Time Overrun Analysis in North Cyprus Building Construction Projects

Seyed Saeed Khademi

Submitted to the
Institute of Graduate Studies and Research
in Partial Fulfilment of the Requirements for the Degree of

Master of Science
in
Civil Engineering

Eastern Mediterranean University
July 2014
Gazimağusa, North Cyprus

Approval of the Institute of Graduate Studies and Research

Prof. Dr. Elvan Yilmaz
Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Master of Science in Civil Engineering.

Prof. Dr. Özgür Eren
Chair, Department of Civil Engineering

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Civil Engineering.

Asst. Prof. Dr. Alireza Rezaei
Supervisor

Examining Committee

1. Assoc. Prof. Dr. Zalihe Sezai _____

2. Asst. Prof. Dr. Giray Ozay _____

3. Asst. Prof. Dr. Alireza Rezaei _____

ABSTRACT

Construction projects are different from the viewpoint of scale, complexity of project variety of design; however, they are same in purpose. The construction projects purpose is timely completing within scheduled time and achieving project objectives. Various project control and project management methods have been developed to ensure achievement of these aims. However, many construction projects do not achieve their objectives and face time overrun.

In order to find out time overrun factors and their causes in construction projects, a comprehensive literature review was conducted. Subsequently, a questionnaire was designed to survey the level of knowledge, application of time management techniques and issues related to delay in construction projects of North Cyprus. The results of questionnaire were used to categorize and prioritize the delay factors. It was found and summarized that “slow decision making”, “qualification and experience of project staff”, “inexperience and low performance subcontractor”, delay in material deliveries to site”, “design changes” were the most important factors causing time overrun in construction projects in North Cyprus.

Furthermore, the outcomes of questionnaire survey were approved by investigating and applying a case study located in kyrenia.

Finally, major time overrun factors were analyzed in more details and mitigation strategies were suggested to reduce or even eliminate their impacts. In addition, a

control model was proposed for application in construction projects on North Cyprus.

Keyword: Time overrun, Delay Factors, Questionnaire Survey, Control Model Construction project, North Cyprus

ÖZ

İnşaat projeleri, tasarımlarındaki karmaşıklık, görünüm, ölçek ve benzeri konularda farklı olsada aslında hedef bakımından birbirinin aynıdırlar. Öyle ki, inşaatın zamanında tamamlanması, proje hedeflerine ulaşması gibi unsurlar bu benzerliği oluşturan etkenlerdir. Bu amaçlara ulaşmayı garanti altına almak için, çeşitli proje kontrol ve yönetim methodları geliştirilmiştir. Fakat birçok inşaat projesi bu hedeflere ulaşmada zamanla ilgili sıkıntılar yaşar.

Çalışma kapsamında yapılan literatür taramasında, zaman anlamında yaşanan bu gecikmelerin nedenleri araştırılmıştır. Bir anket çalışması ve örnek bir saha çalışmasının yardımıyla gecikmeye neden olan faktörler tespit edilmeye çalışılmıştır. Gecikmeye neden olan en önemli beş faktörü neler olduğunu belirlemek ve zamanda gecikmeye neden olacak etkileri hafifletmek amacıyla bir sonuç analizleri yapılmıştır.

Gecikme faktörlerini kategoriye koymak için Anket sonuçları kullanıldı. Buna bağlı olarak “yavaş karar verme”, “proje yetkililerinin yeterlilik ve deneyimleri”, “taşeronun deneyimsizliği ve düşük performansı”, “malzemelerin inşaat alanine gelişinin gecikmesi”, “dizayn da yapılan değişiklikler” bu faktörlerin kuzey kıbrıs inşaat projelerinde zaman aşımına sebep olduğu bunundu.

Ayrıca, anket sonuçları girne de bulunan bir örnek olay üzerinde araştırma ve uygulama yaparak denendi.

Sonuç olarak, büyük zaman kaybı faktörleri çok detaylı şeklide analiz edildi ve bu faktörleri elemek veya azaltmak için hafifletme stratejileri önerildi. Ek olarak, kuzey kıbrıs ta inşaat projelerinde uygulanması için bir control modeli önerilmiştir.

Anahtar kelimeler: zaman aşımı, gecikme faktörleri, Anket Araştırması, inşaat projesi control modeli, kuzey kıbrıs

To my family

ACKNOWLEDGEMENT

It would not be possible for me to finish this research without the guidance of my supervisor, support from my family, and precious helps from my friends.

I would like to thank my supervisor, Asst. Prof. Dr. Alireza Rezaei, for his continuous support, guidance, helpful supervision and valuable critiques during preparation this research.

Special thanks to construction management staff of the Eastern Mediterranean University and their academic and scientific support throughout my MSc studies.

Thanks to contractors, consultants, owners and designers companies for their participation in filling the questionnaire and specially for research case study.

Last but not least, none of this would have been possible without the love, patience and support of my family, my wife, my mom, my dad and my brothers during the study and in my life.

TABLE OF CONTENTS

ABSTRACT iii

DEDICATION vii

ACKNOWLEDGEMENT viii

LIST OF TABLES xii

LIST OF FIGURES xiv

LIST OF ABBREVIATIONS xv

1 INTRODUCTION 1

1.1 Background of the Study 1

1.2 Problem Definition 2

1.3 Aim and Objectives 3

1.5 Work Carried out 3

1.6 Achievement 4

1.7 Thesis Outline 4

2 TIME OVERRUN IN CONSTRUCTION PROJECTS 6

2.1 Introduction 6

2.2 Construction Project 6

2.3 Construction Time 7

2.4 Importance of Time in Construction Projects 8

2.5 Definition of Time Overrun 9

2.6 Factors Causing Time Overrun 12

2.6.1 Unpredictable weather condition 29

2.6.2 Poor site management and supervision 29

2.6.3 Inexperienced and low performance subcontractor and supplier 30

2.6.4 Qualification and experience of project staff 30
2.6.5 Low skilled labor 30
2.6.6 Inaccurate evaluation of project time/duration and poor project duration estimation 31
2.6.7 Lack of proper training and experience of project management 31
2.6.8 Lack of appropriate software 32
2.6.9 Design changes 32
2.6.10 Delay in material deliveries to site 32
2.6.11 Equipment availability and failure 32
2.6.12 Complexity of work 33
2.6.13 Financing and payment for completed work 33
2.6.14 Lack of coordination between contractor, consultant, subcontractor and owner 33
2.6.15 Contract and specification interpretation disagreement 34
2.6.16 Shortage of materials in site 34
2.6.17 Unforeseen site condition or inaccurate specification of site condition 34
2.6.18 Delay in work approval and waiting for sample test approval 34
2.6.19 Inaccuracy of material estimate 35
2.6.20 Slow decision making 35
3 METHODOLOGY 36
3.1 Introduction 36
3.2 Methodology 36
3.3 Questionnaire Survey 40
3.3.1 Questionnaire sections 41
3.4 Case Study 49
3.4.1 Project specification 50

3.4.2 Time planning 50
3.4.3 Time overrun 50
3.5 Comparison of the Results of Questionnaire and the Case Study 53
4 DEVELOPING MITIGATION MEASURES AND PROJECT CONTROL MODEL 54
4.1 Introduction 54
4.2 Mitigating Measures 54
4.2.1 Design changes 55
4.2.2 Slow decision making 56
4.2.3 Qualification and experience of project staff 58
4.2.4 Delay in delivery of materials to site 59
4.2.5 Inadequate experience and low performance of subcontractors 60
4.3 Project Control and Inhibiting Factor Management Model 63
4.3.1 Plan 64
4.3.2 Implementation 65
4.3.3 Finish 68
4.3.4 Project control inhibiting factors 68
5 CONCLUSION AND RECCOMENDATIONS FOR FURTHER STUDIES 69
5.1 Conclusion 69
5.2 Recommendations for further study 70
REFERENCES 72
APPENDIX 79

LIST OF TABLES

Table 1: Number of projects completed on time (Kaming et al, 1997) 13

Table 2: Variables of delays and their Importance, Frequency, and Severity in Construction in Indonesia (Kaming et al, 1997) 13

Table 3: Mean scores (MS) and ranks (R) for ten most significant factors causing delay in building works by different groups of respondent (Chan and Kumaraswamy, 1996 & 1997) 15

Table 4: Mean scores (MS) and ranks (R) for eight major factors categories causing delays in building works by different groups of respondents (Chan and Kumaraswamy, 1996 & 1997) 16

Table 5: Questionnaire respondents by Chan and Kumaraswamy (1996 & 1997) 16

Table 6: Relative importance index of five most important factors causing delays in building works (Chan and Kumaraswamy, 1997) 17

Table 7: Relative importance index of five most important factors causing delays in civil engineering works (Chan and Kumaraswamy, 1997) 18

Table 8: Relative importance index and ranks for delay factor categories by respondent in building works (Chan and Kumaraswamy, 1997) 18

Table 9: Relative importance index and ranks for delay factor categories by respondent in civil engineering works (Chan and Kumaraswamy, 1997) 19

Table 10: Groups of delay ranking and mean RII (Gunduz et al. 2013) 25

Table 11: Fifteen most important factors causing delays (Gunduz et al. 2013) 26

Table 12: Ranking of the top ten factors causing delay in construction projects (Alaghbari et al. 2007) 29

Table 13: Factors causing time overrun in construction project 38

Table 14: Roles of respondents 41

Table 15: Time planning technique..... 46

Table 16: Time planning software 47

Table 17: Projects time overrun 47

Table 18: Ranking of factors affecting construction project time planning..... 49

Table 19: Factors causing time overrun in case study 51

LIST OF FIGURES

Figure 1: Cause and effect diagram (Gunduz et al. 2013) 24

Figure 2: Process of finding mitigating measures and project control model 37

Figure 3: Number of building project in North Cyprus (State Planning Organization, 2006-2013) 39

Figure 4: Proportion and number of building project in North Cyprus (State Planning Organization, 2006-2013) 40

Figure 5: Respondents experience in years 42

Figure 6: Type of companies 43

Figure 7: Projects types undertaken by respondents 43

Figure 8: Classification of buildings in North Cyprus based on area 44

Figure 9: Classification of buildings in North Cyprus based on number of stories 44

Figure 10: Estimated project duration 45

Figure 11: Application time planning 46

Figure 12: Project control and inhibiting factor management model (Olawale and Sun, 2013) 63

LIST OF ABBREVIATIONS

BIM	Building Information Modeling
CPM	Critical Path Method
GDP	Gross Domestic Product
KPI	Key Performance Indicators
MS	Mean Score
MS P	Microsoft Project
PCID	Project Control Implementation Document
PCIM	Project Control Inhibiting and factors Management
PERT	Program Evaluation and Review Technique
R	Ranks
RII	Relative Importance Index
RIW	Relative Importance Weight

Chapter 1

INTRODUCTION

1.1 Background of the Study

The construction industry plays a significant role in economy of many countries. The construction industry contributes in the Gross Domestic Product (GDP) of many countries and for this reason this industry is essential for the economic development of countries. Moreover, it could be mentioned that construction industry has become an important market because of the fact that this industry obtains material and product from other business sectors. The contribution of the construction industry in GDP in north Cyprus is 10.1%.

The Construction industry is developing by increasing in size, complexity and variation of demand. The scope of this industry is also wide, which includes; residential building, commercial building, industrial building, etc. These show the importance of the construction management in construction project to manage and control the construction procedure.

In many countries construction industry has been gradually more recognizing the need for timely efficient completion of project (Chan and Kumaraswamy, 1996). In construction industry timely finishing the project is one of the most important criteria of project success (Rwelamilla and Hall, 1995). Successful projects are actually those

projects which are finished on time within budget and particular quality standard (Chan and Kumaraswamy, 1997).

1.2 Problem Definition

The propose and objectives of project control in construction industry are to make sure that construction projects will be finished within time and cost and reached the plan. Achieving to this aim is a complicated duty undertaken by project managers in practice, which include frequently measuring progress, improving plans and choosing accurate action when needed (Kerzner 2003). During the recent years, various methods of project control such as Bar Chart, Critical Path Method (CPM), and Program Evaluation and Review Technique (PERT) have been developed. Numerous project control software such as Primavera, Microsoft project, etc. have been available to supporting the application. In spite of wide use of project control methods and software in construction projects, still many of the construction projects encounter time overruns.

Time overrun is any delay away from the baseline of planning timetable in construction. Reducing time and cost is the major purpose of managing in construction project. Time delay happens in every section of a construction project and as a result enhances total duration (Yang and Ou, 2008). Infrequently projects are completed on time, and this needs more attention to control construction time.

There are numerous unexpected and unforeseen factors arising during the construction process and direct the projects to encounter time overrun in construction project time planning. Therefore it is needed to specify the causes of the time overrun or delay to reduce and prevent delays in construction projects (Memon et al, 2011).

1.3 Aim and Objectives

Time in construction project is one the significant criteria of defining the successful projects. The propose and objectives of project control in construction industry is to make sure that construction projects will be finished within time and cost and reached the plan. However, time in construction projects is frequently affected by many factors; that due to these factors projects could not be completed within scheduled time and time overrun occurs. According to the definition of the problem, objectives of this research were:

- To understand the importance of time and definition of time overrun in construction projects;
- To identify the existing time overrun factors in construction project planning;
- To specify the reasons of time overrun in construction projects;
- To investigate the time overrun in construction projects in North Cyprus;
- To develop the mitigating measures for the most important factors affecting time in construction projects.

1.5 Work Carried out

Undertaken tasks in this research:

- Understanding the importance and definition of time overrun in construction projects;
- Identifying the existing of construction projects time overrun;
- Specifying the factors causing construction projects time overrun;
- A questionnaire was designed and a case studied to find out the most important time overrun factors in North Cyprus construction projects;
- Developing the mitigation measures for top important factors to minimize the time overrun in construction projects.

1.6 Achievement

According to the result analysis of questionnaire and case study and determining the top important factors as literature topic to find out the reductions measures, the following sections were achieved:

- Showing the existing time overrun in construction projects;
- The most important factor affecting construction projects time overrun;
- The mitigation measures and project control inhibiting factors management model for top important factors causes time overrun in construction projects.

1.7 Thesis Outline

Chapter 1 is the thesis introduction which includes background of the study, problem definition, aim and objectives, methodology and work carryout, and achievements of this study. In chapter 2 description of construction project and construction time defined. After these parts the importance of time in construction project according to the other studies explained. At the next step definitions of time overrun and different kinds of time overrun explained. Then study in this chapter focused on factors causing time overrun in construction projects.

In chapter 3, at the first part methodology of the study and the definition of the specified time overrun factors explained. In the second step questionnaire survey and its sections are described and the results of the questionnaire are analyzed. At the next section case is studied and results of the case study have been analyzed. Then results of both questionnaire and case study are comprised.

In the first part of this chapter 4, mitigation measures and its process are explained. At the second step mitigation measures for each one of top important factors causing

time overrun are presented. After that project control and inhibiting factor management model and its sections are described. Chapter 5 is conclusion, which concludes the study by summary of the process of the study and result of the study, and in the next part further study.

Chapter 2

TIME OVERRUN IN CONSTRUCTION PROJECTS

2.1 Introduction

Need for more capable and timely completion of projects is being increasingly recognized in building industries of many countries. Numerous unexpected changes and problems occur from the design through the construction phase, causing time and cost overrun in projects. So, finding the causes for delays can be one of the basics of keeping the project on construction time (Chan and kumaraswamy, 1996).

In this chapter, description of construction project and construction time defined. After these parts the importance of time in construction project according to the other studies explained. At the next step definitions of time overrun and different kinds of time overrun explained. Then study in this chapter focused on factors causing time overrun in construction projects.

2.2 Construction Project

Project conception can be defined as a need that can content by a physical structure. Design project can be described as owner's demand in a finest and economic way which is contented by translating the initial concept into presentation of a spatial form. The construction phase is to construct the physical form according to the concept of the project and design confirmation (Chan and Kumaraswamy, 1997).

The construction procedure can be separated into three significant phases: project conception, project design and project construction. Frequently, most of project time overrun occurs through construction phase that includes lots of unforeseen factors (Chan and Kumaraswamy, 1997; Ramanathan et al., 2012).

In some construction projects like groundwater projects can be divided into two phases; first one is preconstruction phase which can be defined as time between primary project conception and contract. The second one is after contract to real construction which can be named as construction phase. Overrun in time and cost occur in both two phases, but most of reasons of overrun in projects are found in the construction phase (Frimpong et al, 2003).

According to resource and plan construction industry is one of split and intricate industry. In construction industry timely finishing the project is the most important criterion of project success (Rwelamilla and Hall, 1995; Memon et al, 2011).

2.3 Construction Time

Construction time could be considered as passed time from the beginning of site works to finishing point and completion and delivering of a building to the owner. The construction time of the building is normally defined prior to the beginning of construction. Construction time could be reduced from the owner or by construction planner.

Construction time, even though is just a part of the life cycle duration of the building, is more and more significant for numerous reasons. The construction period needs focus and attention because the great pert of resource spend during this period. Also construction time is a basis for estimating the success of a project.

2.4 Importance of Time in Construction Projects

One of the significant problems in the construction industry is time overrun or delay. Time overruns or delays occur in lots of construction projects and the scales of these delays differ from project to project from just a few days to more than a year. Therefore, it is needed to specify the causes of the time overrun or delay to reduce and prevent them in construction projects.

The purpose and objectives of project control in construction industry is to make sure that construction projects will be finished within time and cost based on the plan. Achieving to this aim is a complicated duty carried out by project managers in practice, that include frequently progress of measuring, improving plan and choosing appropriate action when needed (Olawale and Sun, 2010; Kerzner, 2003).

One of the significant targets of construction industry is to deliver projects on time within fixed budget and also needed quality because any time overrun in finishing projects can have direct influence on the cost of projects (Memon et al, 2011).

On the other hand, one of the important requests of clients in any construction project is timely completion of project. Delivering the project on time is one of the significant indicators of a competent construction industry (Ramanathan et al, 2012). Some critics accrue in construction industry if projects take more time than plan (Bennt et al, 1979). Contractor are mainly concerned with time, cost and quality but still construction projects majority are focused on two of these basic parameters which are time and cost (Bennet and Grice, 1990). The literature highlights time as an indicator for project success (Ramanathan et al, 2012). Successful projects are

those projects finished on time within budget and particular quality standard (Chan and Kumaraswamy, 1997).

Project success can be described as reach to aim and objectives which are determined and scheduled in the project plan. Successful project can be defined as a project that has performed its technical performance, maintained its planning, and stayed within the budget. Tools and techniques are keys of impressive managing a project in project management but beside of those keys, must have a good project management which includes managing equipment, material, workers, budget and methods. All sections of project must be managed together to avoid time and cost overrun during the project (Frimpong et al, 2003).

Despite of numerous management practices in construction projects, time overrun is still a problem in many countries and needs serious consideration. To overcome this problem, early and significant step is to find and realize the reasons and effective factors of these problems (Memon et al, 2011).

2.5 Definition of Time Overrun

Time overrun is a situation in construction project that project could not be completed within the planned time. It is a usual issue encountered in the construction industry all around the world (Ali et al. 2010).

Time overrun is any delay away from the baseline of planning timetable in construction. Reducing time and cost is the major purpose of managing a construction project. Time delay happens in every section of a construction project and as a result enhances total duration (Yang and Ou, 2008). Projects are infrequently completed on time, and this needs more attention to control construction

time because every day of delay increases the cost which barely can be improved (Memon et al, 2011).

Time overrun is a condition that project owner and a contractor together or separately contributes to the project non-completion by specified and decided time period on construction contract (Aibinu and Jagboro, 2002). Further, time overrun defined as an event or act that causes time required extension of the contract tasks performance (Stumpf, 2000). Time overrun definition is a time deferment from the contract estimated duration to finish the project, which could be caused by owner, consultant or contractor, also could be caused by external factors. Time overrun is one of the frequent, complex, risky and costly issues in construction project (Alaghbari et al. 2007).

Delay could be grouped into categories according to how they operate contractually; in general delay can be categorized into following three types:

- Excusable and non-excusable;
- Compensable and non-compensable;
- Concurrent.

Concurrent delay could be defined as a situation in construction that only one factor causes delay in construction, which is normally simple and easy to measure and calculate the resultant time and cost.

Non-excusable delays are those delays caused by contractors or subcontractors or materials suppliers. The contractor may be expected to get compensation from supplier or subcontractor because of delaying but no compensation payable from the

owner. So in non-compensable delay type no extra time or money being supposed to the contractor.

Excusable delay could be determined as factors that are not the responsibility or mistake of any group. In most of the contracts, it is possible for the contractor to get time extension for excusable delays but not additional money for this type of delay.

Compensable delays are those delays caused by owner or its agent. The common compensable delays are inadequate drawing and specifications, owner changes in design or materials, and changes in sequence of the work. Contractor could get additional time and money resulting from compensable delays (Alaghbari et al, 2007).

In construction, delay can be described as time overrun after the finishing date determined in contract or after the date which owner, consultant and contractor agreed to deliver the project. This situation is usually occurred in construction projects. From the view point of owners the significant part of construction project is time and delay in any phase means missing utility and productivity of project. Also time overrun can affect overhead costs because of longer time and changed material and labor cost. Utility and efficiency of project have some indicators; on time completion of project can be defined as one of them but according to source it depends on variety of unforeseen factors. Performance of contractor, owner and consultant and relation between them, completing project within schedule and also accessibility of resource can be some sources (Ramanathan, et al, 2012).

Time overrun plays an important role in construction projects. There are too many factors accountable for time overrun which need to be focused to reach the planned time (Memon et al, 2011).

2.6 Factors Causing Time Overrun

Many studies have been performed to investigate the causes of delay or time overrun in construction projects.

Kaming et al. (1997) specified design changes, poor labor productivity, inadequate planning, and resource shortages as most important factors causing time overrun through a questionnaire survey and some interview among stakeholders of 31 high rise construction projects in Indonesia. A scaling method of very important (4) to not important (1) was applied to recognize variables that respondents comprehended to contribute to time overruns. Participants were then asked to rate the frequency of occurrence for each of the variables in their construction project sites on the scales of (3) high, (2) medium and (1) low. The mean value of the respondents' importance rating for each of the variables was named the importance index. Importance indices were later used to rank the variables. The mean value from respondents' frequency rating were then named frequently index which were used to rank the frequency of variables on sites. Finally severity index was calculated by multiplying the frequently index by the importance index response. The severity indices were used to rank the overall impact of time overrun and cost overruns for high-rise construction sites. Table 1 shows the number of projects completed on time and Table 2 shows the variable delays and their importance, frequently and severity in construction projects in Indonesia. Design changes was ranked first by index=0.91 followed by poor labor

productivity with index=0.65 and inadequate planning by index=0.55, and the last ranked factor was unpredictable weather condition with index=0.24.

Table 1: Number of projects completed on time (Kaming et al, 1997)

	Number and percentage of projects successfully completed by project managers		
	Less than 70%	70-90%	Over 90%
On time (number) (%)	10 30.3	5 15.2	18 54.5

Table 2: Variables of delays and their Importance, Frequency, and Severity in Construction in Indonesia (Kaming et al, 1997)

Variables/ causes of delay	**Importance**		**Frequently**		**Severity**	
	Index	**Rank**	**Index**	**Rank**	**Index**	**Rank**
Unpredictable weather condition	0.60	11	0.39	11	0.24	11
Inaccuracy of materials estimate	0.88	3	0.56	7	0.51	5
Inaccurate prediction of craftsman production rate	0.80	5	0.60	5	0.49	6
Inaccurate prediction of equipment production rate	0.69	9	0.43	10	0.33	10
Materials shortage	0.79	6	0.63	3	0.52	4
Equipment shortage	0.68	10	0.45	9	0.33	9
Skilled labor shortage	0.72	7	0.58	6	0.43	7
Location restriction of the project	0.72	8	0.52	8	0.40	8
Inadequate planning	0.88	2	0.61	4	0.55	3
Poor labor productivity	0.87	4	0.74	2	0.65	2
Design changes	0.93	1	0.98	1	0.91	1
Mean	**0.78**		**0.59**		**0.48**	

Due to the gathering the results of project managers' interviews and analysis, some strategies were specified to minimize the effect of time and cost overrun in construction project, as follow:

- Avoid substructure and earthwork throughout the rainy season in construction activities.
- Activity production rates, unit price of work packages and materials prices should be updated as a cost data.
- Accommodation and facilities for workers should be provided to minimize and avoid trade absents.
- Preventing the price hikes by having long term contract with material supplier of construction.
- Ensure the equipment availability and skilled craftsmen by entering into the long-term contract with subcontractors, containing labor-only subcontractor (Kaming, et al. 1997).

In Hong Kong, Chan and Kumaraswamy (1996 & 1997) studied influencing factors in construction project. The analysis and ranking of delays factors were conducted by dividing the reasons into two groups; the role of owner, consultant and contractor in local construction industry and type of the project. They found out that the important factor of time overrun are "poor site management", "unforeseen ground condition", "low speed of decision making", "client initiated variation" and "necessary variations of works".

The Mean Score (MS) was calculated by Equation 2.1:

$$MS = \frac{\sum(f \times s)}{N} \quad 1 \leq MS \leq 5 \qquad \text{Eq.1}$$

Where *s* is the score given to each factor by the respondents and ranges from 1 to 5 in which, "1" is "not significant" and "5" is "extremely significant"; *f* is frequency of responses to each rating (l-5), for each factor; and *N* is total number of responses

concerning that factor. And also Weighted Average (*WA*) to measure the average score of client, consultant and contractor groups.

$$WA = \sum\left[\left(\frac{n}{N}\right) \times MS\right] \quad (1 \leq WA \leq 5) \qquad \text{Eq. 2}$$

Where n = 27 for client group; 24 for consultant group; and 27 for contractor group; N = 78.

Table 3: Mean scores (MS) and ranks (R) for ten most significant factors causing delay in building works by different groups of respondent (Chan and Kumaraswamy, 1996 & 1997)

Hypothesized factor	Client		Consultant		Contractor		Weighted average	
	MS	R	MS	R	MS	R	MS	R
Poor site management and supervision	4.000	1	4.290	1	4.110	2	4.125	1
Unforeseen ground conditions	3.815	2	4.210	2	3.780	9	3.925	2
Low speed of decision making involving all project teams	3.665	7	4.040	3	4.000	3	3.895	3
Delays in design information	3.445	9	3.710	10	4.445	1	3.875	4
Lack of communication between consultant and contractor	3.705	6	3.915	6	4.000	4	3.870	5
Necessary variation of works	3.780	4	3.915	5	3.890	7	3.860	6
Inadequate contractor experience	3.815	3	3.825	9	3.925	6	3.855	7
Client-initiated variation	3.705	5	4.040	4	3.815	8	3.845	8
Delays in subcontractors work	3.540	8	3.835	8	3.960	5	3.775	9
Improper control over site resource allocation	3.845	10	3.875	7	3.595	10	3.770	10

"Poor site management and supervision" with MS=4.125 was ranked as most important factor causing delay in building project; followed by unforeseen ground condition by MS=3.925 and low speed of decision making with MS=3.895 as the most important factors causing delay in building projects.

Table 4 shows contractor-related factors by MS=3.530 ranked first according to different groups of respondents, design team-related factors with MS=3.500 and labor factors by MS=3.435 as next factors causing delays in building projects.

Table 4: Mean scores (MS) and ranks (R) for eight major factors categories causing delays in building works by different groups of respondents (Chan and Kumaraswamy, 1996 & 1997)

Factor category	Client		Consultant		Contractor		Weighted average	
	MS	R	MS	R	MS	R	MS	R
Contractor-related	3.540	2	3.555	1	3.495	3	3.530	1
Design team-related	3.205	3	3.385	3	3.890	1	3.500	2
Labor	3.585	1	3.410	2	3.310	6	3.435	3
External	2.990	5	3.160	6	3.730	2	3.300	4
Project-related	2.940	6	3.225	4	3.360	5	3.175	5
Materials	3.030	4	3.000	8	3.405	4	3.150	6
Plant equipment	2.885	7	3.180	5	3.170	8	3.075	7
Client-related	2.860	8	3.045	7	3.245	7	3.050	8

In another study by the same authors, the causes of delay were studied in both building and civil engineering project by categorizing the delay factors in eight categories: “project related factors”, “client related factors”, “design team related factors”, “contractor related factors”, “materials”, “labor”, “plant and equipment”, and “external factors”. They distributed questionnaire among 400 projects with the 37% rate of respondents.

Table 5: Questionnaire respondents by Chan and Kumaraswamy (1996 & 1997)

Projects category	Clients	Consultants	Contractors	Total
Building works	27	24	27	78
Civil works	23	25	21	69
Total	50	49	48	147

Table 5 shows the respondents categories including clients, consultants and contractors. The total number of respondents was 147 from which, 78 in building were working in building works and 69 in civil engineering works.

The Relative Important Index (RII) was used in this study as shown in Equation 2.3:

$$RII = \frac{\sum w}{A \times N} \ , (0 \leq index \leq 1) \qquad \text{Eq. 3}$$

Where w = is the weight given to each factor by the respondents and ranges from 1 to 5 1 is "not significant" and 5 is "extremely significant", A = is the highest weight (i.e. 5 in this case), and N = is the total number of respondents.

Tables 6 and 7 show the most important delay factors in building projects and civil engineering projects. In both project types, the most important factors causing delay were "poor site management and supervision" followed by "unforeseen ground condition" and "low speed of decision making involving all project teams" and at least of five most were necessary variation of work.

Table 6: Relative importance index of five most important factors causing delays in building works (Chan and Kumaraswamy, 1997)

Hypothesized factors	**Clients**	**Consultants**	**Contractors**	**Weight average**
Poor site management and supervision	0.763	0.858	0.822	0.813
Unforeseen ground condition	0.763	0.842	0.756	0.785
Low speed of decision making involving all projects teams	0.733	0.808	0.800	0.779
Client initiated variations	0.741	0.808	0.763	0.769
Necessary variations of works	0.756	0.783	0.778	0.772

Table 7: Relative importance index of five most important factors causing delays in civil engineering works (Chan and Kumaraswamy, 1997)

Hypothesized factors	Clients	Consultants	Contractors	Weight average
Poor site management and supervision	0.878	0.792	0.710	0.796
Unforeseen ground condition	0.826	0.816	0.800	0.814
Low speed of decision making involving all projects teams	0.755	0.783	0.743	0.761
Client initiated variations	0.757	0.768	0.743	0.757
Necessary variations of works	-	0.776	0.733	0.756

Table 8 and Table 9 present the ranks of delay factors categories by relative important index (RII) according to client, consultant and contractor in building works and civil engineering works. In both types, contractor related were ranked as most important factors, in building works with RII=0.706 and in civil engineering work with RII=0.680.

Table 8: Relative importance index and ranks for delay factor categories by respondent in building works (Chan and Kumaraswamy, 1997)

Factor category	Client		Consultant		Contractor		Weighted average	
	RII	R	RII	R	RII	R	RII	R
Project- related	0.588	6	0.645	4	0.672	5	0.635	5
Client-related	0.572	8	0.609	7	0.649	7	0.610	8
Design team-related	0.641	3	0.677	3	0.778	1	0.700	2
Contractors-related	0.708	2	0.711	1	0.699	3	0.706	1
Materials	0.606	4	0.600	8	0.681	4	0.630	6
Labor	0.717	1	0.682	2	0.662	6	0.687	3
Plant/equipment	0.577	7	0.636	5	0.634	8	0.615	7
External	0.598	5	0.632	6	0.746	2	0.660	4

Table 9: Relative importance index and ranks for delay factor categories by respondent in civil engineering works (Chan and Kumaraswamy, 1997)

Factor category	Client		Consultant		Contractor		Weighted average	
	RII	R	RII	R	RII	R	RII	R
Project- related	0.619	4	0.646	4	0.615	5	0.628	5
Client-related	0.526	7	0.610	7	0.571	7	0.570	7
Design team-related	0.639	3	0.681	2	0.677	1	0.666	2
Contractors-related	0.701	1	0.701	1	0.632	4	0.680	1
Materials	0.520	8	0.591	8	0.555	8	0.556	8
Labor	0.665	2	0.680	3	0.643	3	0.664	3
Plant/equipment	0.604	6	0.645	5	0.574	6	0.610	6
External	0.605	5	0.618	6	0.672	2	0.630	4

Frimpong et al. (2003) in Ghana studied to estimate and determine the significant factors influencing time and cost overrun in construction. They performed a questionnaire survey including 26 factors and distributed among contractors, consultant and owners of groundwater projects between 1970 and 1999. 55 owners, 40 contractors and 30 consultants were the respondents of the project as random sample. The relative weight was computed using the Equation:

$$RIW = \frac{\sum_{i=1}^{5} ai.ni}{\sum_{j=1}^{N} xj} \times 100 \qquad \text{Eq. 4}$$

Where: x_j=the sum of the j^{th} factor; j=the factors 1, 2, 3, 4,…N; N= is total number of factors (26); a_i= is a constant expressing the weight given to the i^{th} response: i=1, 2, 3, 4, 5.

This study showed that the significant factors that causing time and cost overrun of construction projects are “monthly payment difficulties”, “poor contractor management”, “material procurement”, “poor technical performance”, and “escalation of material prices”. Based on the finding, some recommendations were given as follow (Frimpong et al. 2011):

- Determination of appropriate levels of funding at the project planning stage for the usual payment of contractors completed works.
- Continuous updating personnel knowledge and project management training of the personnel to improve the managerial skill of contractors and have an effective performance.
- Due to the potential of the material procurement to affect time overrun in construction projects, material procurement system should efficiently and effectively be established in projects (Frimpong et al. 2011).

Mansfield et al. (1994) found "financing and payment for completed work", "poor contract management", "changes in site conditions", "shortage of material", and "improper planning" were the most important factor causing time overrun in construction project through a questionnaire survey among contractors, consultant and owners in Nigeria.

Bromolow (1974) found that most of building construction projects in Australia had overrun in time with average of 40% and only one-eighth finished on time.

Assaf and Al-Hejji (2006) studied on time overrun in construction project to find out the average of overrun and the influencing factors on time overrun. A questionnaire was designed with 73 various factors to identify the most important factors according to the contractor, consultant and owner opinion. "Delay in progress payment", "ineffective planning and scheduling of project by contractor", "poor site management and supervision by contractor", "shortage of labor" and "difficulties in financing project by contractor" were specified as most important factors causing time overrun in construction projects. They also found that 70% of construction

projects have time overrun and the average of overrun can be determined between 10 to 30 percent.

Kaliba et al. (2009) determined some of the factors causing delay or time overrun in Zambian road construction projects including: “delay in payment and financial difficulties”, “modification in the contract”, “material procurement and change in drawings”, “staffing problems”, “equipment unavailability”, “poor supervision”, “construction mistakes”, “poor coordination on site” and “change in specifications”.

A study conducted by Ogunlana and Promkuntong (1996) on Thailand’s construction project defined; shortages or inadequacies in industry, clients and consultant, incompetence or inadequacies of contractors as important factors causing delay in construction projects.

According to the viewpoint and opinion of construction contractors and consultants, the significant reasons of time overrun among several reasons in construction projects could be defined as “owner interference”, “inadequate contractor experience”, “financing and payment”, “labor productivity”, “slow decision making”, “improper planning”, and “subcontractor” (Odeh and Battaineh, 2002).

Odeyinka and Yusif (1997) conducted a study on causes of time overrun in building projects in Nigeria by categorizing factors into client related, contractor related and extraneous related. They found out “variation in orders”, “slow decision making”, and “cash flow problems” related to client. Found out “Financial difficulties”, “material management problems”, “planning and scheduling problems”, “inadequate site inspection”, “equipment management problems” and “shortage of labor” related

to contractor. And Specified weather condition and labor disputes as extraneous related factors.

Kazaz et al. (2012) studied the factors causing time extension in construction projects in Turkey. A questionnaire including 34 factors was distributed among to 71 construction contractors from which; 55.6% were project managers and 44.4% were site managers. The aim of the survey was to find out the important factors affecting construction project duration. The study determined "design and material changes", "delay of payment", "cash flow problems", "contractor financial problems", and "poor labor productivity" as important factors with design and material changes with the highest rank.

Toor and Ogunlana (2008) conducted a survey to explore the important factor causing delay in construction projects in Thailand. Procreate questionnaire including 75 factors together with a number of interviews were applied to 80 project managers to rank the most important factors. The project managers were working as client, consultant, designers and construction during the project. Survey showed that "lack of standardization in design", "lack of contractor's experience" and control over the project", "inadequate experience of staff", "lack of competent subcontractors/ suppliers" and "an unrealistic project schedule" received the highest ranks.

El-Rezak et al. (2008) compiled list of reasons of time overrun or delay in building projects in Egypt by conducting literature review and interviews. A questionnaire including 32 causes was formed to explore the most important factors causing building project time overrun. Questionnaires were distributed to project stakeholders including owners, consultants and contractors. "Financing by contractor

during construction", "delay in contractor's payment by owner", "design changes by owner or his agent during construction", "sectional payment during construction", "non utilization of professional construction and contractual management" were found as most important causes of delay in building projects.

Sambavian and Soon (2007) identified 10 most important factors causing time overrun or delay by a questionnaire survey in Malaysian construction industry. These factors were identified as "contractor improper planning", "contractor poor site management", "inadequate contractor experience", "inadequate client finance" and "payment for completed work", "problem with contractor", "shortage in material", "labor supply", "equipment availability and failure", "lack of communication between client, consultant and contractor", and "mistakes during the construction stage".

Seven most important factors affecting time overrun in construction projects by contractors were recognized by Ali et al. (2010). The contractor "financial difficulties", "material shortage", "labor shortage", "poor site management", "equipment and tool shortage", "coordination problem", and "construction mistake and defective work".

In another study conducted by Lo et al. (2006) on delay in civil engineering projects in Hong Kong, they identified 30 causes of time overrun through a questionnaire survey among 272 civil construction practitioners. The result of the study showed "inadequate resources due to contractor/lack of capital", "unforeseen ground condition" and "exceptionally low bids" as most significant causes of construction

time overrun in civil engineering projects. “Poor site management and supervision”, and “slow coordination” were also found in ten of the most important causes.

Gunduz et al. (2013) carried out survey about the causes of delay in construction projects in Turkey. 83 different delay factors were identified according to literature review and interviews, and then categorized into 9 major groups; “consultant-related factors”, “contractor-related factors”, “design-related factors”, “equipment-related factors”, “externally-related factors”, “labor-related factors”, “material-related factors”, “owner-related factors”, and “project-related factors”. The fishbone diagram or cause-and-effect diagram used by Gunduz et al. (2013) shows the grouping of delay factors (Figure 1). An interview questionnaire include those factors was designed and filled out by 64 experienced construction professional, and relative importance index method was used to find the important construction project delay factors.

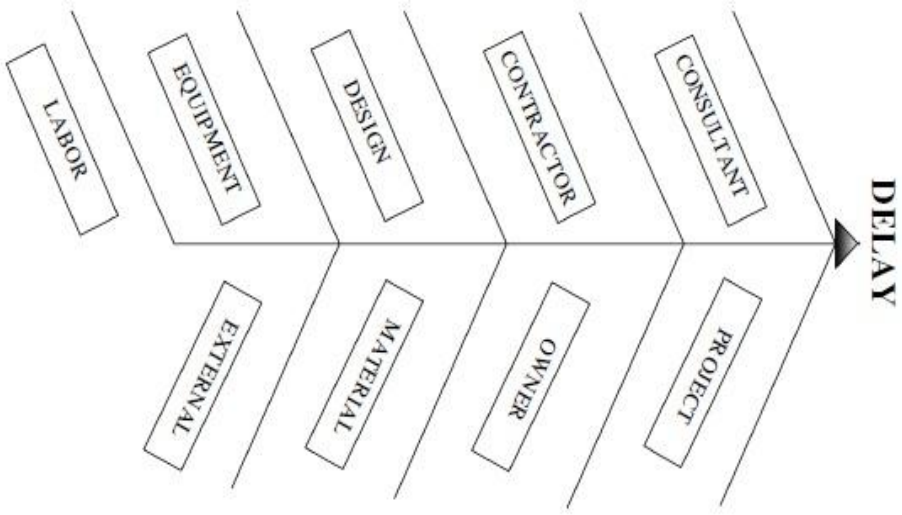

Figure 1: Cause and effect diagram (Gunduz et al. 2013)

According to this study “inadequate contractor experience” (RII=0.863), “ineffective project planning and scheduling” (RII=0.844), “poor site management and

supervision" (RII=0.844), "design changes by owner or agent during construction" (RII=0.813), and "late delivery of material" (RII=0.803) were the most important factors causing delay in construction projects (Table 11). Contractor- related factor by RII= 0.773 was the most important category to cause delay as showed in Table 10.

Table 10: Groups of delay ranking and mean RII (Gunduz et al. 2013)

Groups of factors	**RII**	**Rank**
Contractor-related factors	0.773	1
Owner-related factors	0.730	2
Consultant-related factors	0.723	3
Design-related factors	0.704	4
Material-related factors	0.692	5
Equipment-related factors	0.683	6
Labor-related factors	0.655	7
Project-related factors	0.648	8
Extremity-related factors	0.627	9

In another study a questionnaire survey was conducted on 250 construction projects in UK by Olawale and Sun (2010) followed by interviews to identify the important factors affecting time and cost control during construction projects. Relative importance index (RII) method was used for each individual factor. The factors were ranked in relation to their RII. According to this survey "design changes" considered as most important factor affecting time control in projects which was followed by "inaccurate evaluation of project duration", "complexity of works", "project risk and uncertainties" and "non-performance of subcontractor and supplier". Furthermore some mitigating measure for the top affecting factors on time control developed.

Table 11: Fifteen most important factors causing delays (Gunduz et al. 2013)

No.	15 most important factors causing delays	Factor group	RII	Rank
1	Inadequate contractor experience	Contractor related	0.863	1
2	Ineffective project planning and scheduling	Contractor related	0.844	2
3	Poor site management and supervision	Contractor related	0.844	2
4	Design changes by owner or agent during construction	Design related	0.813	4
5	Late delivery of materials	Materials related	0.803	5
6	Unreliable subcontractors	Contractor related	0.797	6
7	Delay in performing inspection and testing	Consultant related	0.784	7
8	Unqualified/inexperience workers	Labor related	0.784	7
9	Change orders	Owner related	0.778	9
10	Delay in site delivery	Owner related	0.778	9
11	Delay in approving design documents	Owner related	0.775	11
12	Delay in progress payments	Owner related	0.775	11
13	Slowness in decision making	Owner related	0.775	11
14	Poor communication and coordination	Consultant related	0.756	14
15	Unexpected surface and subsurface conditions (soil, water, etc.)	External related	0.780	14

Ninety mitigating measures were developed for the inhibiting factors which were ranked as top five most important factors including “design changes”, “evaluation of project duration”, “complexity of works”, “project risk and uncertainties” and “non-performance of subcontractor and supplier”. These mitigating measures could be used to help project managers in projects as good practice checklist to improve the efficiency of control in their projects (Olawale and Sun, 2010).

Olawale snd Sun (2013) developed project control and inhibiting factors management (PCIM) model for time and cost control in addition to identifying important factors influencing time and cost in construction projects and mitigate the affecting factors.

The PCIM model included three main sections. The first section which is the main phase includes planning, implementation, and finish; the second phase of the model is project control section containing monitor, report, analyze, feedback, action, and revise plan. The last section shows that project control is frequently inhibited by some factors such as “design changes”, “risk and uncertainties”, “complexity”, “inaccurate evaluation of time”, and “non-performance of subcontractors” are the “project control inhibiting factors” in the model which is could be different for other projects (Olawale and Sun, 2013).

A questionnaire survey was performed by Alaghbari et al. (2007) in Malaysia to find out the significant factors causing delay in building construction projects. In the study, 31 factors were grouped into four major categories; “contractor factors”, “consultant factors”, “owner factor”, and “external factors”. Level of the importance of each factor in each category and also top ten most important factors from all categories were measured by the following Equation:

$$MS = 4 - \frac{\sum(f \times s)}{N} \qquad (1 \leq MS \leq 4) \qquad \text{Eq. 5}$$

Where *MS* is the mean score, *f* is the frequency of responses to each rating (1-4), *s* is the score given to each factor by the respondents (ranges from 1 to 4), and *N* is the total number of responses concerning that factor (78).

In the ranking of contractor factors category based on the mean value financial problem was the first ranking which was followed by “shortage of material on site”, “poor site management”, “construction mistake and defective work”, and “delay in delivery of material to site”.

Result of the analysis in the consultant factors causing delay in building construction projects showed that “too late supervision” and “slowness in making decisions”, “slow to give instructions”, and “lack of consultant experience” had the highest rank in consultant category.

“Financial problem”, “slowness in decisions”, “contract modification (replace and add new works to the project, change specifications)” were the most important factors causing delay in construction project in the owners category.

The most important external factors causing delay in building construction project were “lack of materials on the market”, “poor site condition”, “lack of equipment and tools on the market”, and “poor weather conditions”.

Tables 12 shows the top ten most important factors causing delay in building construction projects in Malaysia. Contractor factors with five of the top ten factors were ranked first which were followed by consultant factors, owner factors and at last external factors.

Table 12: Ranking of the top ten factors causing delay in construction projects (Alaghbari et al. 2007)

Factors	Mean	SD	Ranking	Responsible
Financial difficulties and economic problems	1.26	0.44	1	Owner
Financial problem	1.44	0.68	2	Contractor
Supervision too late and slowness in making decisions	1.62	0.61	3	Consultant
Slow to give instruction	1.63	0.74	4	Consultant
Lack of materials on market	1.63	0.76	4	External
Poor site management	1.67	0.75	5	Contractor
Material shortage on site	1.67	0.75	5	Contractor
Construction mistakes and defective works	1.71	0.69	6	Contractor
Delay in delivery of material to site	1.73	0.73	7	Contractor
Slowness in making decisions	1.78	0.83	8	Owner
Lack of consultant experience	1.79	0.71	9	Consultant
Incomplete documents	1.81	0.76	10	Consultant

Many factors that causing delay in construction projects were identified among different studies during the research; the description of time overrun factor which were effective on causing time overrun in the studies are given as follow:

2.6.1 Unpredictable weather condition

Construction projects depend on climate situation, which vary by the location of the projects. For instance extremely hot weather can affect construction work or heavy rain may stop work in foundation and structure stage specially in concrete structure (Kaming et al. 1997).

2.6.2 Poor site management and supervision

One of the most important factors in causing the construction delays is poor site management, which occurs at the site and negatively influences work (Sambasivan and Soon, 2007). Effective site management is very important by contractors to make sure projects are completed within time. Poor site management arises when contractor does not have enough experience and lack of knowledge to manage the project team (Kadir et al. 2005). For project manger it is so important the

construction work and projects team efficiently. Poor site managing by project manager could affect progress of work and also project team, which has effect on project time.

2.6.3 Inexperienced and low performance subcontractor and supplier

In the projects lots of subcontractors are working under main contractors. The projects could be completed and finished on planned time if subcontractors are competent and capable. If the subcontractor are inexperienced or under performs, the projects can be delayed (Sambasivan and Soon, 2007). On the other hand, Olawale and Sun (2010) mentioned that it is not inevitably and necessarily the mistake of the subcontractors but may be because of lack of effective and good management by the contractor. Inappropriate communication of the objectives and aim of the project to subcontractor or disability to recognize nonperformance in time are some examples.

2.6.4 Qualification and experience of project staff

Construction projects are usually complex works including coordination of many relevant activities carried out by several subcontractors. The general contractor is responsible for managing and planning the process. One of the main causes of the project changes is poor site management and supervision by contractors. This can be caused by lack of experience and inappropriate management structure and inadequate managerial skills (Sun and Meng, 2009).

2.6.5 Low skilled labor

Low skilled labors can be broadly recognized as usual cause of unplanned rework and project change. In recent years, the difficulty of work coordination between subcontractors has increased because of the growing trend of using subcontractor instead of main contractor direct labor (Sun and Meng, 2009). A low level productivity of worker may perhaps result in activity time extension and overrun in

total project duration. Lack of concentration of workers can also cause the faulty and poor quality construction work. Poor quality causes loss of time and rework in construction project (Kazaz et al. 2012).

2.6.6 Inaccurate evaluation of project time/duration and poor project duration estimation

Improper planning at early stages of project would be apparent during the project and can cause delay in many stages of project. Only those projects can be well implemented which are well planned. One of the reasons of inaccurate evaluation of project duration is that time planning of project is often estimated without technical and scientific basis. Besides, sometimes construction project work plans are prepared by inexperience planners or those planners that do not have good perception of construction process**.** On the other hand early delivery of project from owner is sometimes accepted by professional team without considering how this work would be actualized and this could cause time overrun in construction project (Olawale and Sun, 2010).

2.6.7 Lack of proper training and experience of project management

Odeh and Battaineh (2002) specified inadequate contractor as an important factor. Projects cannot be appropriately planned and managed by contractors with inadequate experience (Sambasivan and Soon, 2007). Schedulers should be familiar with the duration of activities, construction method and optimal sequencing of construction work to plan the projects and estimators should have experience and knowledge about wage costs for operators and outputs of equipment to estimate (Kaming et al. 1997).

2.6.8 Lack of appropriate software

During the recent decades, various methods of project control have been developed and numerous software became available for project control methods support. However, with wide range of using these software and methods in implementation, lots of construction projects still experience time overruns (Olawale and Sun, 2010).

2.6.9 Design changes

The effects of design changes on construction projects schedule and cost is often underestimated (Olawale and Sun, 2010). Design changes may be caused by the owners needs, or can be caused by poor original designs, which make to be difficult to build. For example, changing design of building according to the changed method allows the constructing building in several stages to prepare adequate working space. Availability of the completeness of working drawing at the time estimate could be an example of causes of delay in construction project (Kaming et al. 1997).

2.6.10 Delay in material deliveries to site

Sometimes the quantity of materials delivered by the supplier is less than the ordered quantity. This will cause material shortage because the amounts of ordered materials are not delivered to site. Van der Rhee et al. (2009) found that late delivery of materials by suppliers is significant factor because it has direct effect on completion of construction project. Improper communication and coordination is an important problem because misunderstandings between suppliers and contractors will affect early delivery or late delivery of materials to construction site (Ali et al. 2010).

2.6.11 Equipment availability and failure

Some contractors have not their own equipment and need to rent the required equipment. Within the seasons that many projects are under construction, the equipment are poorly maintained and in short supply (Sambasivan and Soon, 2007).

Some contractors may own the equipment, but the capacity of the equipment cannot always meet the need and the contractors may not fully appreciate by maximum capacity of equipment (Kaming, et al.1997). This can cause failure of the equipment. Usage of equipment should be planned by contractor according to the construction work to be performed through specific period of time because the rented equipment must be returned to supplier at the finishing of rent period (Ali et al. 2010).

2.6.12 Complexity of work

Complexity in project could be described as mixture of factors or as a single factor that have effects on actual actions and response which in use to accomplish the outcomes of project (Wood and Ashton, 2009). Construction projects might sometimes contain some type of complexity; which can affect time and cost control. Interface of different phases, stages or different trade often are the main cause of project complexity through the construction project implementation (Olawale and Sun, 2010).

2.6.13 Financing and payment for completed work

Construction work involves large amount of money and delay in payments could be difficult for contractors to stand the heavy daily expenses of construction. Work progress could be delayed because of late payment by the owner because there is improper cash flow to support expenses of construction (Sambasivan and Soon, 2007).

2.6.14 Lack of coordination between contractor, consultant, subcontractor and owner

There are many groups involved in construction projects such as contractor, subcontractor, consultant and owner. The coordination between the groups is very important for the success of the project. Sometimes it may be difficult for these

groups to coordinate well to complete the project. Any problem with coordination can cause misunderstanding in construction projects, and subsequently causes delay in implementation of construction projects (Sambasivan and Soon, 2007).

2.6.15 Contract and specification interpretation disagreement

Specifications are part of contracts which define and explain the requirements of materials, equipments, design, etc. Specifications show how a building project will look like when completed. Specifications should clearly explain complete details. Disagreement in construction project sections which are not clearly and correctly defined and explained could affect the scheduled time.

2.6.16 Shortage of materials in site

Construction projects regularly need large amount of materials and equipment to move and modify them. Managing the materials is a significant element in construction project control and planning. Poor materials management can result in unavoidable delay in construction. Decision about the materials preparation may be needed during the scheduling and planning stages; and it is not a concern during the control stage. Delay may occur due to not availability of material for one activity in site.

2.6.17 Unforeseen site condition or inaccurate specification of site condition

Unforeseen ground condition or site condition can be recognized as a delay factor to project after work starts on site. These are concerned with soil conditions, unidentified condition or wrongly located specifications on plans (Chan and Kumaraswamy, 1997).

2.6.18 Delay in work approval and waiting for sample test approval

Construction projects include various phases. Any phase of the project is implemented by different responsible party according to quality and quantity

specified in contract specifications. Reaching to the goal of the contract specification in each part must be approved by responsible party. Sometimes delay in approving or not reaching the specifications goals could cause delay in that section of the project.

2.6.19 Inaccuracy of material estimate

Shortage of materials in site can be due to many reasons; one of them is poor planning of materials. Contractor's poor material planning can cause material shortage because the required construction materials may not be available at a certain time. This can be due to error in planning stage which will cause delay in construction project (Ali et al. 2010).

2.6.20 Slow decision making

Slow decision making is identified as a significant factor causing delay in construction projects in many studies. Coordination and communication management between construction team and design team for decision making is one of the important factors in construction time. For achieving a successful project, design drawing, specifications with a clearly basis to plans should provide the contractor and the responsible for making decision should be identified.

Chapter 3

METHODOLOGY

3.1 Introduction

In this chapter, at the first part methodology of the study and the definition of the specified time overrun factors explained. In the second step questionnaire survey and its sections are described and the results of the questionnaire are analyzed. At the next section case is studied and results of the case study have been analyzed. Then results of both questionnaire and case study are comprised.

3.2 Methodology

The methodology of this research contains both qualitative and quantitative methods. The qualitative method includes literature review and case study, and the quantitative method is performed through a questionnaire survey. At the first step of research, relevant literature review was conducted to find out the importance of time and definition of time overrun in construction projects. Literature survey was with special focus on identifying and specifying the factors which cause time overrun in construction projects. In the second part of this research, a survey was conducted through a questionnaire to specify the most important factors influencing time planning and causing time overrun in construction projects in North Cyprus. Prior to the survey, important factors were recognized with a literature review. Many factors causing delay in construction projects were identified among different studies. Then the factors were shortlisted due to overlapping and relation to each other. The sources of these factors are shown in Table 13. Respondents were also asked to write

other factors which affect their project time planning. A few of the respondents highlighted some factors which were related to one of the listed factors. On the other hand, a case study was analyzed to assess the causes of time overrun in a real construction project. Duo to the analysis of the questionnaire survey and case study, five most important factors causing time overrun were specified and selected. Furthermore, reduction method and measures to mitigate the time overrun factors were proposed. Figure 2 shows the process of finding the mitigation measures and project control model.

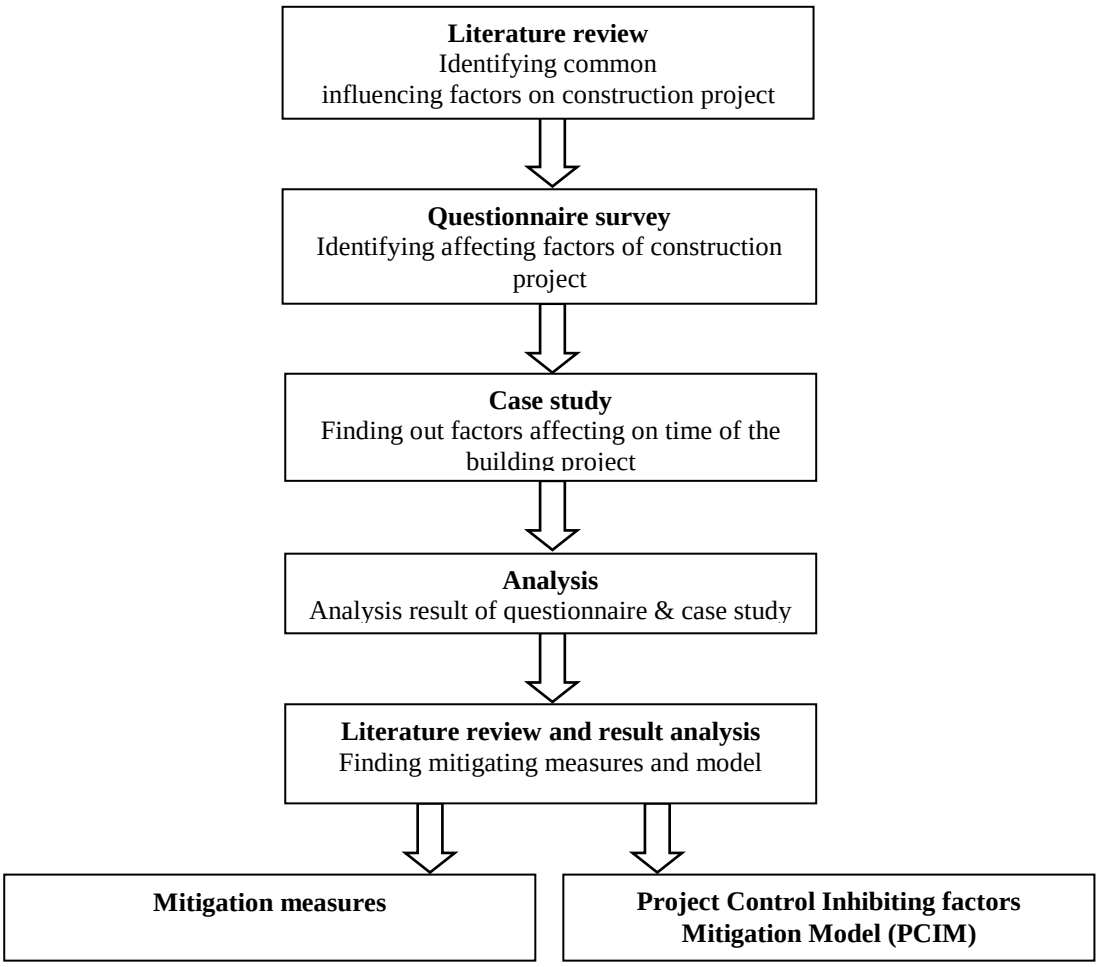

Figure 2: Process of finding mitigating measures and project control model

Table 13: Factors causing time overrun in construction project

Factors	**Sources**
Unpredictable weather condition	Olawale and Sun (2010), Gunduz et al. (2013), Frimpong et al. (2003), Kaming et al. (1997), Kazaz et al. (2011)
Poor site management and supervision	Sambavian and Soon (2007), Alaghbari et al. (2007), Frimpong et al. (2003)
Inexperience and low performance subcontractor and supplier	Manfeild et al. (1994), kumaraswamy and chan (1998)
Qualification and experience of project staff	Sambavian and Soon (2007), Alaghbari et al. (2007), Frimpong et al. (2003), El-rezak et al. (2008), Toor and Ogunlana (2008)
Low skilled labor	Kming et al. (1997), Kmaraswamy and Chan (1998), Kazaz et al. (2011), Alaghbari et al. (2007)
Inaccurate evaluation of project time/ duration and poor project duration estimation	Kaming et al. (1997), Mansfield et al. (1994), Kumaraswamy and chan (1998), Frimpong et al. (2003)
Lack of proper training and experience of project management	Chan and Kumaraswamy (1996), Olawale and Sun (2010), Toor and Ogunlana (2008)
Lack of appropriate software	Olawale and Sun (2010), Gunduz et al (2013)
Design changes	Mansfield et al. (1994), kaming et al. (1997), Olawale and Sun (2010), Sun and Meng (2009)
Delay in materials deliveries to site	Alaghbari et al (2007), frimpong et al (2003), El-rezak et al. (2008), Gunduz et al. (2013)
Equipment availability and failure	Kaming et al. (1997), Memon et al. (2011), Odeh and Battaineh (2002), Rahman et al. (2006)
Complexity of work	Olawale and Sun (2010), Chan and Kumaraswamy (1996), Nkado (1995)
Financing and payment for completed work	Fimpong et al. (2003), Odeh and Battaineh (2002), Olawale and Sun (2010)
Lack of coordination between contractor, consultant, subcontractor and owner	Gunduz et al. (2013), Sambavian and Soon (2007), Kazaz et al. (2012), Kumaraswamy and Chan (1998)
Contract and specification interpretation disagreement	Olawale and sun (2010), Rehman et al. (2006), Kazaz et al. (2012)
Shortage of materials in site	Toor and Ogunlana (2008), Raman et al. (2006), Memon et al. (2011)
Unforeseen site condition or inaccurate specification of site condition (soil investigation, water table…)	Kazaz et al. (2012), El-rezak et al. (2008), Memon et al. (2011), Alaghbari et al. (2007),
Waiting time for approval of sample test	El-rezak et al. (2008), Gunduz et al. (2013), Chan and Kumaraswamy (1997)
Delay in work approval	Frimpong et al. (2003), Chan and Kumaraswamy (1996), Lo et al. (2006), Sambavian and Soon (2007)
Inaccuracy of material estimate	Lo et al. (2006), Toor and Ogunlana (2008), Kaming et al. (1997)
Slow decision making	Alaghbari et al. (2007), Gunduz et al. (2013), El-rezak et al (2008), Toor and Ogunlana (2008)

A questionnaire including these factors was distributed among construction companies to rate the importance of effective factors in building construction project in North Cyprus.

The building construction industry is developing quantitative and qualitative by increasing in number of project, size of the project, complexity, variation of design and difference in type of farming and techniques. And also the type of the building such as; residential building, commercial building, industrial building, etc. The most regular framing and technique in North Cyprus building construction is reinforced concrete structures. In recent years, building construction projects in North Cyprus were also increasing as shown in Figure 3. It represents the total urban and rural building construction from 1990 to 2009. The total number of building construction projects were increased slightly during the last two decades but number of building constructions grew exponentially 2002 in comparison to previous years.

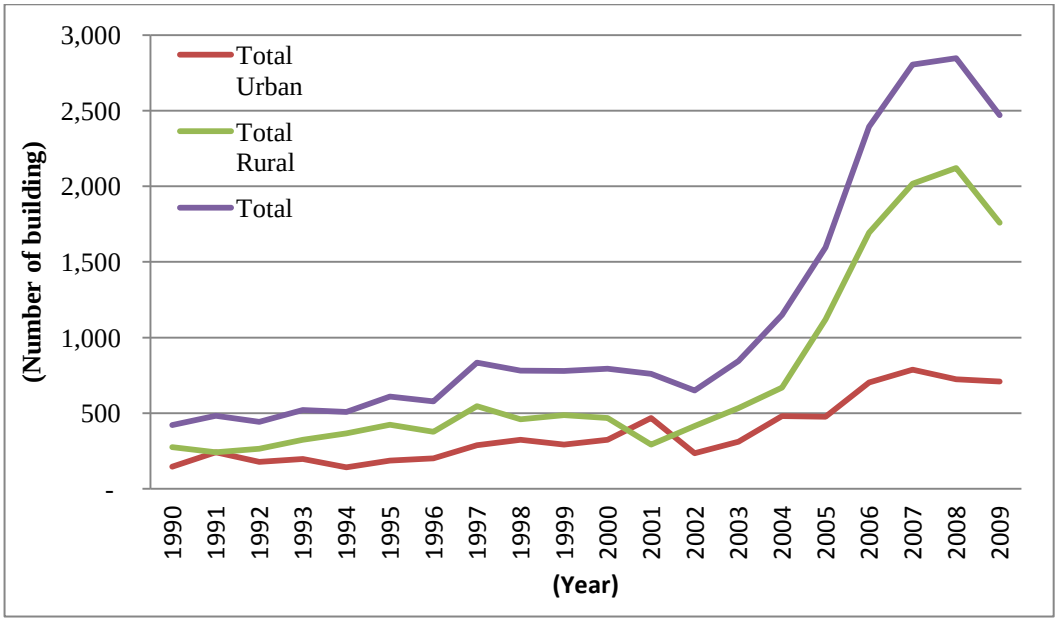

Figure 3: Number of building project in North Cyprus (State Planning Organization, 2006-2013)

The variation of the building construction projects among the cities is shown in Figure 4. Based on this Figure, Kyrenia has the largest number of building constructions in comparison to other cities followed by Nicosia and Famagusta while Iskele and Guzelyurt have the lowest number. Generally kyrenia, Nicosia and Famagusta have most of the construction projects in North Cyprus.

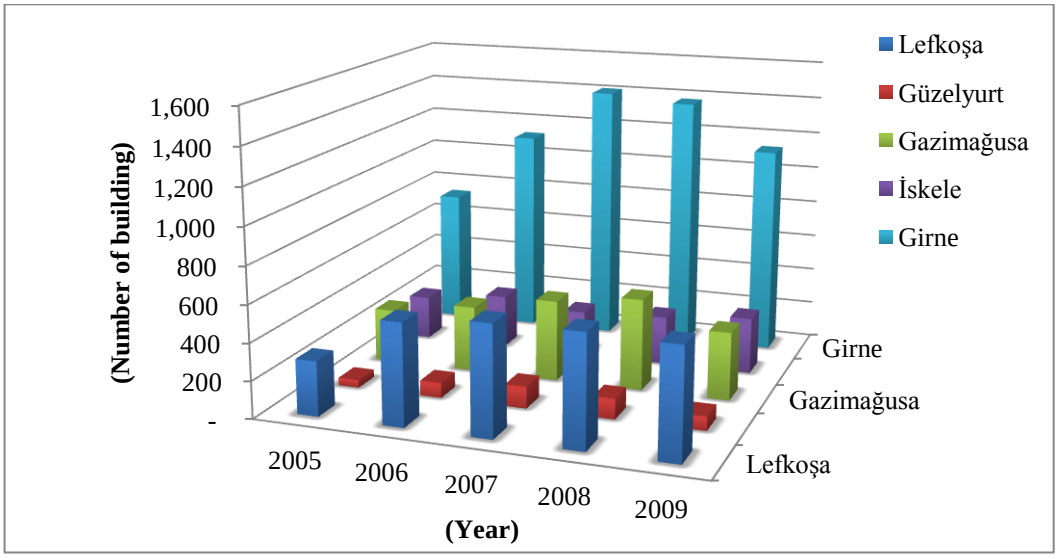

Figure 4: Proportion and number of building project in North Cyprus (State Planning Organization, 2006-2013)

3.3 Questionnaire Survey

This research was conducted to identify the most important factors influencing time planning time overrun occurrence in construction projects. The factors outlined in Table 13 were used in questionnaire. The questionnaire was distributed randomly among construction companies with different roles such as owner, contractor, consultant, and designer in Kyrenia, Nicosia, and Famagusta. The questionnaire was distributed to 75 companies. Response rate of the survey was 53.3%. Proportions of the companies which response the questionnaire were; 35% from Kyrenia, 37.5% form Famagusta and 27.5% from Nicosia. Five point Likert scale was used to rank

the level of importance factors as extremely important, important, moderately important, unimportant, and extremely unimportant. Numerical values given to each scale to evaluate the rating was:

1= Extremely important

2= Important

3= Moderately important

4= Unimportant

5= Extremely unimportant

3.3.1 Questionnaire sections

The questionnaire contained two sections with the first section including questions about respondents, companies and their projects.

3.3.1.1 Roles of respondents

Profiles of the respondents are shown in Table 14 and Figure 5. 30% of the respondents that completed the questionnaire were director/senior manager and 27.5% of the respondents were construction managers and project manager which shows knowledge of respondents on management issue.

Table 14: Roles of respondents

Respondents Role	Percent%	Valid Percent	Cumulative Percent
Director/senior manager	30	30	30
Contract manager	2.5	2.5	32.5
Construction manager	10	10	42.5
Project manager	17.5	17.5	60
Quantity surveyor	2.5	2.5	62.5
Designer	22.5	22.5	85
Engineer	10	10	95
Project control	5	5	100
Total	100	100	

3.3.1.2 Respondents experience

Experience of respondents in Figure 5 shows that almost 40% of the respondents had more than 12 years and nearly 20% of the respondents had more than 20 years experience in construction project which proves their adequate experience in construction projects.

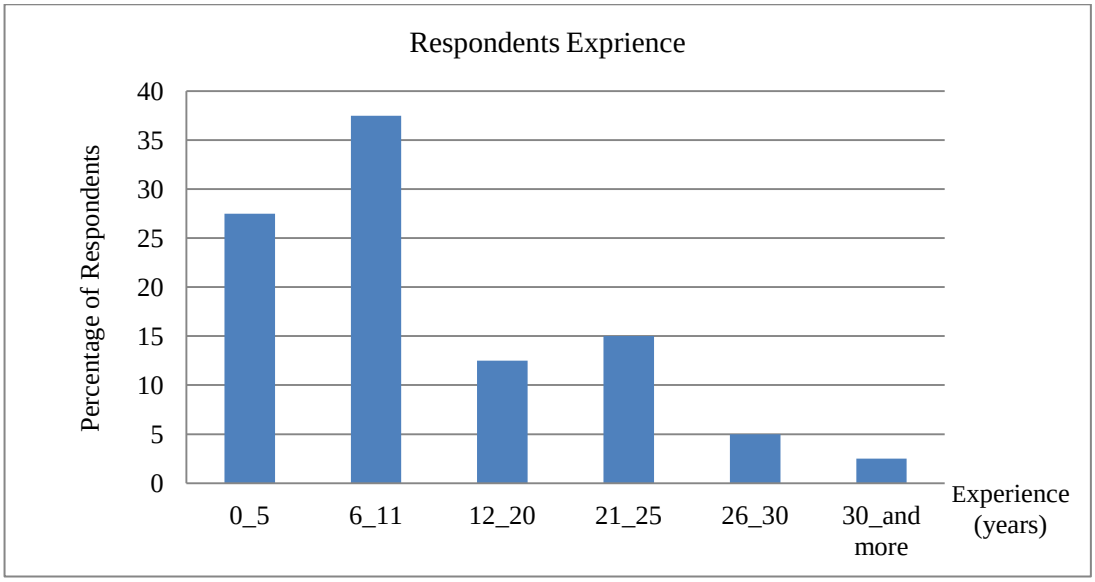

Figure 5: Respondents experience in years

3.3.1.3 Type of companies

Figure 6 shows that 67.5% of the respondents companies were contractor, owner or owner and contractor. 25.5% of the companies were consultant, designer or consultant and designer.

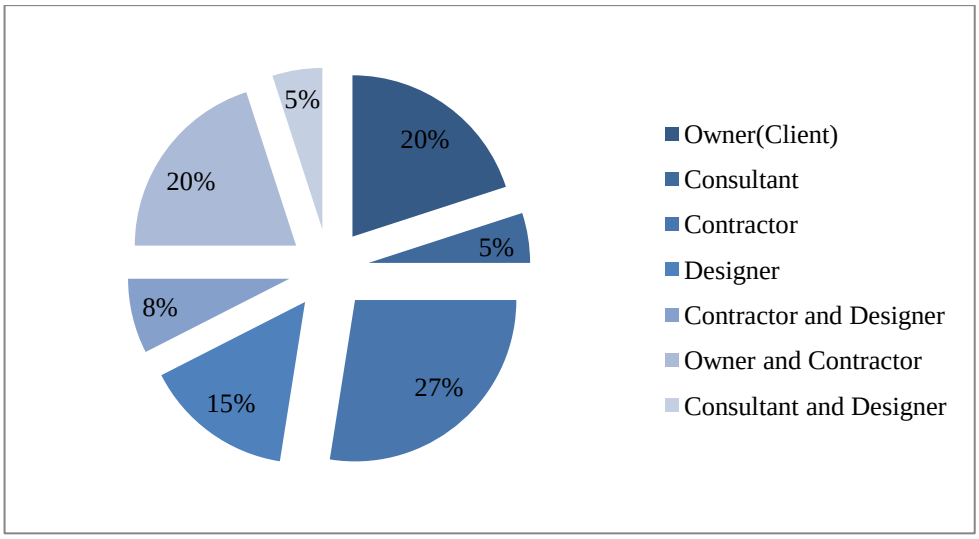

Figure 6: Type of companies

3.3.1.4 Type of projects

Figure 7 shows type of the projects undertaken by the respondents companies. 57.5% of the respondents were working in residential building projects, 25% in commercial building projects, 15% complex and 2.5% industrial construction.

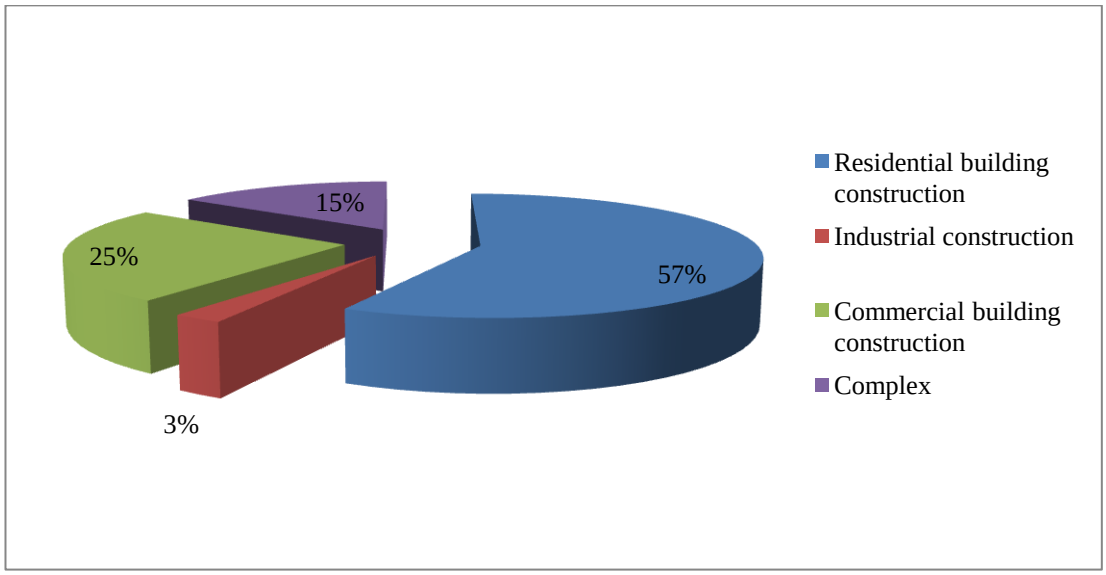

Figure 7: Projects types undertaken by respondents

3.3.1.5 Size of the projects

Figures 8 and 9 present the classification of construction projects in North Cyprus according to their area and number of stories based on results achieved from

questionnaires. The figures show that about 35% of the projects had 5000 m² to more than 10000 m² under construction, 15% of the construction projects were 2500 m²-5000 m² and 50 % of the projects were up to 2500 m². 60 percent of the projects had more than 6 stories, 35% were 3-5 stories and 5 percent were 1-2 stories.

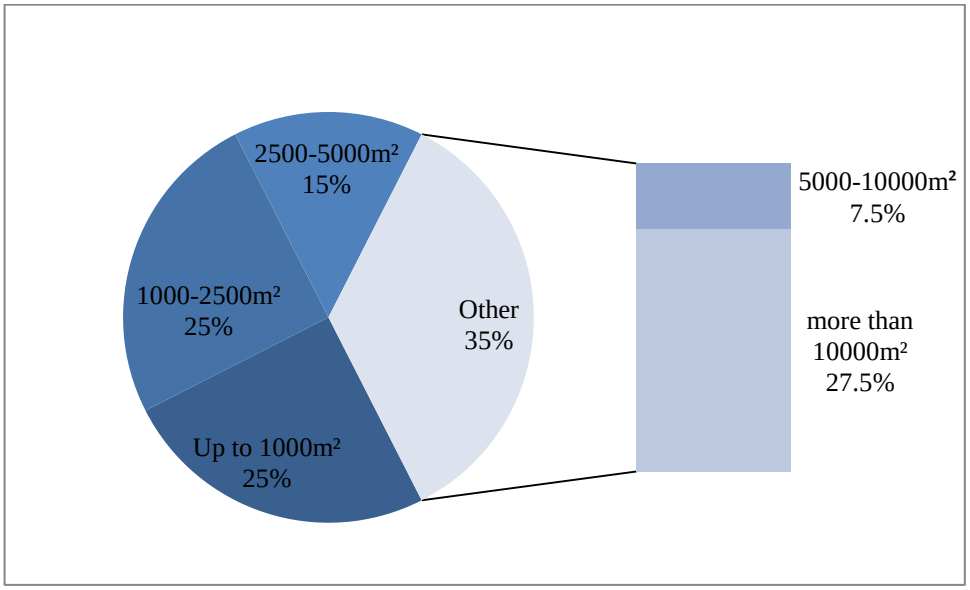

Figure 8: Classification of buildings in North Cyprus based on area

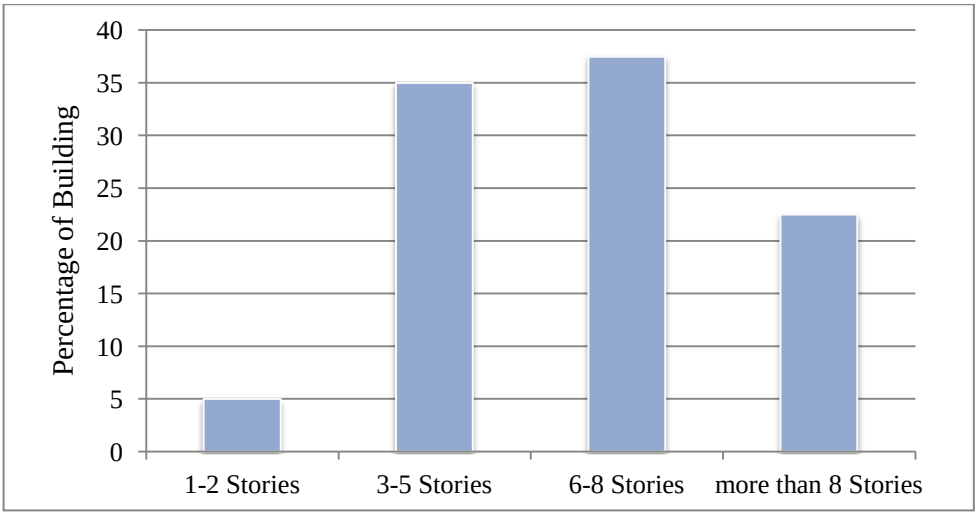

Figure 9: Classification of buildings in North Cyprus based on number of stories

3.3.1.6 Estimated duration of projects

Estimated duration of the construction projects in Figure 10 shows that 72.5% of the estimated durations were up to 24 month, 15% of the projects had durations of 25-30 month and 12.5% of the construction projects had 31 month to more than 49 month estimated duration.

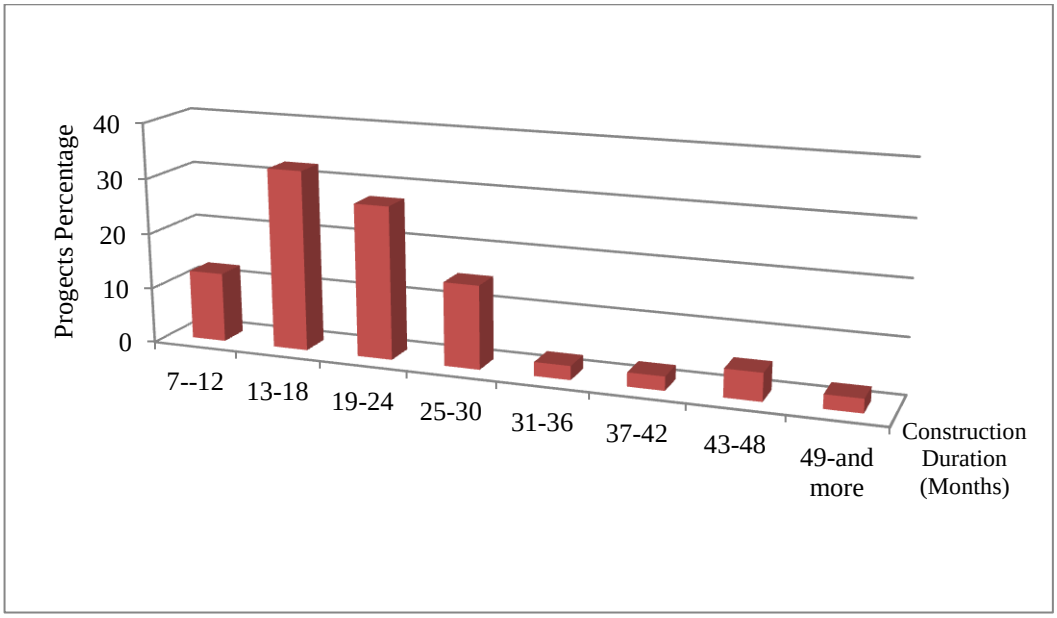

Figure 10: Estimated project duration

3.3.1.7 Applying time planning on projects

Nowadays time planning and control is one of the essential issues in managing construction projects. According to Figure 11, 37.5% of the respondent companies always apply time planning on their construction projects, 42.5% of the respondents indicated that they frequently apply time planning on their projects and 20% of the respondents companies stated they rarely apply or do not apply time planning on their construction projects.

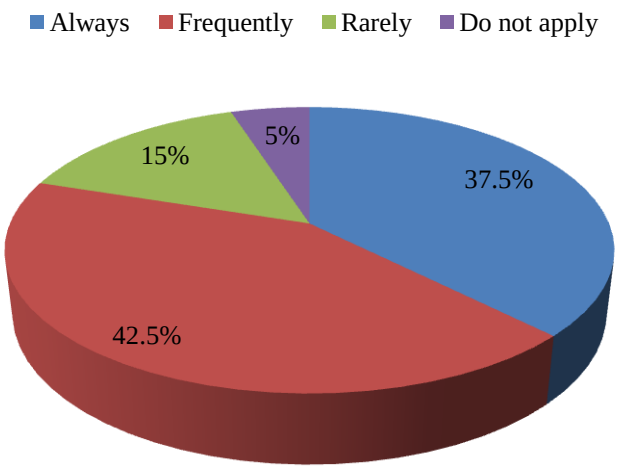

Figure 11: Application time planning

3.3.1.8 Time planning technique and software

The most common time planning technique used by 52% of the respondents was bar chart (Table 15). Critical Path Method (CPM) was used by 7.5% of the respondents; and 20% of the respondents stated that use other time planning techniques; however, did not specify and 20% did not answer this question or mentioned that they do not use any time planning technique. Microsoft project was common time planning software being used by the respondents (Table 16). 55% of the respondents used Microsoft project in their construction projects, Primavera was used by 5% of the respondents, 20% used other time planning software which they did not specify and 20% of the respondents did not answer this question.

Table 15: Time planning technique

Time planning technique	Percentage (%)
Bar chart	52.5
Critical path method(CPM)	7.5
Other	20
Do not use	20
Total	100

Table 16: Time planning software

Time planning software	Percentage (%)
Microsoft project	55
Primavera	5
Other	20
Do not use	20
Total	100

3.3.1.9 Time overrun in projects

In spite of the wide application of time planning technique and software, time overrun is quite usual in construction projects. Table 17 shows the proportion of construction projects experiencing this problem. 27.5% of the construction projects had 0-5% time overrun on their project, 32.5% of the projects time overrun were 6-11%, 12-20% and 21-25%, and proportion of the projects that had more than 26% were 30%.

Table 17: Projects time overrun

Time overrun in projects	Projects (%)	Valid Percent	Cumulative Percent
0-5%	27.5	27.5	27.5
6-11%	20	20	47.5
12-20%	17.5	17.5	65
21-25%	5	5	70
26-30%	10	10	80
31-40%	7.5	7.5	87.5
48-55%	7.5	7.5	95
70%-and more	5	5	100
Total	100	100	

3.3.1.10 Second questionnaire section

In the second section of the questionnaire, respondents were asked to rate the level of importance for each identified factor by using five scales of extremely important (5), important (4), moderately important (3), unimportant (2), and extremely unimportant (1). Respondents were also asked to give suggestions on how to reduce the effect of the factors. The relative importance of each factor was then calculated by Relative Importance Index (RII) which was used in similar studies by Kumaraswany and Chan (1997, 1998) and Olawale and Sun (2010) (Equation 5).

$$RII = \frac{\sum w}{A \times N} \ , (0 \leq index \leq 1) \qquad \text{Eq. 6}$$

Where w = is the weight given to each factor by the respondents and ranges from 1 to 5, A = is the highest weight or rank (i.e. 5 in this case), and N = is the total number of respondents that answered the question.

Rank and RII of the factors affecting time overrun in the projects are summarized in Table 18. The table specified highlights that “slow decision making” is considered as the most important factor affecting time planning of the construction projects with a RII=0.855. This factor was followed by “qualification and experience of project staff” with a RII=0.835. These factor were followed by “inexperience and low performance of subcontractor and supplier” with RII=0.821, “delay in material deliveries to site” with RII=0.820, and “design change” with RII=0.810.

Table 18: Ranking of factors affecting construction project time planning

Factors	RII	Rank
Unpredictable weather condition	0.750	10
Poor site management and supervision	0.760	9
Inexperience and low performance subcontractor and supplier	0.821	3
Qualification and experience of project staff	0.835	2
Low skilled labor	0.770	8
Inaccurate evaluation of project time/ duration and poor project duration estimation	0.738	13
Lack of proper training and experience of project management	0.730	14
Lack of appropriate software	0.615	20
Design changes	0.810	5
Delay in materials deliveries to site	0.820	4
Equipment availability and failure	0.675	19
Complexity of work	0.680	18
Financing and payment for completed work	0.800	6
Lack of coordination between contractor, consultant, subcontractor and owner	0.745	11
Contract and specification interpretation disagreement	0.740	12
Shortage of materials in site	0.675	19
Unforeseen site condition or inaccurate specification of site condition (soil investigation, water table…)	0.687	17
Waiting time for approval of sample test	0.705	15
Delay in work approval	0.775	7
Inaccuracy of material estimate	0.700	16
Slow decision making	0.855	1

At the next step of the study a relative case will be studied to carry out the major practical time overrun factors in Kyrenia which has the highest rank in number of building construction projects among other cities in North Cyprus.

3.4 Case Study

Time planning in construction projects is one of the most important factors since finishing the project within the scheduled time is one of the major criteria of the successful project. However, time overrun is frequently experienced by most of the construction projects. This section shows the time overrun and factors causing time overrun in a hotel construction project in Kyrenia as case study. An interview conducted with project manager of the case; during this interview, some verbal data

and documents about construction project provided. The following sections summarize the interview results about the case study and its specifications.

3.4.1 Project specification

In this section a hotel construction project in Kyrenia was analyzed as a case study. The project's area under construction is 38,860.25 m², with an open area of 21,000 m². This 8 floor building contains 118 rooms which are various in each story. It was selected as the case due to the size which is quite large and the variety of phases during construction.

3.4.2 Time planning

The case study project contains time planning which was designed in Microsoft Project that is one of the most common software in construction project. Based on project manager's provided data, project duration was estimated to be 632 days by considering almost 1500 activity excluding concrete structure which was not defined in the MS Project.

3.4.3 Time overrun

The case study construction project was not completed within estimated duration which was specified by planning and experienced time overrun. The time overrun occurred due to various factors in different activities and sections. Late finish of each activity could affect the succeeding activity then causing late delivery of the project and facing time overrun. According to documents received from project manager, the factors causing time overrun in case study are listed in Table 19. In this table, activities are shown by their descriptions which were defined in MS Project time planning.

Table 19: Factors causing time overrun in case study

	Activity Description	Affecting Factors	Estimated Duration of Activity (Day)	Delay in Duration (Day)
1	Wall framework(carcass) of floors	Delay in delivery of materials to site	39	14
2	Drywall covering	Delay in delivery of materials to site	36	14
3	Ceiling framework	Delay in delivery of materials to site	67	14
4	Ceiling drywall covering	Design change	37	21
5	Aluminum joinery installation	Delay in delivery of materials to site	33	30
6	Roof top terrace isolation	Unpredictable weather condition	7	45
7	First floor precast outer wall	Unpredictable weather condition	188	90
8	Marble cladding of first floor outer(façade)	Unpredictable weather condition	88	90
9	Bathrooms marble cladding	Design changes, changes because material quality, labor	102	90
10	Terrace ceramic coating	Delay in delivery of materials to site, late delivery of previous activity	78	50
11	Wood furniture (wall, column, etc.) in corridor	Lack of proper training and experience of project management(slow decision making), delay in delivery of material to site, labor	57	75
12	Floor carpeting	Delay in delivery of material to site, late delivery of previous activity	87	75
13	Glass handrails installation	Inexperienced and low performance subcontractor, delay in delivery of materials to site	50	105
14	Fixture installation of corridor	Late delivery of previous activity	28	_
15	Fine work-floor screed beam	Design change	_	_
16	Wall carcass (framework)	Design change	97	40
17	Kartonpiyer work	Inaccurate estimation of work duration	58	60
18	Installation of aluminum window and glass fitting	Inexperience and low performance subcontractor, low skilled labor	70	60
19	Basement isolation	Design change, unpredictable weather condition	5	60
20	Marble cladding of façade	Unpredictable weather condition, delay in delivery of materials to site	51	90
21	Balcony ceramics	Late delivery of previous activity	44	_
22	Installation of main kitchen equipment	Late delivery of previous activity	40	120
23	Fixture of rooms	Late delivery of previous activity	_	_

24	Canopy steel carcass(framework)	Slow decision making	30	90
25	Laying the land	Slow decision making	45	90
26	Electrical wiring	Late delivery of previous activity	5	90
27	Lighting elements installation	Delay in delivery of materials to site	5	120
28	Pipe installation of bathroom (3^{rd} , 4^{th}, 5^{th} floors)	Design changes	45	21
29	Fan coil installation of ground floors	Delay in delivery of materials to site	7	30
30	Central air conditions (klima) installation	Delay in delivery of materials to site	135	_
31	Air conditions(klima) vent(grilles), diffusers installation	Delay in delivery of materials to site	146	45
32	Bathrooms plumbing, bathtubs and bathrooms sink installation	Delay in delivery of materials to site	59	45
33	Elevator works and installation	Late delivery of previous activity	_	_
34	Pool implementation and equipment installation	Unpredictable weather condition	69	60

According to Table 19, it can be mentioned that late delivery of materials to site had the most considerable effect on the project which affected fourteen activities and caused delay in project duration, followed by design changes that affected six activities and unpredictable weather condition which had effect on six activities. After these factors, inexperienced and low performance subcontractor by affecting three activities, slow decision making, and inaccurate estimation of work duration were the other affecting factors. Late delivery of previous activities was also one of the mentioned factors by the project managers.

One of the significant issues in time management is using an appropriate technique and software to plan and manage the time and well implementing them. Some issues occurred in implementation of the software that could further affect project to have extra delay in addition to the affecting factors. The software related factors were; not updating the schedule in proportion to delay, and not defining durations of some activities.

3.5 Comparison of the Results of Questionnaire and the Case Study

By comparing the results of case study and questionnaire survey, similar important factors could be summarized. It could be mentioned that results of the case study confirm the most important factors considered by respondents in questionnaire survey. According to the results most important factors were slow decision making, delay in material delivery to site, inexperienced and low performance subcontractors, qualification and experience of project staff, and design changes. These factors should be controlled and reduced before and during the construction project procedure to achieve completion of the project within scheduled time and avoid or minimize time overrun in project and have effective construction time planning.

Chapter 4

DEVELOPING MITIGATION MEASURES AND PROJECT CONTROL MODEL

4.1 Introduction

In the first part of this chapter, mitigation measures and its process are explained. At the second step mitigation measures for each one of top important factors causing time overrun are presented. After that project control and inhibiting factor management model and its sections are described.

4.2 Mitigating Measures

Analysis is required to identify the effect of time overrun in construction project by taking the suitable action to mitigate time overrun (Abdul-Rahman et al, 2006). It is significant for the estimated activity duration to be improved according to the unexpected events, misunderstandings and mistakes, actual skill level, and efficiency of work time (Lock, 1996). Mitigation attempts are needed to minimize faults and losses which could be achieved by lots of procedures such as timely and reasonable re-procurement, and protection of completed work (Bramble and Callahen, 1992). The importance is to identify and predict the problems at the early stage of construction to analyze the causes and apply most appropriate solutions (Abdul-Rahman et al, 2006).

Following the case study and survey analysis, the specified top delay factors were investigated in greater depth by literature review and questionnaire survey

respondents' suggestions to find out how they could be controlled in construction projects. According to the importance of the factors and the fact that the factors were common in case study and questionnaire survey results, top five of factors were focused.

The selected factors for further study were slow decision making, design changes, inadequate experience and low performance of subcontractors, qualification and experience of project staff, and delay in delivery of materials. The mitigation strategies for abovementioned factors are represented follow:

4.2.1 Design changes

In order to overcome and minimize the delays caused by design changes, the following points could be considered:

1. Difference of design development and design change should be identified clearly at the project beginning.
2. Design change cause needs to always be determined.
3. Determination of the design change provision within the building contract.
4. The design change's time concept should be agreed and specified at the early stage of the project and before possible changes.
5. Developing a plan to manage the design project risk by recognition the possible design changes as a risk.
6. Design freezing at the proper project phase or implementing intermediate freezing design at different project phases according to the contract type.
7. Announcement of how all related project teams will be impacted prior to going forward with the change.
8. The project should be Design with considerable detail whenever possible at outset of project.

9. Allocation/preparation of enough resources such as equipment, labor, etc. to manage with a design change.
10. Sufficient updating and highlighting the design changes on all documentation of the project such as reports, specifications, drawings, etc.
11. Make sure timely resolution of design change issues, queries and authorization requests.
12. Before the project commencement, the change management procedure needs to be agreed and put in place (if possible, including into the contract).
13. Obtaining the entire design changes on a list with related schedule implication to discussion and checking during project team meeting.
14. Discussions with the related project teams on how to manage the design changes before the project starts, and if possible, including it into the contract.
15. Containing a design manager responsible for design change process management and reviewing relevant information where possible.
16. Make sure anybody does not make any design change without authorization and knowledge of relevant project team.
17. Design changes should be reasonably timed when possible, for example; late design changes could affect the ability of schedule control of project.
18. Effective analysis of the design change's direct and indirect effect (domino effect) on other activities or the project area as one change can impulsive other changes. (Olawale and Sun, 2010)

4.2.2 Slow decision making

The proper actions to prevent or minimize the effect of slow decision making could be summarized as:

1. Design drawings and specifications should provide with clearly defined basis to the resource need.
2. The construction information flow among all project team members should be organized well and timely, and responsible person for decision making should be clearly identified. Building Information Modeling (BIM) could be a proper solution for this purpose.
3. Adequate communication between all project teams should be provided which could also be solved through BIM application.
4. Communication systems and overall organizational structure should be developed during the life of the construction projects.
5. Roles and responsibilities of all project stakeholders should be obviously and clearly defined.
6. Decision making and communication must be accelerated among all project team.
7. The project should be broken down to manageable sections.
8. Making sure the project is adequately and clearly understood before construction phase starts.
9. Project implementation plan should be developed before the project start.
10. Assigning experienced personnel to the project who had handled similar discussed situations before.
11. Contribute and advise to the management and planning by calling the specialist.
12. Problem solving and idea generation by conducting brainstorming and workshops before and during the project.

13. Specify the complex part of the project, getting information about it and prioritizing the activities of that part.
14. Find out sections of the project which have not enough specification to improve before starting the project.

4.2.3 Qualification and experience of project staff

This factor could be overcome through consideration of the following suggestions:

1. Project should have a capable site manager to implement work smoothly.
2. Improving site management by employing skilled staff to carry out and update the scheduling before and during the project.
3. Both managerial and technical staff should have knowledge updated with continuous professional development schemes.
4. Recognizing the needs for effective site management and supervision.
5. The project teams should pay more attention to upgrading their managerial and technical personnel knowledge and skill by conducting proper training programs.
6. Conducting short courses before and during the projects.
7. Work-training programs for staff to be more familiar with current project techniques and processes to have effective performance.
8. Hire personnel with qualification and experience at the project level.
9. Ensuring that the project personnel are trained well in construction process.
10. Develop efficient disciplinary mechanism to undertake low performers by sharing the performance.
11. Applying human resource development methods to personnel and engineers.
12. Analyzing the current workload of staff to ensure their capability of the commitment.

13. Review and evaluate the references and pre-qualification of the new staff in project team.
14. Ensuring that project team activities will develop cooperation and works toward the project goals.
15. Plan to manage the key positions in project management team by persons having experience in similar project.
16. Project team should gain required experience before the project.

4.2.4 Delay in delivery of materials to site

Delays which are resulted from late delivery of materials to site could be optimized through the following considerations:

1. Adequate planning of construction activities contains accurate material estimates and material management.
2. Establishing efficient and effective material procurement system within project.
3. Improving material procurement process to be implemented properly and avoid supply delay before and during the project.
4. Rehabilitate poor management of the material in project.
5. Site supervision to investigate and control amount of material at the early stage prior to by activities start.
6. Matching the existing material in site with planned estimated materials by experienced person to have continuous coordination with supplier.
7. Reviewing and improving estimated material before and during the construction project.
8. Have good coordination and communication with material provider for on time delivery.

9. Accurate material estimation with exact quantity and quality of the material before starting the project.
10. Define the material supplier and material provider before project commence.
11. Assign experienced responsible material suppliers in project.
12. Specify some alternative material providers to have more choices in late delivery situation.
13. Order materials at proper time before starting the activities.

4.2.5 Inadequate experience and low performance of subcontractors

For this purpose, the following suggestions could be taken into account:

1. To ensure subcontractor understand what is expected from them, properly guiding them in relation to the construction project.
2. Developing a suitable working relationship with subcontractors.
3. Placing a system in project to identify low performance in subcontractor work in order to prevent to get worse and advise as soon as possible.
4. Using performance measurements such as Key Performance Indicators (KPI) to monitor subcontractor performance and output in their work.
5. Subcontractors may gives a better service, if there is a collaborative and partnering relationship with them.
6. Integrating a “progress-performance-payment” criterion in the subcontract where practicable for example specifies a certain amount could be paid when a stage of project has been achieved.
7. Subcontractor incorporation in team of site management throughout the work courses where practicable.
8. Early involving relevant subcontractor doing critical project part in order to advise on design.

9. Low performance issues could be prevents and improve by using the previous important retention of continuous low performing subcontractor.
10. Make sure that a timely payment system provided in project for subcontractor completed work to prevent subcontractor financial difficulty.
11. Build communicating and relationship at subcontractor management level.
12. Understanding and finding the basis cause of any low performance and working with the subcontractor to see how could be help.
13. Decrease the retention for best performing and trusted subcontractor.
14. Make sure that inexperience and low performance situation improved by going throughout subcontractor's management different level.
15. Selection of the subcontractors depending on their experience and performance and good tender, not the cheapest offer.
16. Ensuring implementation strategy that subcontractor uses for a subcontract work fits well with the project time performance requirements.
17. Ensuring that subcontractors are allocated sufficient time to finish subcontract work.
18. Sharing the KPI results of the subcontractor and reviewing their weaknesses individually so they can improve their performance.
19. Having the knowledge to allocate those parts of project that subcontractors are best able to undertake and avoid giving them, project parts that they are not good at.
20. Having a training system in construction project place to guide and learn subcontractors according to the projects aim and objectives such as control processes, technique and tools.

21. To have encouraged healthy competition to improve the work quality, it is better to have more than one subcontractor in specific part of project. (Olawale and Sun, 2010)

Also in addition to the mitigation method, project control and inhibiting factor management model could be used to reduce and control affecting factors on construction project time.

4.3 Project Control and Inhibiting Factor Management Model

The project control and inhibiting factors management model (PCIM) model which evaluated by Olawale and Sun (2013), is consisted of three main sections: plan, implementation and finish.

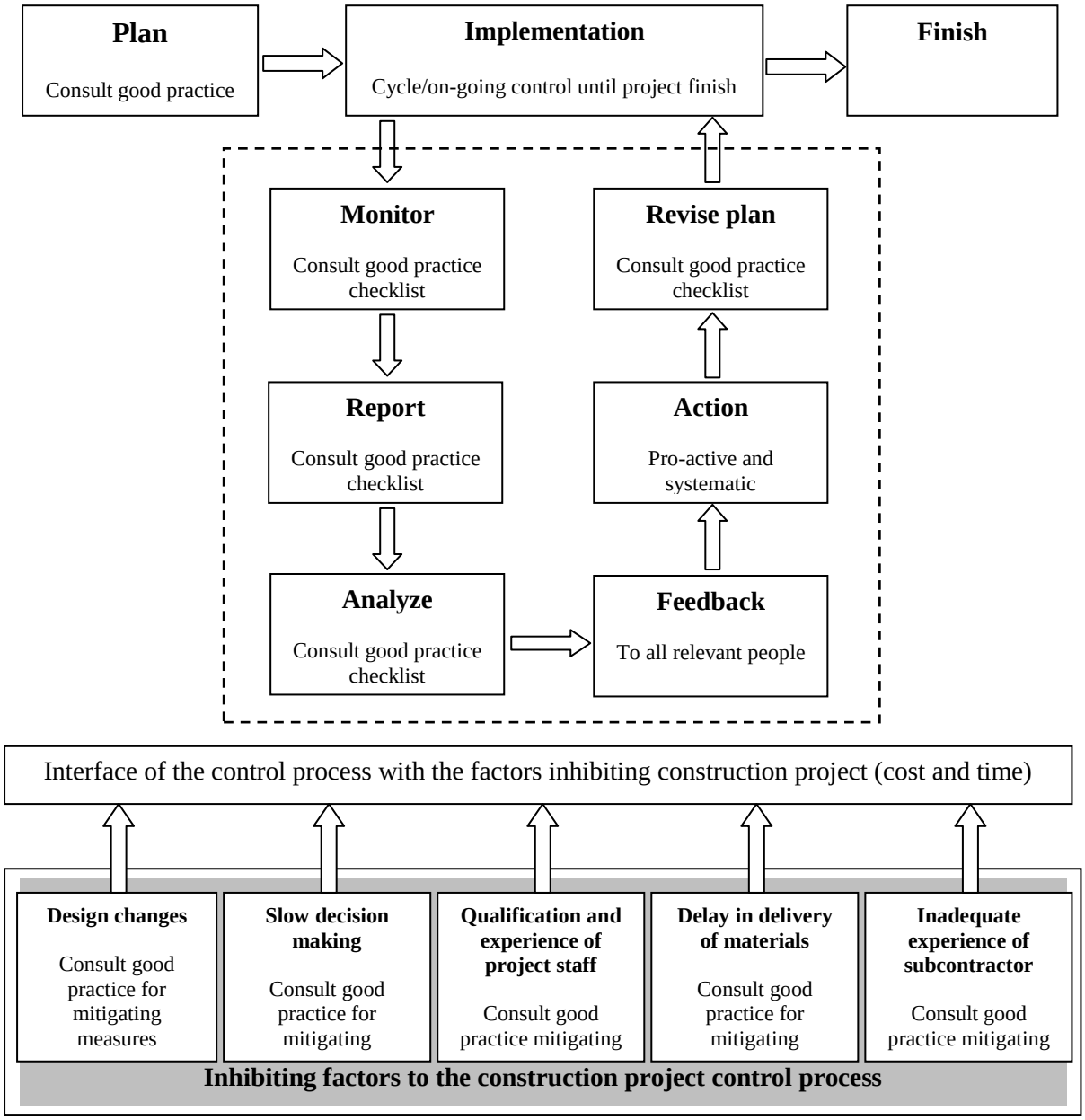

Figure 12: Project control and inhibiting factor management model (Olawale and Sun, 2013)

The last section at the bottom shows that project control frequently inhibited by some factors. “Design changes”, “slow decision making”, “Qualification and experience of

project staff", "delay in delivery of materials to site", and "inadequate experience and low performance subcontractor" are the project control inhibiting factors in the model. This section could be different for different projects.

The phases of the PCIM model are explained in more details in the next parts:

4.3.1 Plan

Planning describes the definition of objective, recognizing activities to be accomplished, resources and methods to be used to perform the tasks (Olawale and Sun, 2013). The suggestion of the PCIM is that the project control should begin at the planning phase. The issue is much effort at during the project planning stage spent on implementation plan includes. Project management practitioners frequently do not plan how to control the project at the beginning of the projects. The PCIM model recognizes this issue and suggests the consideration of how project will be controlled through the implementation, in addition to time scheduling of works and estimating cost. Hence a significant part of the PCIM is a document preparation that describes how projects will be controlled through projects planning phases. This document has been named the project control implementation document (PCID) which will carry out duties of the project team in relation to the project controlling, template of the reports, destination of the reports, frequency of reporting and monitoring, necessary information for effective project control, and project control technique and tools to be used in project. The PCID will be ready in consultation by the project manager and will be distributed to site management team and also all project team. To ensure that project being controlled according to the schedule, the project manager should frequently review the PCID for each project.

4.3.2 Implementation

The next phase after planning is the implementation phase of the project. During this phase, concepts of the plan become into reality. The implementation of project is the most risky phase; problems could often occur during this stage. Therefore time need to be controlled at this stage. Project control during the implementation phase includes iterative and cyclic process of following activities:

4.3.2.1 Monitor

After planning the project and getting to the implementation phase, the plan of the project needs to be monitored throughout the implementation phase. The purpose of this step is to ensure that project achieving the objectives by providing the information and project effect assessment by management with using this information. The PCIM suggests that the monitoring step should be separate stage in controlling the process, that monitoring should clearly begin by site management team and planning control by site-based quantity surveyors reporting. Furthermore, adding monitoring into the site management team duties could improved monitoring.

4.3.2.2 Report

The PCIM model next step after monitoring is reporting. This step provides clear report of the work being performed; predict future performance in term of schedule of the project, and measures actual performance against objectives set before on the plan. And also it shows the management action to overcome potential and existing problems and their effect (Barrie and Paulson, 1984). This model supports a more structured approach throughout a measures number, which specifies reports destination, cycle of the reporting, template of the reporting, by adding them as a reporting system at the beginning of project and makes sure that reporting is certain

and arranged and is not only achieved during the progress meeting. And also using the simple method to send the report to be check and analyze by the responsible.

4.3.2.3 Analyze

After reporting, analyzing is the next step in PCIM model. During this step, submitted reports containing time information is analyzed. After gathering the data, the project teams should determine and calculate the impact and the size of the differences whether the project is performing as predicted or not (Turner, 1999). It is one of the significant steps throughout the control process because proper analysis could be effective in renovation a failing project. Besides, the model advocates the process and use of the results to predict project future performance. The PCIM model developer notes that combination of the cost and time during the analysis step could be more effective. Program Evaluation and Review Technique (PERT) is suggested for more complex projects, as useful technique (Olawale and Sun, 2013).

4.3.2.4 Feedback

The next step approved and presented by the PCIM model is feedback. The feedback is the process that the analysis results which conducted on the reporting and monitoring information steps distributed to all participants and relevant responsible involved with the project and has an action to take. This is very significant during the process of the project control but often is not frequent in most project control models. The PCIM model suggests that to feedback the findings to project management team and site, irrespective of the analysis results, process and system should be put in place. In practice, the only method is transferring information of the project control to the project office from the site. The project office infrequently provides feedback on their findings except when the findings are negative. The PCIM model proposes the project control team to send feedback report to the site team at set periods. This

could motivate the site team that reporting and monitoring they conducted and transfer to the project office is actually being used and is not useless. Also feedback report could be sent to project decision makers such as senior managers that can act on analysis stage findings. Eventually, having procedure of dedicated feedback makes sure that information is transferred efficiently and quickly, and is not useless.

4.3.2.5 Action

The action step makes sure that the analysis step information is put into act. The objective of action is to create a practical and timely plan for accomplishing each activity that matches current knowledge, estimates, and the overall plan of project (Mawdesley et al, 1997). The teams should evaluate and identify alternative action courses as effective action to obviating a problem situation to defeat variances. Action is actually only in use to the correct activities that have gone wrong. The PCIM model notes that to have effective actions in project control, actions should be proactive and reactive. Produced information in the analysis should have ability to show the probable problem and also plan actions well in progress rather than waiting for problem to happen; action should be in use immediately if possible. Also the effect of taken action should be analysis before acting, because some action may cause delay in project or create problems in the future of project.

4.3.2.6 Revise plan

A plan revision contains updating the previous plan of the project that shows the effect of actions that taken as conducted analysis result. This has been considered as separated step rather than tagging and adding to the original planning step. The primary planning should be remaining as baseline, while the revised plan could be utilized for ongoing the project. Ending point of one cycle iteration is revised plan that could be repeated constantly during project implementation.

4.3.3 Finish

Eventually, the PCIM model moves to finishing step when the project completed and initial plan and revised plan conceived and accepted by the teams during achieving the course of project.

4.3.4 Project control inhibiting factors

This section shows the most important factors affecting construction project time planning. As mentioned previously, these factors were specified through questionnaire and case study. This part of the model could be different in other construction projects.

The PCIM model with combination of the mitigation measure as good practice checklist prepares a general guidance and systematic framework to control time and cost in construction project by project managers. (Olawale and Sun, 2013)

Chapter 5

CONCLUSION AND RECCOMENDATIONS FOR FURTHER STUDIES

5.1 Conclusion

Timely completion of construction project is one of the criteria of the success in project, on the other hand many of construction project encounter time overrun and it became common issue in construction industry and affect project performance. Construction projects time overrun caused by various factors. Time overrun can be avoided or minimized when their causes factors are clearly identified. The aims of this study was to specify the time overrun factors in construction projects in North Cyprus and to find method or measure to minimize them, because time overrun is considered to be an important issue in construction industry.

In order to achieve these aims a comprehensive literature review was conducted to specify the affecting factors cause time overrun in construction project. Afterward a designed questionnaire was distributed to building construction companies in Kyrenia, Famagusta and Nicosia to survey the application of time management techniques and factors causing time overrun and level of their importance in construction projects of North Cyprus. Duo to results of questionnaire survey “slow decision making”, “qualification and experience of project staff”, “inexperience and low performance subcontractor”, delay in material deliveries to site”, “design changes” were the most important factors causing time overrun in construction project in North Cyprus.

Moreover, a hotel construction project studied in Kyrenia which had the highest rank in number of building construction projects among other cities as a case study to find out the existing factors causing time overrun in a specific construction project. The result of the case study approved most important factors considering by questionnaire survey respondents.

The specified top delay factors were investigated in greater depth by discussion and questionnaire survey respondents' suggestions to find out how they could be controlled in construction projects. According to the importance of the factors and the fact that the factors were common in case study and questionnaire survey results, top five of factors were focused. About 82 reduction or mitigation measures and also a Project Control Inhibiting factors Management model were suggested to reduce and minimize the factors causing time overrun in North Cyprus construction projects.

5.2 Recommendations for further study

There are some different suggestions for further study that can be recommended after this research. These recommendations are mentioned below.

This research focused on the causes of time overrun in construction project. This issue avoids the project to be completed on scheduled time as one of the aims of projects or as success criteria. However in construction projects, quality and cost are two significant criteria of the successful project. Due to this reason, the suggestion for further study is to find out the affecting factors on cost and quality of construction projects together or separately.

Different structural systems of building construction could be further investigated to find out delays in each kind of structure or comparing the delay in construction

project by two different structures. Furthermore various activities in construction projects could be studied in more details to find the effect of each separated activity on the overall project delay.

REFERENCES

Abdul-Rahman, H., Berawi, M. A., Berawi, A. R., Mohamed, O., Othman, M., & Yahya, I. A. (2006) 'Delay mitigation in the Malaysian construction industry', *Journal of Construction Engineering and Management*, 132 (2), 125-133.

Aibinu, A. A. & Jagboro, G. O. (2002) 'The effects of construction delays on project delivery in Nigerian construction industry', *International Journal of Project Management*, 20, 593-599.

Alaghbari, W., Kadir, M. R. A., Salim, A., & Ernawati (2007) 'The significant factors causing delay of building construction projects in Malaysia', *Engineering, Construction and Architectural Management*, 14 (2), 192-206.

Ali, A. S., Smith, A., Pitt, M., & Chan, H.C. (2010) 'Contractors perception of factors contributing to project delay: case study of commercial projects in klang valley, Malaysia', *Journal of Design and Built Environment*, 6 (2).

Assaf, S. A. & Al-Hejji, S. (2006) 'Causes of delay in large construction projects', *International Journal of Project Management*, 24, 349-357.

Barrie, D. & Paulson, B. (1984). Professional construction manager, McGraw-Hill, New York.

Bennett, J. & Grice, T. (1990) 'Procurement systems for building', In:Brandon, P. (ed) *Quantity Surveying Techniques: New Directions*, Blackwell Scientific Publications, Oxford.

Bennett, J., Flanagan, R., Goodacre, P., Gray, C., McLaughlin, N. & Norman, G. (1979) UK and US Construction Industries: A comparison of Design and Contract Procedures Surveyors Publications, UK London.

Bramble, B. B. & Callahan, M. T. _1992_. *Construction delay claims*, 2nd Ed., Wiley, New York.

Bromilow, F. J. (1974) 'Measurement of scheduling of construction time and cost performance in the building industry' *The Chartered Builder*, 10.

Chan, D. W. M. & Kumaraswamy, M. M. (1996), 'An Evaluation of Construction Time Performance in the Building industry', *Building and Environment*, 31(6), 569-578.

Chan, D. W. M. & Kumaraswamy, M. M. (1997), 'A comparative study of causes of time overruns in Hong Kong construction projects', *International Journal of Project Management*, 15 (1), 55-63.

El-Rezak M. E. A., Bassioni, H. A., & Mobarak, A. M. (2008) 'Causes of delay in building construction projects in Egypt', *Journal of Construction Engineering and Management*, 134 (11), 831-841.

Frimpong, Y., Oluwoye, J., & Crawford, L. (2003) 'Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as case study', *International Journal of Project Management,* 21, 321-326.

Gunduz, M., Nielsen, Y., & Ozdemir, M. (2013) 'Qualification of delay factors using the relative importance index method for construction projects in Turkey', *Journal of Management in Engineering*, 29 (2), 133-139.

Kadir, M.R.A., Lee, W.P., Jaafar M.S., Sapuan S.M. & Ali, A.A.A. (2005). Factors affecting construction labour productivity for Malaysian residential projects. *Structural Survey* 23(1): pp.42-54.

Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997) 'Factors influencing construction time and cost overruns on high-rise projects in Indonesia', *Construction Management and Economics*, 15, 83-94.

Kaliba, C., Muya, M., & Mumba, K. (2009) 'Cost escalation and schedule delays in road construction projects in Zambia', *International Journal of Project Management*, 27, 522–531.

Kazaz, A., Ulubeyli, S., & Tuncbilekli, N. A. (2012) 'Causes of delays in construction projects in Turkey', *Journal of civil Engineering and Management*, 18 (3), 426-435.

Kerzner, H. (2003) ‘Project Management: A Systems Approach to Planning, Scheduling, and Controlling’ John Wiley and Sons, Hoboken, NJ.

Lo, T. Y., Fung, W. H., & Tung, C. F. (2006) ‘Construction delays in Hong Kong civil engineering projects’, *Journal of Construction Engineering and Management*, 132 (6), 636-649.

Lock, D. _1996_. *Project management*, 6th Ed., Gower, Aldershot. Martin, C. C. _1976_. *Project management: How to make it work*, New York.

Mansfield, N.R., Ugwu, O. O. & Doran, T. (1994) ‘Causes of delay and cost overruns in Nigerian construction projects’, *International Journal of Project Management*, 12 (4), 254–260.

Mawdesley, M., Askey, W., & O’Reilly, M. (1997) Planning and controlling construction projects: The best laid plans, Englemere Services Ltd., Ascot, UK.

Memon, A. H., Rahman, I. A., Razaki abdullah, M., & Aziz, A. A. A. (2011) ‘Time Overrun in Construction Projects from the Perspective of Project Management Consultant (PMC)’, *Journal of Surveying Construction & Property*, 2 (1), 54-66.

Nkado, R. N. (1995) ‘Construction time-influencing factors: the contractor’s perpective’, *construction management and economics*, 13, 81-89.

Odeh, A. M. & Battaineh, H. T. (2002) 'Cause of construction delay: traditional contracts', *International Journal of Project Management*, 20, 67-73.

Odeyinka H. A. & Yusif A. (1997) 'The causes and effects of construction delays on completion cost of housing project in Nigeria', *Journal of Financial Management Property Construction*, 2 (3), 31-44.

Ogunlana SO & Promkuntong K. (1996) 'Construction delays in a fast growing economy: comparing Thailand with other economies', *International Journal of Project Management*, 14 (1), 37-45.

Olawale, A. Y. & Sun, M. (2010) 'Cost and time control of construction projects: inhibiting factors and mitigating measures in practice', *Construction Management and Economics*, 28, 509-526.

Olawale, Y. & Sun, M. (2013) 'PCIM: Project Control and Inhibiting-Factors Management Model', *Journal of Management in Engineering*, 29 (1), 60-70.

Rwelamila, P. D. & Hall, K. A. (1995), 'Total systems intervention: an integrated approach to time, cost and quality management', *Construction Management and Economics*, 13, 235-241.

Ramanathan, C., Narayanan, S. P., & Idrus, A. B. (2012) 'Construction delays causing risks on time and cost - a critical review', *Australasian Journal of Construction Economics and Building*, 12 (1), 37-57.

Sambavian, M. & Soon, Y. W. (2007) 'Causes and effects of delay in Malaysian construction industry', *International Journal of Project Management*, 25, 517-526.

State Planning Organization, North Cyprus. (2006-2013)

Stumpf, G.R. (2000) 'Schedule Delay Analysis', *Cost Engineering* , 42 (7), 32-43.

Sun, M. & Meng, X. (2009) 'Taxonomy for change causes and effects in construction projects', *International Journal of Project Management*, 27, 560-572.

Toor, S. R. & Ogunlana, S. O. (2008) 'Problems Causing delays in major construction projects in Thailand', *Construction Management and Economics*, 26, 395-408.

Turner, J. (1999). The handbook of project-based management, McGraw-Hill, London.

Van der Rhee, B., Verma, R., & Plaschka, G. (2009) 'Understanding trade-offs in the supplier selection process: The role of flexibility, delivery, and value-added services/support' *International Journal of Production Economics*, 120 (1), 30-41.

Wood, H. & Ashton, P. (2009) 'Factors of complexity in construction projects', in Dainty, A. (ed.) *Procs 25th Annual ARCOM Conference*, Nottingham, UK, 7–9

September, Association of Researchers in Construction Management, Reading, 857–66.

Yang, J. B. & Ou, S. F. (2008) ‘Using structural equation modeling to analyze relationships among key causes of delay in construction’, *Canadian Journal of Civil Engineering* 35, 321–332.

APPENDIX

Appendix 1:

This questionnaire prepared as a part of master program in Eastern Mediterranean University (EMU):

1. Roles of respondents:

   Director/senior manager□, Contract manager□, Construction manager□ Project manager□ Quantity Surveyor□ Others□ If other please specify…….

2. Years of respondents experience:

   0-5□ 6-11□ 12-20□ 21-25□ 26-30□ 30-and more□

3. Type of company: (you can choose more than one)

   Owner (Client)□ Consultant□ contractor□ Designer□ Other□ If other please specify……

4. Type of your project:

   Residential building construction□ Industrial construction□ Commercial construction□ complex□ other□ If other please specify……

5. What is the size (number of stories) of your project?

   1-2 stories□ 3-5stories□ 6-8 stories□ more than 8 stories□

6. What is the size (Area) of your project?

   Up to 1000m^2□ 1000-2500m^2□ 2500-5000m^2□ 5000-10000m^2□ more than 10000m^2□

7. What is the estimated duration (month) of your project?

   0-6□ 7-12□ 13-18□ 19-24□ 25-30□ 31-36□ 37-42□ 43-48□ 49-and more□

8. Is your company applying time plan on projects?

   Always□ Frequently□ Rarely□ Do not apply□

9. What is your time planning technique?

   Bar chart□ Critical Path Method (CPM)□ PERT□ LOB□ Other□

   If other please specify……

10. What kind of software do you use for time planning?

    Microsoft project□ Asta power project□ Primavera□ Project commander□ Other□ If other please specify..……

11. What is the average time delay in your projects?

    0-5%□ 6-11%□ 12-20%□ 21-25%□ 26-30%□ 31-40%□ 41-47%□ 48-55%□ 56-61%□ 62-70%□ 70%-and more□

12. Rate the level of importance of factor in affecting your construction projects time planning:

Factors in affecting your construction projects time planning:	Extremely Important 5	Important 4	Moderately Important 3	Unimportant 2	Extremely Unimportant 1
Unpredictable weather condition					
Poor site management and supervision					
Inexperienced and low performance subcontractor and suppliers					
Qualification and experience of project staff					
Low skilled labor					
Inaccurate evaluation of project time/duration or poor project duration estimation					
Lack of proper training and experience of Project Management					
Lack of appropriate software					
Design changes					
Delay in material deliveries to site					
Equipment availability and failure					
Complexity of work					

Financing and payment for completed works					
Lack of coordination between contractor, consultant, subcontractor and owner (client)					
Contract and specification interpretation disagreement					
Shortage of material in site					
Unforeseen site condition or inaccurate specification of site condition (soil investigation, water table…)					
Waiting time for approval of sample test					
Delay in work approval					
Inaccuracy of material estimate					
Slow decision making					

13. Please write your suggestion to reduce the effects of above factors which have the highest level in your opinion:

14. What are the problems which have been made in your project by encountering time overrun?