Jackson, 2002). For example, British library faced three times over the original budget, Guy’s house at £152M doubled its original budget (NAO, 1998) parliamentary office building in London also at cost of £250M doubled its original budget (Wheeler, 1998) and Holyroad project in Glasgow took £230M against £90M of the original budget (Fairs, 2001). Olawale & Sun (2010) conducting a survey on cost overrun problems in construction projects stated that 41% of respondents experienced overrun on just less than 10% of their projects while 59% of respondents experience cost overrun on 10% or more of their projects.

- **USA Scenario:** A study conducted in 1994 consisting of 8,000 projects showed that only 16% of the projects satisfied the three famous performance criteria: completing projects on time, within budgeted cost and quality standard (Frame, 1997). In study of project performance of cost plus fixed fee projects, Chang (2002) conducted case studies on four projects. He found that the entire four projects were facing cost overrun ranging from 12.3% to 51.3% at an average of 24.8% of the contract amount. The Government
Accountability Office also stated that 77% of highway projects in the USA experienced cost escalation (Cantarelli, Flyvbjerg, Molin, & Wee, 2010).

- **Netherlands Scenario:** Investigation on 87 projects (29 road projects, 28 rail projects and 30 fixed link projects) revealed that cost overrun was the common problem at an average of 10.3% of project cost. The study showed that the percentage of cost overrun in road projects was the highest with the rate of 18.5% followed by rail projects with 7.6% and finally fixed link project with 4.5% (Cantarelli, 2009).

- **Norway Scenario:** Odeck (2004) studied the performance of construction projects controlled by Norwegian Public Roads Administration. He found that that cost overrun was a severe problem and the amount of overruns ranged from -59% to 183%.

- **Slovenia Scenario:** In a study of 92 traffic structures, it was found that contracted construction price overrun was 51 % as cited by (Zujo et al., 2010).

- **Sweden Scenario:** The Auditor General of Sweden (1995) report showed a narrow focus on cost overruns involving transport projects. It covered 15 projects (8 road and 7 rail projects). The report showed that average capital cost overrun for road projects was 86% (ranging between 2 and 182%) and for rail projects this overrun was 17% (ranging from -14% to 74%) as cited by (Cantarelli et al., 2010).

- **Portugal Scenario:** Auditing report of public projects published by the National Court of Audit Portugal (NACL, 2000) on the cost performance of 26 major motorway projects, underground projects launched between 1985 and 2000 and 98 Expo projects revealed that in motorway projects, average cost overrun was 39% of project cost. In underground projects, cost overrun averaged 311% while the Expo projects had cost overruns averaged as much as 41%. Further, an investigating 66 construction projects with average initial contract amount was €16.530.674. Average final costs of these projects reached €18.584.954 with an average cost overrun of €2.054.280 i.e. 12% of the initial average cost (Moura, Teixeira, & Pires, 2007).

Cost performance of construction projects in developed countries is summarized in table 2.2.
### Table 2.2: Cost Performance in Developed Countries

<table>
<thead>
<tr>
<th>Origin</th>
<th>Reference</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>DETR (2000)</td>
<td>55% of projects were overrun</td>
</tr>
<tr>
<td></td>
<td>Jackson (2002)</td>
<td>1/3 of project face overrun</td>
</tr>
<tr>
<td></td>
<td>Olawale and Sun (2010)</td>
<td>More than 10% of project face cost overrun</td>
</tr>
<tr>
<td>USA</td>
<td>Frame (1997)</td>
<td>84% project overrun</td>
</tr>
<tr>
<td></td>
<td>Chang (2002)</td>
<td>100% of projects overrun at average 24.8%</td>
</tr>
<tr>
<td></td>
<td>Kaliba et al. (2009)</td>
<td>77% of highway projects face cost overrun</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Cantarelli (2009)</td>
<td>Cost overrun amounts 10.3% of project cost</td>
</tr>
<tr>
<td>Norway</td>
<td>Odeck (2004)</td>
<td>Cost overrun ranged from -59% to 183% of project cost</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Zujo (2010)</td>
<td>Cost overrun was recorded as 51% of tender cost</td>
</tr>
<tr>
<td>Sweden</td>
<td>Auditor General of Sweden (1994)</td>
<td>Average capital cost overrun for road projects equals to 86% of estimated cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average cost overrun for rail projects equals to 17%</td>
</tr>
<tr>
<td>Portugal</td>
<td>N.A.C.L (2000)</td>
<td>In motorway projects cost overrun was 39%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In underground projects cost overrun was 311% of original estimate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expo projects faced cost overrun at an average rate of 41% of project cost</td>
</tr>
<tr>
<td></td>
<td>Moura et al. (2007)</td>
<td>Construction Projects had overrun at average rate of 12% of budgeted cost</td>
</tr>
</tbody>
</table>

#### 2.3.2.2 Developing Countries

Compared to developed countries, the trend of cost overrun is more severe in developing countries as discussed below:

- **Bosnia and Herzegovina:** In a study of 177 structures, it was found that the contracted price was not met in 41.23% of structures. Another study of 53 building projects including 29 new construction and 24 reconstruction projects showed that average cost overrun in reconstruction projects was 9.23% while it was 6.84% for new construction projects (Zujo et al., 2010; Zujo & Car, 2008).

- **Croatia:** A multi-annual research of cost overruns conducted as part of the scientific project on construction project risk and resource management.
pointed out that the occurrence of price overrun was in no less than 81% projects as cited by (Zujo et al., 2010).

- **Ghana:** Frimpong et al. (2003) studied cost performance of water drilling projects and found that 38 of total of 47 investigated projects (at a rate of 75%) were facing cost overrun whereas only 25% were completed within the budget.

- **India:** A study of 290 projects showed a total of Rs 20,024 crore over the contract cost of projects as Rs 27,568 with an average of 73% of cost overrun as cited by (Gupta, 2009).

- **Korea:** Lee (2008) investigated 161 projects which included 138 road projects, 16 rail projects, 2 airport and 5 port projects. Findings of study showed that 95% of road projects had cost overrun at rate of 50% of the project cost, all the rail projects faced cost overrun at the rate of 50% of projects cost while airports projects had overrun of more than 100% of project cost and port projects had approximately 40% of cost overrun.

- **Kuwait:** In study of 450 private housing projects in 27 metropolitan districts, Koushki, Al-Rashid, & Kartam (2005) noted that 33% of the projects faced cost overrun which resulted in increasing the cost of house from US$ 381,612 to US$385,492 (with increase of US$ 3,880).

- **Malaysia:** Malaysians Auditor General 2008 (in Khamidi, Khan, & Idrus 2011) showed that completion of electrified double track project between Rawang and Ipoh resulted in a cost overrun of RM 1.43 billion. Endut et al. (2009) analyzed cost overrun problems by investigating 308 public and 51 private projects (a total of 359 projects). They found that only 46.8% and 37.2% of public sector and private sector projects completed within the budget respectively with average cost deviation of the project was 2.08%. The maximum deviation was found as 80.76% of project cost. Further, in MARA large construction project, research conducted by Abdullah et al. (2009) revealed that more that 90% of large MARA construction project experienced delay since 1984 with major effects of time and cost overrun. Later on, in qualitative study of project performance of D & B project through eight case studies Potty, Idrus, & Ramanathan (2011) found that seven projects were facing cost overrun, however the risk of these overruns
was borne by contractors as the projects were awarded on fixed price conditions.

- **Nigeria:** Jackson & Steven (2001) studied the problem of cost overrun by investigating 15 projects in Ilorin and found that 73.7% of projects faced cost overrun at an average of 34.7% of the initial project cost. They also conducted a questionnaire survey and mentioned that only 10% of respondents have not experienced cost overruns at all while 75% of the respondents mentioned that cost overruns have sometimes occurred in building projects, 15% said it always occurred. Through 61 cases studies Aibinu & Jagboro (2002) found that the projects had a mean percentage cost overrun of 17.34%. Later on an investigation of 137 construction projects showed that 55% of projects were facing cost overrun problem. These overrun ranged from 5% to a maximum amount of 808% of project cost (Olatunji, 2008). A research of cost escalation on infrastructure projects conducted by Omoriegie & Radford (2006) showed that a minimum percentage of cost escalation was found as 14% of the budgeted cost.

- **Pakistan:** Azhar et al. (2008) stated that cost overrun was a common problem in construction projects. The minimum range of cost overrun experienced was found as near around the 10% of the total cost of the project. In large construction firms these overrun ranged up to about 40% while in medium size firms this percentage increased up to nearly about 60% of the project cost.

- **Thailand:** Meeampol & Ogunlana (2006) studied cost performance on 99 highway construction projects and found that only 46 projects only were satisfied with cost performance while the others faced poor cost performance.

- **Uganda:** Northern by-pass project in Kampala was overrun by more than 100% and a study of a total of 30 projects showed that 53% of the projects had cost overruns (Apolot, Alinaitwe, & Tindiwensi, 2011).

- **Vietnam:** Government has acknowledged the construction cost overruns problem as the big headache, especially with government-related funded projects (Le-Hoai et al., 2008).

- **Zambia:** Kaliba, Muya, & Mumba (2009) studying the project performance in road construction projects of worth US$542.7 found that more than 50% of projects could not meet the contract budget and were facing cost overrun.
Cost performance of construction projects in developing countries is summarized in table 2.3.

**Table 2.3: Cost Performance in Developing Countries**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Reference</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosnia and Herzegovina</td>
<td>Zujo and Pusic (2008)</td>
<td>Reconstruction building projects had cost overrun at average rate of 9.23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New building projects had cost overrun at average rate of 6.84%</td>
</tr>
<tr>
<td></td>
<td>Zujo et al. (2010)</td>
<td>41.23% of projects faced cost overrun</td>
</tr>
<tr>
<td>Croatia</td>
<td>Zujo et al. (2010)</td>
<td>More than 81% project had cost overrun</td>
</tr>
<tr>
<td>Ghana</td>
<td>Frimpong et al (203)</td>
<td>75% of the project face cost overrun run</td>
</tr>
<tr>
<td>India</td>
<td>Gupta (2009)</td>
<td>Project faced cost overrun at an average rate of 73% contracted price of projects</td>
</tr>
<tr>
<td>Korea</td>
<td>Lee (2008)</td>
<td>95% of road projects had cost overrun at rate of 50% of the project cost</td>
</tr>
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<td></td>
<td></td>
<td>all the rail projects faced cost overrun at the rate of 50% of projects cost</td>
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<tr>
<td></td>
<td></td>
<td>Airport projects had overrun of more than 100% of project cost</td>
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<td></td>
<td></td>
<td>Port projects had cost overrun at rate of 40% of project cost</td>
</tr>
<tr>
<td>Kuwait</td>
<td>Koushki et al. (2005)</td>
<td>33% of the projects faced cost overrun resulting in increase US$ 3,880 in cost of house</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Malaysians Auditor General (2008)</td>
<td>Cost overrun of RM 1.43 billion in electrified double track project between Rawang and Ipoh</td>
</tr>
<tr>
<td></td>
<td>Endut et al (2009)</td>
<td>46.8% and 37.2% of public sector and private sector projects completed within the budget</td>
</tr>
<tr>
<td></td>
<td>Abdullah MR (2009)</td>
<td>90% of large MARA construction project experience overruns</td>
</tr>
<tr>
<td></td>
<td>Potty et al (2011)</td>
<td>87.5% of D&amp;B projects face cost overrun</td>
</tr>
<tr>
<td>Nigeria</td>
<td>Jackson and Steven (2001)</td>
<td>90% respondents participating in survey agreed that they experience cost overruns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average cost overrun was found as 34.7% of the initial project cost</td>
</tr>
<tr>
<td></td>
<td>Aibinu and Jagboro (2002)</td>
<td>Mean percentage cost overrun of 17.34%</td>
</tr>
<tr>
<td></td>
<td>Olatunji (2005)</td>
<td>55% of projects faced cost overrun problem ranging from 5% to 808% of project cost</td>
</tr>
<tr>
<td></td>
<td>Omoregie and Radford (2006)</td>
<td>Minimum percentage of cost escalation in Infrastructure projects was 14% of the budgeted cost</td>
</tr>
<tr>
<td>Pakistan</td>
<td>Azhar et al (2008)</td>
<td>Cost overrun ranged from 10% to 60%</td>
</tr>
<tr>
<td>Thailand</td>
<td>Meeampol and Ogunlana (2006)</td>
<td>53% highway projects had poor cost performance</td>
</tr>
<tr>
<td>Uganda</td>
<td>Sepuuya (2008)</td>
<td>Northern by-pass project was overrun by more than 100% of project cost</td>
</tr>
</tbody>
</table>
2.4 Causative Factors of Cost Overrun

Cost overrun in construction projects can occur due to many factors. It is very crucial to determine these factors in improving cost performance. Since, many research works had been carried out in determining these factors, hence a comprehensive literature review was carried out to uncover these factors affecting cost overrun for further investigation in construction industry of Malaysia.

Kaming, Olomolaiye, Holt, & Harris (1997) identified factors influencing construction cost overruns on high-rise building projects in Indonesia through a questionnaire survey administered on 31 project managers. The results showed that major factors affecting project cost were materials cost increased by inflation, inaccurate quantity take-off, labour cost increased due to environment restriction, lack of experience of project location, lack of experience of project type, unpredictable weather conditions and lack of experience of local regulation.

Jackson & Steven (2001) examined the causes of cost overrun in building projects of Ilorin through questionnaire survey and found that major factors of cost overruns were fluctuation in the prices of materials/Labour, variation orders, delay in honouring certificates, lack of proper analysis of tenders, selection of incompetent contractors, lack of proper appraisal of projects and unrealistic representation of clients needs.

Jackson (2002) studied reasons of budget overrun in UK through questionnaire survey and found that major reasons of overrun were design changes, design development factors, information availability, method of estimation, performance of design team and project management.

Chang (2002) studied the reasons of cost increase through 4 case projects to quantify their contributions in engineering design projects in USA. The finding of the
study showed that the major reason for cost increase was owner request of changes in scope and additional works.

Frimpong et al. (2003) conducted a questionnaire survey consisting of 26 factors to study major contributors of cost overrun in groundwater drilling projects in Ghana. Out of 26 factors considered, top 10 factors are monthly payment difficulties, poor contract management, material procurement, inflation, contractor’s financial difficulties, escalation of material prices, cash flow during construction, planning and scheduling deficiencies, bad weather and deficiencies in cost estimates prepared.

Koushki et al. (2005) studying problem of cost increase in the private residential projects of Kuwait mentioned that three main contributors to cost overruns were contractor-related problems, material-related problems and owners’ financial constraints.

Omoregie & Radford (2006) study found out the major factors causing cost overrun in infrastructure projects of Nigeria were price fluctuations, financing & payments of completed works, poor contract management, schedule delay, changes in site conditions, inaccurate estimates, shortage of material, imported materials & plant items, additional works, design changes, subcontractors & nominated suppliers, weather, non-adherence to contract conditions, mistakes & discrepancies in contract conditions and fraudulent practices.

Azhar et al. (2008) investigated cost overrun causes in construction industry of Pakistan. A survey using questionnaire containing forty two (42) factors showed that the top ten cost overrun factors found were fluctuation in prices of raw materials, unstable cost of manufactured materials, high cost of machineries, lowest bidding procurement procedures, poor project (site) management/ poor cost control, delays between design and procurement phases, incorrect/ inappropriate methods of cost estimation, additional work, improper planning, and unsupportive government policies.

Le-Hoai et al. (2008) studied the causes of cost overrun in large construction project of Vietnam using questionnaire survey. The investigation included 21 causative factors and top 5 common and very sever causes of cost overrun were poor site management and supervision, poor project management assistance, financial difficulties of owner, financial difficulties of contractor; design changes.
Enshassi et al. (2009) conducted questionnaire survey to identify major causes of cost overrun in construction projects of Gaza by investigating 42 factors amongst contractors, consultants and owners. Results indicated that top ten factors that cause cost overruns as perceived by the three parties include increment of materials prices due to continuous border closures, delay in construction, supply of raw materials and equipment by contractors, fluctuations in the cost of building materials, unsettlement of the local currency in relation to dollar value, project materials monopoly by some suppliers, resources constraint: funds and associated auxiliaries not ready, lack of cost planning/monitoring during pre-and post contract stages, improvements to standard drawings during construction stage, design changes, and inaccurate quantity take-off.

Kaliba et al. (2009) carried out a study to determine the contributors of cost escalation in road construction projects of Zambia. The finding of study showed that the main causes of cost escalation included bad or inclement weather due to heavy rain and flooding, scope changes, environmental protection and mitigation costs, schedule delay, strikes, technical challenges, inflation and local government pressure.

Ameh et al. (2010) investigated the causes of cost overrun in 53 telecommunication projects of Nigeria through structured questionnaire survey containing 42 factors. Survey results showed that top seven factors were lack of experience of contractors, cost of material, fluctuation in the prices of materials, frequent design changes, economic stability, high interest rates charged by banks on loans received by contractors, mode of financing, bonds & payments as well as fraudulent practices & kickbacks.

These identified factors are part of the whole literature review on the factors causing cost overrun happening worldwide. Comprehensive review consisting of 46 published articles has resulted in identifying 78 common factors of cost overrun which were considered for further investigation to find the relevancy and significance of these factors towards Malaysian construction industry. As a part of literature review, studies on time overrun factors were also considered as cost overrun is directly correlated with time overrun (Abdullah, 2010; Aibinu & Jagboro, 2002) and it is difficult to separate the factors causing overrun between cost and time overrun as the reasons for cost increases are normally also the reasons for time
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