Causes of Schedule Delays in Large Building Construction Projects in Bangladesh

BY

MUHAMMAD SAIFUL ISLAM

A Thesis Presented to the
DEANSHIP OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING & MANAGEMENT

May 2014

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

DHAHRAN 31261, SAUDI ARABIA

DEANSHIP OF GRADUATE STUDIES

This thesis written by **MUHAMMAD SAIFUL ISLAM** under the direction of his thesis committee, and approved by all the members, has been presented to and accepted by the Dean of Graduate Studies, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN CONSTRUCTION ENGINEERING & MANAGEMENT.**

Thesis Committee

Dr. Bambang Trigunarsyah Suhariadi (Advisor)

Dr. Sadi Assaf (Member)

Dr. Mohammad Hassanain (Member)

Dr. Khalaf Al-Ofi
Department Chairman

Dr. Salam A. Zummo
Dean of Graduate Studies

5/6/14
Date

IN THE NAME OF ALLAH, THE MOST MERCIFUL, THE MOST GRACIOUS

Dedicated

to

My Late Grandmother (May Allah grant her eternal rest, Aameen) & Beloved Parents

ACKNOWLEDGEMENTS

All praise is due only to ALLAH subhanawa ta' aala the sustainer of the worlds, the most merciful for his guidance and protection throughout the period of this study and to come out with reality work. I acknowledge the authority of King Fahd University of Petroleum and Minerals for providing me the opportunity and logistics supports in pursuing MS program in Construction Engineering and Management.

I wish to express my sincere appreciation and thanks to Dr. Bambang Trigunarsyah Suhariadi, PHD, PMP, Associate Professor, Department of Construction Engineering and Management (CEM) for his supervision and guidance throughout this research. He has been acting not only as a supervisor but a mentor throughout my study. I also wish to thank my thesis committee member Professor Dr. Sadi Assaf and Dr. Mohammad Hassanain for their continuous support and untiring effort in completing this research. I am particularly indebted to Professor Dr. Assaf for research induction which motivated me to do research in this field. I would also like to take this opportunity to thank Department Chairman Dr. Khalaf Al-Ofi for his co-operation. I am also obligated to other faculty members and staff of CEM for their support. I am also grateful to the construction professionals in Bangladesh to participate in the interview survey for providing the valuable data for this research. Their efforts were the key to success for completing this study.

I would also like to wish all the Bangladeshi students, faculty members, and staff in KFUPM for the moral support and homely treatment that I received throughout the MS program. I am equally grateful to my colleague Prof. Dr. Aktarul Islam Chawdhury and Mr. Bashirul Haq, Dept. of Civil and Environmental Engineering, Shahjalal University of Science and Technology, Bangladesh, for their cooperation and moral support. I am most indebted to my beloved wife and siblings for their special encouragement, prayers and mental support in the period of my MS program.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

THESIS ABSTRACT

Name: **MUHAMMAD SAIFUL ISLAM**

Title: **CAUSES OF SCHEDULE DELAYS IN LARGE BUILDING CONSTRUCTION PROJECTS IN BANGLADESH**

Major Field: **CONSTRUCTION ENGINEERING & MSNSGEMENT**

Date of Degree: **14 May, 2014.**

Construction delay is a common problem worldwide and ascertain as one of the basic reasons to create unsuccessful project. This study addressed the delay issues of the larger building construction projects in Bangladesh (BD) to extract the important causes of delay and justify the level of relationship among the parties involved in construction project. To achieve these objectives, first of all, related literatures were reviewed and 109 factors of delay were identified. Then pilot survey was conducted to find the most relevant causes of delay with BD construction project and 79 factors were finally selected. Based on these factors, questionnaire was designed for asking frequency and severity of the causes based on Likert's scale. To collect the data, interview survey was conducted among the 20 owners, 20 engineers, and 30 contractors. Frequency index, severity index, and importance index were calculated to rank and categorize the factors to find most important causes of delay. The most important causes of delay identified by the respondents are lack of experience construction manager, lowest bidder selection, funding shortage by owner, improper planning and scheduling, lack of skilled workers, site constraints, contractor's cash flow problem during construction, escalation resources process, contractor's excessive workload etc. Furthermore, Spearman's correlation shows strong positive correlation exists between contractors and engineers, moderate positive relation exists between engineers and owners, and poor but positive relation exists between owners and contractors. Kruskal-Wallis test concluded that there are no significance differences among the respondent groups to select most important factors in regards of frequency and severity of delay but 95% confidence level achieved for only few factors.

Finally, the study has been recommended similar studies for other projects such as causes of delay in infrastructure projects, quantifying delay for specific factor and developing model of schedule loss, causes of cost overrun of large building project in BD etc.

THESIS ABSTRACT (ملخص الرسالة)

الإسم: محمــد ســيف الإســلام

عنوان الرسالة: أسباب التأخر في تنفيذ المشاريع الإنشائية االكبيرة في بنغلادش

التخصص: الإدارة و هندسة التشييد

تاريخ الدرجة العلمية:14 مايو 2014

التأخير في تنفيذ المشاريع تعتبر مشكلة شائعة في جميع أنحاء العالم و يعد واحد من الأسباب الرئيسية في كون المشاريع غير ناجحة.. هذه الدراسة تهتم بتداعيات الـتأخير في المشاريع الإنشائية للبنايات الكبيرة في بنغلادش وذلك لاستخلاص الحالات المهمة و للتأخير و تحديد مستوى العلاقة بين الأطراف المشاركة في المشروع. الدراسات السابقة تم مراجعتها و 109 عامل للتأخير تم إستخلاصها في هذه الدراسة إستطلاع ميداني تم عقده لإيجاد الأسباب الأكثر شيوعا للتأخير في تنفيذ المشاريع الإنشائية في بنغلادش و 79 عاملا لهذا الـتأخير تم أختيارها. إعتمادا على هذه العوامل, تم عمل إستطلاع لمعرفة الأسباب المشتركة و قوتها أعتمادا على مقياس Likert's . لجمع المعلومات تم عقد مقابلات مع 20 من ملاك الشركات و 20 من المهندسين و 30 من المقاولين .مقياس التكرار و مقياس الأهمية و مقياس الصرامة تم أعتبارها في التقييم و تصنيف العوامل الأكثر أهمية للتأخير .الأسباب الأكثر تأثيرا في تأخير المشاريع هي نقص خبرة مدير المشروع, أختيار العطاء الأقل سعرا, نقص التمويل من المالك, ضعف التخطيط و الجدولة, نقص خبرة العمال, قيود الموقع, نقص سيولة المقاول, , الحمل الزائد على المقاول .بالإضافة إلى ذلك " Spearman's correlation " أثبت ترابط وثيق بين المقاولين و المهندسين, و أيضا وجود علاقة إيجابية مقبولة بين المهندسين و الملاك, علاقات ضعيفة لكن إيجابية بين الملاك و المقاولين. " Kruskal-Wallis test . " أستنتج عدم وجود أختلافات كبيرة بين المجموعات التي أجري عليها الأستفتاء لأختيار العامل الأكثر أهمية من حيث التكرار و الصرامة لمعرفة سبب الـأخير بإنجاز المشاريع لكن 95% من مستويات الثقة أنجزت لعوامل قليلة. بالنهاية, هذه الدراسة أوصت بدراسات مشابهة لمشاريع أخرى كأسباب التأخير في مشاريع البنية التحتية, تحديد مقدار التأخير لأسباب محددة و تطوير نموذج للخسائر و أسباب تجاوز التكلفة المحددة لمشاريع البنايات الكبيرة في بنغلادش

CHAPTER 1

INTRODUCTION

1.1. BACKGROUND

The problem of delays in the construction industry is a global phenomenon (Sambasivan and Soon 2007). Construction project delay is defined by Assaf and Hejji (2006) as "the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project". Delay in construction can be characterized as extended construction duration and interference activities which disturb the construction program (Kikwasi 2012). According to Frimpong et al. (2003), a successful project means that the project has accomplished its technical performance, maintained its schedule, and remained within budgetary costs. Consequently, it is obvious for any county to find out the major causes of delay in construction project for minimizing and if possible, avoiding the delays and their subsequent impacts (El-Razek et al. 2008).

Construction industry has significant contribution to the national GDP of a country. It also provides good numbers of employment opportunities worldwide. The metropolitan cities of Bangladesh are densely populated and are rising rapidly. For ensuring housing and other facilities, construction industries are contributing impressively. However, schedule delays of the projects delivery create serious drawback to return sufficient

revenue from this industry. Since, construction delays are for the most part costly, and completing projects on time is beneficial to all project parties, it is essential to identify the actual causes of delay in order to avoid the delays and minimize their corresponding expenses. But no current research is found about the corresponding factors of causes of delays at construction projects in Bangladesh (BD) to solve the existing problems. Thus, intensive research is a potential need at present time to find out the causes of time overrun and its impact on country's nation economy.

1.2. PROBLEM STATEMENT

Research focusing on construction delays has often been done in the last decades at different parts of the developing world and many causes were found affecting construction and suggestions made to improve the overall delay scenario. Since finding the factors affecting schedule overrun is very important to achieve the targeted cost and revenue return of the project, research is being carried out in many countries like Saudi Arabia, United Arab Emirate (UAE), Egypt, Jordan, India, Pakistan, Nepal, Malaysia, Thailand, Singapore, Hong Kong, Turkey, Zambia, Vietnam, Ghana, Indonesia, Iran, Tanzania, even Palestine (Gaza Strip) on the time delay in construction industry. However, Bangladesh which is one of the rapidly rising developing countries where investment in this sector is remarkable (Jabeen, 2013) particularly in privately funded projects like commercial, residential, and high apartment housing etc., for doing profitable business, very few researches have been found to know about the problems occurring in construction fields which contribute to the failure of the achievement of the

target schedule. Salam et al. (2001) have studied the causes of delay in construction projects where the scope was confined in housing or apartment development projects in Bangladesh and another research conducted by Ahsan and Gunawan (2010), where they focused on factors identifying time and cost performance in development projects funded by Asian Development Bank (ADB) in several Asian countries and considered Bangladesh as one of the scope areas. Besides, their research was limited to only charity projects but not in construction business industry where huge investment is made by private entrepreneurs. However, the capital city of Bangladesh is most densely populated city over the world having approximately above 14.6 million people where the density of population is 45000 per square kilometer (Bangladesh Bureau of Statistics, Census 2011). In addition, almost 70% of the city dwellers are living in rental houses because they have no land in the city. Due to lack of government rule to regulate the space rent, the house rent sharply increased to 250% in last two decades (Jabeen, 2013). Although the building construction business was very slow in 1970s, now the rapidly increasing country population migrating in large number to divisional cities is a great concern and for satisfying their housing and employment demands, an organization named Real Estate and Housing Association of Bangladesh (REHAB) is working all over the country and their current member is over 1081(http://www.rehab-bd.org/rehab_profile.php). They are developing building projects particularly apartments and selling them to the city dwellers. REHAB (2012) projected almost 100,000 apartments required for next three years to meet the housing needs in Dhaka city and there is only a handful of public projects to cope with this huge residential demands which have encouraged private entrepreneurs to develop apartments. Like the capital city, other metropolitan cities are also very densely

populated and growing fast either horizontally or vertically to provide good shelter for the occupants. However, the business is now becoming very challenging due to several reasons such as improper feasibility study, incompetent management, traditional construction works, inexperienced consultants and overwhelming load of contractors, unskilled work forces, and some not-business-friendly government rules to get permission for utility facilities. Almost 2.4 million people are working in the construction industry of Bangladesh and the industry contributes about 20% of national GDP particularly by private funded building construction projects (Jabeen, 2013). Thus, to make the investment secure, durable and profitable in this fast growing sector, the aim of this study is to find out frequently encountered and significant causes of delays of construction projects funded by private investors in Bangladesh.

1.3. OBJECTIVE OF THE STUDY

The aim of the study is to analyze the causes of delays in construction projects in Bangladesh. In order to achieve the aim, this research focuses on the following objectives:

1. To identify the causes of schedule overrun of construction projects in study areas.
2. To find the frequent, severe, and important causes of delays.
3. To know the correlation and variance among the respondent parties for the causes of delays and justify their judgments.

1.4. SIGNIFICANCE OF THE STUDY

Finding the causes of schedule delay is absolutely necessary to achieve targeted time of the project. The delay factors vary with respect to type of the project, location, country's general economy, availability of the experts and technologies, environmental condition etc. Thus, in a country like Bangladesh for a particular type of project such type of study is precondition for economically feasible investment and subsequently to get a successful project. Research in construction management is found very rare in this region and no detailed study is found specifically for large building construction project. But, for good management system, it is important to know the many sources of delay existing in the construction industry and the level of understanding of different professionals involved. This research aimed to discover the relationship and expertise level of the parties those are involved in this sectors regarding project delay. Four basic steps of the project are: feasibility study, procurement, construction, and commissioning. This study will identify the causes of delay in every phase of the project to make the management system efficient because identifying problem goes halfway to suggest a solution. In conclusion, the study will provide following benefits:

1. Project parties will know most important causes of delay and will be aware about them for safe investment.
2. Each expert group will inform about their role to delay the project schedule.
3. National and international investor will emphasize to seek experience and successful contractors and A/E firms (consultants).
4. Most frequent/significant but manageable causes of delay will be discovered and project parties will be aware about those to manage the risk of the project.

1.5. SCOPE AND LIMITATION

There were many scopes of work related to schedule delay in construction project but due to limitation of time and facilities, all the tasks of this study were not possible for me to do. Some of the scopes of study and corresponding limitations are mentioned below:

1. The study was performed sampling a group of the respondents representing the whole population of the project experts.
2. Although it represents the construction projects of Bangladesh, yet only eastern region like Sylhet metropolitan city was chosen for data collection.
3. Construction delay are occurring at both public and private funded building construction projects, but only private funded projects were taken into consideration.
4. While construction project means road, bridge, industrial buildings, academic and other public buildings, etc. but commercial, residential, or multipurpose buildings were selected and experts were asked for interview align with predefined structures.
5. Only qualitative data were collected but quantitative effects of delays such as how many days of delay occurred for respective factors were not asked.
6. Finding the effects of delay in terms of cost was out of the objectives of the study which might be very essential for effective project management.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Unlike manufacturing industries, many parties involve in construction industry which creates numerous problems and subsequently the industry is turned as high-risk trade sector (Semple et al., 1995). Construction industry deals with various written documents to ensure proper contract management among the parties. Every project is designed with predefined schedule, budgeted cost, and expected quality. All these are mentioned in the contract documents. Due to improper contract management and some other unexpected events, so many claims and disputes are raised by the parties. Delays is one of the major source of claim and frequently encountered problem in construction arena where its attributes are well known but fundamental factors and subsequent impacts are not understood by the experts. That is why many projects are suffering by schedule overrun. As a result, the projects are failed to earn sufficient revenue (Semple et al., 1995; Berawi et al., 2006). Besides, delays have negative impacts on business for both contractors and developers for example it degrades the reputation of the companies. For this reason, the companies are lost the market and even may run out of the construction business. It also increases construction cost by the influence of several factors such as escalation of resources price, economic recession, extreme weather, political unrest etc. (Enshassi et al., 2009). Construction project has five basic stages which are feasibility study, design,

procurement, construction, and project delivery. Success of the project mostly depends on the best effort in preconstruction stage. In this phase, good project execution manual is developed by the competent professional project manager. The project manual guides investor, contractor, and construction manager to execute the project activities and management strategies in successive stages of the project. Due to lack of improper management, delays may arise at feasibility phase and continue till to the end of construction work. In the lifecycle of a construction project three parties e.g., owner, A/E or consultant, and contractor are closely involved. Thus, they are the key players of schedule overrun of a project. In addition, some other factors for example country's general economy, international trade market, inflation of resource prices, lack of managerial service, environmental factors etc. are the causes of project delays (Assaf and Al-Hejji, 2006; Al-momani, 2000; Berawi et al., 2006). The following sections are briefly discussed about the history of studies of schedule delays, causes and effects of delays, delays in developing countries, and remedial actions of construction delays recommended by the previous studies.

2.2 PREVIOUS STUDIES RELATED TO SCHEDULE DELAYS

Research on schedule delay is a common term and many articles have been published in different scientific journals on this issue. Mohammed and Isah(2012)have studied causes of delay frequently occurred in the construction project in Nigeria. They did qualitative survey but in quantitative form and calculated simply the mean and standard deviation to

rank the factors and discussed the variation among the respondents. Another article found by Oladapo (2007) who also studied on Nigerian construction projects to assess time and cost overrun by quantitative approach. He has computed the importance indices of the factors of delay to rank them. Besides, he also performed F-test and t-test to justify whether the result varies by the type and size of the projects. Al-Momani (2000) studied to develop models of planned vs. actual length (time) of the government projects in Jordan which was actually the quantitative analysis of construction delay. They considered different type of projects such as housing, medical centre, infrastructure etc. Sambasivan and Soon (2007) have conducted research about causes of delay and subsequent effects on construction project in Malaysian. The scopes of their study were to find the causes of delays in different types and sizes of the projects. Besides, the methodologies of their study were ranking the important causes of delay by relative importance indices, and finding correlation between cause and effect with respect to different parameters such as clients, contractors, consultant, material, labor etc. Another article has been published based on the construction delay in Malaysia by Hamzah et al. (2011) where they just considered the factors of delay found by thorough literature review. They have done the theoretical analysis of those factors to facilitate the further study on schedule overrun of the projects funded by Malaysian Ministry of Higher Education. Alaghbari et al. (2007) studied on finding the important factors of delays and considered only building projects in Malaysia. Then they ranked the factors on the basis of relative importance indices as well as evaluated the level of importance of each factor. They found different categories of delay, for instance, concurrent, non-excusable, and excusable. Besides, excusable delay was sub-divided by them as non-compensable and

compensable. Causes of delay in Libyan construction projects have been studied by Tumi et al. (2009). They ranked the factors based on the mean of the responses and calculated the standard deviation to check the correlation among the respondents. Odeh and Battaineh(2002)studied on the cases of delay in construction industry and focused on the conventional agreement systems. They surveyed different types of project like road, building, water and sewerage system etc. They selected the projects according to the contract value like as more than 1,40,000 USD. Their respondents were contractors and consultants. The factors were ranked by computing importance indices of the causes of delays. They have applied Spearman's rank correlation technique to establish the relationship between the two parties. Chan and Kumaraswamy (1997) studied on the analysis of schedule performance of building construction projects in Hong Kong. The respondent groups were owner, consultant, and contractor. They found factors of delay from literature review and conducted questionnaire survey based on the rating scale of 1 to 5. For data analysis, they computed mean scores of each factors of delay, Spearman's rank correlation coefficients, and conducted t-test with 95% confidence level to check the correlation between two parties. A comparative study has been done by Promkuntong et al. (1996) for construction delay in Thailand with other parts of the world. They were concerned only about the multistoried building in the capital city Bangkok. Oluwoye et al. (2003) studied on ground water projects in Ghana to discover the causes of schedule and cost infested. They calculated relative importance indices to rank the causes. Kendall's Coefficient of Concordance (KCC) was calculated to know the variance among three respondent groups. Analyses of causes of budgeted time extension and fund shortage in mega construction project in Vietnam have been done by Le-Hoai et al.

(2008). They have calculated frequency, severity, and importance indices for all the factors and then ranked the factors depend on the indices. Besides, Spearman's correlation coefficient also was calculated to establish the relationship of the respondents groups. Furthermore factor analysis has been done to identify most important causes of delay and cost overrun of construction project. Othman et al. (2006) have developed a time performance index model (TPI) and identified the factors of causing delay in civil engineering project in Malaysia. They used multiple regression analysis process to develop the model. They conducted hypothesis test by t-test and checked the validity of the model. Moreover, they developed individual TPI models for several types of projects such as irrigation and drainage, sewerage projects, etc. Lo et al. (2006) studied on the causes of project delay in Hong Kong where they focused on different types of civil engineer projects. Their respondent groups were contractors, consultants, and owners. They have computed mean scores of the factors of delay for ranking of the causes. Besides, for correlation analysis among the parties, they used the method developed by Okpala and Aiekwu(1988) which is called ranking agreement factor (RA) between pair of respondent groups. Kazaz et al. (2012) studied on factors of delay in Turkish construction project and compared with other countries. Assaf and Al-Hejji (2006) studied to find the factors affecting schedule delay in mega projects of Saudi Arabian construction industry. Frequency, severity, and importance indices were calculated for each factors and ranked in order. Spearman's correlation coefficient was also calculated to discover the relationship between the pairs of respondents. El-Razek et al. (2008) studied on the schedule delays specifically in building structures such as housing, industrial, commercial, institutional etc. in Egypt. They had carried out interview survey among the

three parties such as owners, consultants, and contractors. In their study, the factors were ranked by the importance indices which were calculated based on survey data. Besides, Spearman's correlation coefficient for each pair group was also computed to find the relationship among the expert groups. Delays and other problems in large projects in Vietnam have been studied by Long et al. (2004). They ranked of the factors of delay on the basis of frequency of occurrence and level of severity. Spearman's rank correlation also has been done to ensure the level of relationship among the respondent groups. Furthermore, factor analysis has been done to discover the most significant factors of delay. Aibinu and Odeyinka (2006) studied on the causes of delay in Nigerian construction projects. Their study was covered different types and sizes of building projects. They reached in conclusion by Pareto analysis, Kendall coefficient of concordance test, t-test etc. Manavazhi and Adhikari (2002) studied on delay in construction projects due to procurement of raw materials and equipments in Nepal. Doloi et al. (2012) studied on the causes of delays in different types of construction projects in India. They have collected data by interview survey and computed relative importance indices to rank the causes. Besides, they have done factor analysis and multiple regressions modeling to discover the severity of the factors of delay. Enshassi et al. (2009) studied on the condition of Gaza Strip and its effects on time and cost variation in construction projects. The reliability of questionnaire has been checked by Cronbach's α test and found highly reliable. Besides, their study has been computed importance indices for the factors and justifies the relationship between the pair of respondents by Spearman's rank correlation. Kaliba et al. (2009) studied on the factors affecting time delay and cost acceleration of Zambian road construction projects. The projects sizes

were medium to large and interview survey was conducted among the construction stakeholders. Likert's scale was used to ask the respondents against respective factors of delay or cost overrun, and then weighted averages were computed for ranking the causes. Consequently the most important factors of delay were discovered. Sweis et al. (2008) have done a case study on Jordanian construction project to find the causes of delay. They emphasized particularly on the residential building projects. The causes were classified by Drewin's Open Conversion System. Their study has been considered experts like consultant, contractor and owner to conduct questionnaire survey. The causes were then ranked by only frequency index and one-way ANOVA of means of the factors were done to justify the variation among the respondent groups. Faridi and El-Sayegh (2006) studied on the important causes of delay in construction project in UAE. They calculated the relative importance indices for individual causes and ranked accordingly. Besides, Spearman's rank correlation coefficient in the couple of respondent groups was computed to check the level of relationship exists between the parties. Ahsan and Gunawan (2010) have analyzed the causes of time delay in development projects funded by Asian Development Bank (ADB). They have discovered most important causes of such projects in Bangladesh and listed the causes in order according to their importance. Salam et al. (2001) performed a study to analysis the causes of schedule overrun in Bangladeshi construction projects. They mainly focused on the high rise building projects in the capital city of Dhaka. They calculated the relative importance index for each cause of delay. In addition, regression analysis and factor group analysis were done to know comprehensively about the severe causes of delay and the relationship among the respondent groups. Kikwasi (2013) studied on the causes of construction delay in

Tanzania. Like other studies, they also calculated the relative importance indices for all the selected causes of delay and ranked them to identify the most important ones. Pourrostam and Ismail (2012) have studied on the causes and effects of delay in construction projects in Iran. They accumulated the causes of delay found in previous study and made questionnaire to perform the survey. Then relative importance index of each causes of delay was calculated and ranked the causes subsequently. Also, Spearman's correlation process was used to find the significant relationship between the respondent groups. Hwang et al. (2013) studied on the important factors of delay in government housing project in Singapore. They calculated the importance index, frequency index, and critical index to find the most significant causes of delay. Moreover, they analyzed Spearman's rank correlation and performed level of significance (0.05) test to justify the ranks found by different groups of respondents. Analyses of causes and effects of construction delay in Pakistan have been studied by Haseeb et al. (2011). They ranked the causes based on the mean, mode, and critical index found by data analysis. These are the few examples of studies of delay in construction projects worldwide.

2.3 TYPES OF DELAYS IN CONSTRUCTION PROJECTS

Delays in construction projects are classified as excusable, inexcusable, and concurrent (Ahuja et al., 1994; Alaghbari et al., 2007; Tumi et al., 2009; Hamzah et al., 2011; Ahmed et al. 2003). Excusable delays can be defined as the causes happen by the inappropriate actions or lack of actions of owner and also by force majeure like labor

strike, bad weather, etc. The excusable delays are two types i.e. compensable and non-compensable. Compensable causes are some actions done by owner and consultant. Some common compensable delays are late approval of detail drawings, frequent change order, error in design/specification, delays due to different site condition, interference with contractor during construction, site inaccessibility, delay to deliver owner furnished property, delay to get permission from respective authorities, delay in progress payment, late interpretation of plans and specification, impractical design, etc. (Potts 1995; Abdul-Rahman and Berawi, 2006). Non-compensable causes are the factors (i.e. force majeure) out of control of owner, contractor, or consultant (i.e. political unrest, strike, bad weather, government role etc.).Sometime these actions are called the "acts of God" (Tumi et al., 2009). Inexcusable delays are caused by contractor, sub-contractor, and vendors etc. which have no recovery except speed up the work or reimburse the owner (Tumi et al., 2009). Finally, the concurrent delay is defined by Alaghbari et al. (2007) as the delay occurred in a project by superimposing two or more factors at the same time of construction works which is mostly critical to resolve.

2.4 CAUSES OF DELAYS IN CONSTRUCTION PROJECTS

Nine major groups of construction delays are found for example, financial, owner, contactor, consultant, manpower and resources, project, managerial, rules and regulation, and environment (Kazaz et al., 2012; Chum and Kumaraswamy, 1996; and El-Razek et al., 2008; Assaf and Hejji, 2006). Besides, 79 sub-factors of delays under the major

groups are also identified by reviewing previous studies on causes of delay in construction projects. All these factors are discussed briefly in the following sections.

2.4.1 Financial

Both owner and contractor need sufficient fund to carry out any project. At the conceptual time of project, owner's source of funding is important to ensure continuous flow of money to perform the project work from beginning to end. Different types of factors are identified by the researchers which are closely related to project financing such as fund shortage by owner, delay in contractor's progress payment by owner, interference in owners decision, contractor's cash flow problem during construction, fluctuation in material prices, high interest rate, economic recession or inflation etc. (Assaf and Al-Hejji, 2006; Sambasivan and Soon, 2007; Frimpong et al., 2003). These factors are discussed follows:

Fund Shortage by Owner

Each project needs certain amount of fund to complete the work. This fund is budgeted mostly at the beginning of the work based on the design and specification of the project. Besides, fund shortage of owner creates some other problems such as delay in progress payment, material shortage at the site, and finally work may stop at immature stage (Stephen et al. 1996). Thus, to ensure continuity of work, enough sources of funding is very much important. Frimpong et al.(2003) Odeh and Battaineh (2002); Mohammed and Isah(2012)found this factor as one of the major causes of delay in Ghana, Nigeria and Jordan respectively.

Delay in Contractor's Progress Payment by Owner

Usually contractor submit periodic bill to the owner after competing each phase of work. It may be submitted monthly or after finishing certain units of works which ismentioned in the contract letter. According to the agreement, owner pays the bill verifying the quantity of works. Such type of payment is called progress payment by owner during construction. In other word, progress payment can be defined as the payment by owner to contractor after completing a specific task, or some time period, or some percentage of total cost of the project. This is important because contractor invests money to do some work then asks for the payment. If the payment is delayed by owner, contractor can subsequently slow the work, reduce the manpower, or sometime stop the work depends on the situation. This type of delay has been found in construction project in Turkey, Malaysia, Zambia etc. (Kazaz et al., 2012; Sambasivan and Soon 2007; Kaliba et al., 2009).

Interference in Owners' Decision

If the project has multiple owners for sources of fund, it may create some chaos to take decision for funding by the investors which is called interference in owners' decision for funding. Joint stock business in building development is very common. But, if the proper rules and regulations are not followed by the directors or shareholders of the company, interference in decision making would be frequently encountered problem. As a result, this problem influences the above two factors of delay in construction industry. Sometimes, construction project may be terminated because of this factor of delay. This is identified as one of the most important causes of delay in Saudi Arabia, Malaysia,

Jordan, Vietnam etc. (Al-Khalil and Al-Ghafly, 1999; Sambasivan and Soon 2007; Odeh and Battaineh, 2002;Long et al., 2004).

Contractor's Cash Flow Problem during Construction

Contractor needs some liquid money to run the project which is the gap between cash outflow and inflow. Cash outflow is the money required for equipments, manpower, and procurement of materials etc. and cash outflow is the bill received from owner. This liquid money ensures the continuity of the work. If the contractor does not have enough money to finance the project in its construction phases, then it is termed as contractor's cash flow problem during construction, which is a common problem of construction industry in different countries, for instance, Florida (USA), Vietnam, Thailand, United Kingdom, Lebanon, Ghana etc. (Ahmed and Azhar, 2002;Le-Hoai et al., 2008; Promkuntong et al., 1996; Sullivan and Harris, 1985; Mezher and Tawil, 1998;Fugar and Agyakwah-baah, 2003).

Fluctuation in Material Prices

Due to variety of reasons, prices of construction materials may fluctuate abruptly. Cost estimator fails to understand the market prices of the materials to make an accurate budget. Eventually, this problem increase the project cost. Thus, to control project cost, project owner sometimes delays the material procurement which in fact delays the schedule of the project. Such type of cause of delay found in Ethiopia, Malaysia, Nigeria, and UK (Nega, 2008; Memon et al., 2011; Ameh et al., 2010;Olawale and Sun, 2010).

High Interest Rate, Economic Recession or Inflation

Depend on country's general economy or strategy, the rate of interest of bank loan may high enough. In this situation, the investor does not willing to take bank loan to continue the construction work. Thus, project can stop or delay due to fund crisis. Nigerian construction industry is facing this problem (Aibinu and Jagboro, 2002). In the period of recession, economic activity becomes slowdown and people do not motivate to invest money. Accordingly, all the construction activities also crumble. Moreover, inflation of construction materials increase the total cost of the project, particularly, it has enormous impact on mega project. As a result, it leads to retard or terminate the construction works. These factors have been found by the researchers in Malaysia, Ghana, UK etc. (Sambasivan and Soon, 2007;Frimpong et al., 2003;Sun and Meng, 2009).

2.4.2 Owner

In construction industry, owner plays key role from inception phase to end of the project. Since, owner's has various scopes of works; there are plenty of options to delay the project by them, e.g., improper feasibility study, change order in design, lack of proper management, delay in decision making, lowest bidder selection, poor contract management by owner, delay to approve shop drawing, no involvement of consultant in design/construction phase, mistake in competent consultant selection, very poor consultancy fee pay to the consultant etc.

Improper Feasibility Study

Dictionary meaning of feasibility study is the "assessment of practicality of a proposed plan or method". It is an analysis and evaluation of a proposed project to justify whether

the project is technically feasible and economical profitable within the budgeted cost. Proper feasibility study by competent and experienced consultant is the prerequisite for a successful project (Long et al., 2004; and Kazaz et al., 2012; Shen et al., 2010). Thus, improper feasibility study effects on project schedule and cost performance and this problem found in Jordan, Pakistan, UAE, Norway etc. (Odeh and Battaineh, 2002;Haseeb et al., 2011;Motaleb and Kishk, 2010;Mahamid, 2011).

Frequent Change Order by Owner during Construction

To change work type, quality, quantity or schedule, owner sometime writes an order letter to the contractor after execution of the agreement. This type of written document is defined as change order (Al-Dubaisi, 2008). Change in design during construction is a most common habit of owner and it frequently reduces the effective working time in construction (Ogunlana et al,. 1996; Assaf and Hejji, 2006, and Sweis et al., 2008). Particularly, private sector projects are suffered more by changing the architectural drawing with the change of economic condition, owner's marketing policy, personal demand or choice, escalation of material prices etc. (Ogunlana et al. 1996).

Lack of Proper Management

Lack of proper management by owner is another cause of delay in construction project. Management is a collective term which means good plan, budget/cost control, and coordination among the parties from feasibility phase to completion of the project. In construction industry, owner has to do it properly for successful project. But lack of proper management is the outcome of lack of knowledge of owner in this arena (Alaghbari et al. 2007). So, owners need experience construction manager to manage the

project works properly. But very few professional construction managers with good knowledge and experiences are available in developing countries (Mitra and Tan 2012). Therefore, improper management is more or less common in many countries for instance, Saudi Arabia, Malaysia, Nigeria etc. (Mitra and Tan 2012; Abdul-Rahman and Berawi, 2006; Elinwa and Joshua, 2001).

Delay in Decision Making

Owners are responsible to give decisions in many stages of construction project and need very good communication or coordination with consultants and contractors. For example, owners have the sole authority to select best architectural drawings, change or modify any parts of the drawing, prefer material for construction, desire level of construction quality, choose schedule of works etc. To do these works, usually owner takes more time, and delays in decision making which is found in the construction projects in UAE, Turkey, Saudi Arabia, Jordan etc. (Motaleb and Kishk, 2013; Kazaz et al., 2011;Assaf and Al-Hejji, 2006; Odeh and Battaineh, 2002).

Lowest Bidder Selection

Owners invite bidders to submit bid for the project. There is normal practice to select lowest bidder in construction industry. But, research shows that this type of bidders is always failing to achieve budgeted time, cost, and quality of the project. Particularly, lowest bidder selection is one of the major factors of delay in Saudi Arabia, Malaysia, Pakistan, Egypt, Palestine etc. (Mahamid, 2013;Shehu et al., 2014; Ejaz et al., 2013; Marzouk and El-Rasas, 2014; Enshassi and Modough, 2012;Enshassi and Modough, 2012).

Poor Contract Management by Owner

Proper contract management means all administrative works are performed according to the contract. Owner are responsible for invitation to bid, evaluation of bid, contract award, execution of contract, provide owner furnished property, progress payment in due time, maintain relationship with other parties according to the contract, deal with problems raise in construction period, actively sharing information with the A/E or contractors etc. All those things should be in proper ways. Thus, to achieve the project objects, poor contract management is a great obstacle. This factor of delay found in the construction industry in Malaysia, Nigeria, Egypt etc. (Ramanathan et al., 2012; Mansfield et al., 1994; Amer, 1994).

Delay to Approve Shop Drawing

After completing the shop drawing by the A/E farm, owner is the authorized party who will approve it. If owner delays to approve the drawing, then the project will be delayed. Researchers in many countries like India, USA, Egypt, UAE etc. found this factor as one of the top most frequent causes of delay (cAhmed and Azhar, 2002;El-Razek et al., 2008; Faridi and El-Sayegh, 2006).

2.4.3 Contractor

Different types of contractors are involved in construction projects, for example, general contractor, subcontractor, electrical contractor, plumbing and sanitary contractor etc. They have vital role to achieve the schedule of the project. Some contractor related factors of delays are improper construction planning and scheduling, improper progress

monitoring and cost control, poor site management, inaccurate cost estimation, incompetent project team, lack of experience, lack of modern equipment, lack of database for estimating activity duration and resources, inadequate site inspection, multiple subcontractors, lack of skilled sub-contractor, lack of relationship between labor and management, lack of appropriate and modern techniques in construction etc. (Mansfield et al., 1994; Ogunlana et al., 1996; Chum and Kumaraswamy, 1996; Alaghbari et al., 2007; Kazaz et al., 2012). These factors are briefly discussed below:

Improper Planning and Scheduling

This is contractor's duty to prepare work plan and develop realistic schedule. Sometimes, contractor does not know about the work scopes and they don't have previous records about their work performance per day. Thus, they fail to make good work plan and feasible schedule. Besides, contractor makes tight schedule to increase the chance of winning bid. But, later on they cannot achieve the target. Therefore, improper planning and scheduling is one of the major factors of time overrun in construction project. Construction projects in many countries, for instance, Malaysia, Taiwan, India, Singapore, Turkey etc. (Sorooshian, 2014;Yau et al., 2012;Pal and Nagrale, 2013;Hwang et al., 2013;Gündüz et al., 2013) become slow down by this factor of delay.

Improper Progress Monitoring and Cost Control

After proper planning, monitoring at execution level of work is very much important to reach the target. It can be daily, weekly, or monthly basis based on the data collected by site engineers. Although contractor monitors the work progress but proper monitoring is necessary to justify the work rate (e.g., unit/day) which was considered to design project

schedule. If the actual performance rate is lower than the designed value, contractor needs to increase or change the workforces or equipments to keep work on schedule. If contractor does not monitor the work schedule periodically, after certain phases of the project, it is not possible to control the schedule delay. Similar analysis is needed for cost control because if cost goes beyond the budget, contractor will reduce the manpower and equipments; subsequently it impacts on the schedule. This problem found in Palestine, Uganda, South Africa etc. (Enshassi and Modough, 2012;Apolot et al., 2011; Ramabodu and Verster, 2010).

Poor Site Management

Site management is a collective term which includes material management, labor and equipment management, coordinate and communicate with corresponding persons or parties, record keeping etc. Poor management of these activities in the site increases project complexity and inflate ineffective time which leads to schedule delay. Poor site management were found in the construction projects in India, Ghana, Malaysia, UK etc. (Doloi et al., 2012; Fugar and Agyakwah-baah, 2003; Fugar and Agyakwah-baah, 2010; Ibrahim et al., 2010;Y. A. Olawale and Sun, 2010).

Inaccurate Cost Estimation

Before submission of bid, contractor estimates the project cost based on the design and specifications. Accuracy of the estimation is very much important for two basic reasons, like as bid award, and completion of works within the budgeted cost. If the estimated cost is too low than the real value, although there is a good chance of winning bid but contractor will unable to earn profit from the project. Alternatively, if the cost is too high

than the bid prices of other bidders, contractor will unsuccessful to win the bid. Some causes of inaccurate cost estimation are unclear scope of work, no past records about pricing, lack of sufficient market analysis etc. The consequence of inaccurate cost estimation is high enough to delay the schedule or even terminate the contract. Particularly, if it is lower than actual project cost, contractor does not work properly and delays the project by various means. This factor of delay is found very important in the construction industry in Indonesia, Nigeria, Vietnam, Saudi Arabia, Zambia, Malaysia, Iran etc. (Kaming et al., 1997;Mansfield et al., 1994;Kaliba et al., 2009;Long et al., 2004;Assaf and Al-Hejji, 2006;Kaliba et al., 2009;Sambasivan and Soon, 2007; Pourrostam and Ismail, 2011).

Incompetent Project Team

Team work in a project is very essential. Competency with good combination as well as coordination is required for the team members to finish the task quickly and effectively. Because, competent project team can serves good quality of work without delaying schedule. Many contractors do not have competent workforces which is one of the frequent and severe causes of delay in many countries for example Singapore, Malaysia, UAE, South Africa (Hwang and Yang, 2014;Memon et al., 2011;Motaleb and Kishk, 2010;Lee, 2011).

Lack of Experience

Since individual project has different characteristics and many classes of people are involved in construction industry, contractor's prior experience to work in similar project is very important to get success (Wambeke et al., 2011). If the contractor has lack of

experience and knowledge, it will make all the above factors of delay. Thus, experts in construction projects of different countries identified lack of experience as one of the major causes of delay. This factor of delay found in Saudi Arabia, Taiwan, Turkey, Malaysia, UAE, UK (Mahamid, 2013;Yang et al., 2013;Gunduz et al., 2012; Sorooshian, 2014; Nahyan et al., 2012;Olawale and Sun, 2010).

Lack of Modern Equipment

Now-a-days modern equipments are available in international market. Some modern equipment are back hoe, soil compactor, grader, concrete cutter, lifting cranes, hydraulic jacks etc. which are contributing to speed up the construction in its different phases of works. However, most of the contractors in many countries have not these equipments. Thus, lack of modern equipment was identified as a major cause of delay in developing countries like Malaysia, Iran, India etc. (Sorooshian, 2014; Ghoddousi and Hosseini, 2012; Doloi et al., 2012).

Lack of Database for Estimating Activity Duration and Resources

Record keeping is significant for any type of project works. In construction industry, it is essential for contractor to store the data regarding the performance rate of manpower and equipment. Besides, quantity of resources and corresponding price list of the resources must be kept in a secured way. It helps contractor to estimate good budget for similar project. The contractors who have the lack of appropriate database to maintain the project records, they fail to estimate reasonable activity duration and resources requirement. This issue found as one of the important factors of delay in Egypt (El-Razek et al., 2008).

Inadequate Site Inspection

Adequate site inspection is necessary by contractor "to ensure a project's compliance with its specification and statutory requirements" (online business dictionary, 2014). It is contractor's or his representative's duty to visit the site regularly and be informed about the work progress and problems. This activity will be helpful to keep the project on schedule. But if the inspection is not enough or inadequate then many unwanted issues may arise in the site to delay the project. Besides, lack of inspection by contractor means insufficient monitoring of the work also, which subsequently pushes the laborers to become lethargic. All sorts of thing are responsible for project delay. This factor of delay found in construction project in Thailand (Promkuntong et al., 1996).

Multiple and Incompetent Subcontractors

The role of sub-contractor is to work some parts of the project or provide services for general contractor. If there are too many sub-contractors in the site, some critical issues are took place in the project like as technical interface and schedule conflict, site access, health and safety of works etc. and these problems extend the project schedule. Besides, subcontractors are not competent enough to provide good quality of works in due time. Thus, multiple and incompetent subcontractors are responsible for time overrun of construction project. Subcontractor related factors of delays found in Iran, India, Turkey, Malaysia etc. (Pourrostam and Ismail, 2012; Doloi et al., 2012; Gunduz et al., 2012; Sambasivan and Soon, 2007).

Lack of Relationship between Labor and Management

Good relationship between labor and management is essential to ensure effective working environment and achieve the goal of the project. Lack of relationship between these two parties create chaos, distrust, disrespect each other, lack of sharing information, etc.

which are responsible for project cost and time overrun. This factor was identified as the cause of delay in Turkish construction project (Kazaz et al., 2012).

Lack of Appropriate and Modern Techniques in Construction

Modern techniques and methods of construction play significant roles to reduce construction time and cost (Methods, 2007). But appropriate use of the technique for specific work in right place is also important. For example, large soil compaction machine is efficient to use in big project site but hand driven compactor is good for small site. Thus selecting suitable and modern techniques by contractor are necessary to avoid schedule delay in project site. Ibrahim et al. (2010) have identified this factor as the case of delay at construction project in Malaysia.

2.4.4 Consultant (A/E)

The role of consultants is wide from feasibility study to the end of the construction project. They are the sole agent of preparing design and specification for the project. The consultant team prepares the shop drawing, and estimates the cost of the project for owner. Besides, A/E firm has the duties to analyze constructability, supervise construction works, control the quality, and ensure that the project is developing as per drawing. Thus, they are also responsible for schedule overrun in various ways, for instance, lack of experience, error in design, delay in preparation of shop drawing, conflict between drawing and specification, delay in response, lack of responsibility, delay in work inspection and approval, inadequate constructability analysis etc. (Alaghbari et al., 2007; Assaf et al., 2006; Ogunlanaet al. 1996).These factors are discussed briefly in the next sections.

Lack of Experience

It is mentioned above that consultant has many duties in project design and execution. If they don't have enough knowledge and prior experience of working in the same project, they will not capable to serve efficiently. Thus, it will act as an important cause of delay in construction project. Ogunlana et al. (1996) reported that 75% of the projects were delayed by incomplete and inconsistent drawing in Thailand which was the consequence of lack of experience of the consultant. Many projects in other countries like Iran, Malaysia, UAE etc. also experienced same problem (Pourrostam and Ismail, 2012; Alaghbari et al., 2007; Nahyan et al., 2012).

Error in Design

Design error can be found in both architectural drawing and structural design. In both cases, if error is identified during construction, revised design is necessary to continue the work. But, it is a common issue that consultant dose not response quickly to correct the design error. As a result, workers cannot carry on the work and it delays the project. Error in design mostly found in Saudi Arabia, UAE, and Jordan (Mahamid, 2013; Nahyan et al., 2012; Al-Momani, 2000).

Delay in Preparation/Approval of Shop Drawing

Engineers' Joint Contract Documents Committee (EJCDC) defines shop drawing in its Form No. 1910-8, Standard General Conditions, for the construction contract as : "All drawings, diagrams, illustrations, schedules, and other data or information, which are specifically prepares or assembled by or for contractor and submitted by contractor to illustrate some portion of the work" (Hatem and Lenart, 2010). In some cases A/E farms

are prepared or approved the shop drawing for the contractor to illustrate the works in details. But, they do not provide the shop drawing in due time. Thus, delay in preparation of shop drawing is found as the factor of schedule overrun (El-Razek et al., 2008; Salam et al., 2001; Assaf et al., 1995)

Conflict between Drawing and Specification

It is contractor's responsibility to review all drawings and specifications before starting work. They need to know about their work which will get from drawing. Specification will answer the question about the quality of work and materials performance desired by owner. If there is conflict between contract drawings and specification, usually specifications will get priority. AIA MBA Joint Committee (2010) recommended that when contractor will find such problem, he should instantly contact with A/E and request for written clarification. On the other hand, when A/E will find an inconsistency, he should ask to contactor to provide written explanation of the requirement. But, if both parties are not cordial to response quickly to revise the conflict between drawing and specification, the work will be delayed. This factor was responsible for construction delay in India, Uganda, UAE, Egypt, Saudi Arabia; Jordan (Doloi et al., 2012; Apolot et al., 2011; El-Sayegh, 2008; El-Razek et al., 2008; Assaf and Al-Hejji, 2006; Al-Momani, 2000).

Delay in Response

Consultant has many duties in design and construction phases. In design phase, close interaction with owner is obvious to develop a desired plan for him. Frequent changes in design or draw some alternative plans are also important. Besides, during construction

phases, A/E has role to site visit for work inspection and approval, check the invoice submit for progress payment and approve, early response for any change in drawing and specification. But if engineer delays to perform his activities, the project will be delayed. This factor of delay encountered in Egypt, India, Malaysia, Nigeria, (Marzouk and El-Rasas, 2014; Doloi et al., 2012; Alaghbari et al., 2007; Odeyinka and Yusif, 1997).

Lack of Responsibility

Consultancy is recognized as a profession according to law but also entailed "responsibility, obligation and liabilities between parties to an agreement" mentioned by Dr. Abdul Majid, former president of Association of Consulting Engineers Malaysia (Seminar on Responsibility of Consultant). If consultants are not responsible to do the works, some issues will arise frequently in the construction industry such as design error, delay in response, conflict in drawing and specification, late inspection and approval of works and materials etc. Therefore, this factor was recognized as one of the important causes of delay in Malaysia, Nigeria, and Vietnam (Alaghbari et al., 2007; Aibinu and Odeyinka, 2006; Long et al., 2004).

Delay in Work Inspection and Approval

It is engineer's responsibility to inspect and approve work in the site to proceed for next step. If consultant does not visit the site in right time, it may postpone the work for few days. Consultant in many countries, for example, Nigeria, Malaysia, Vietnam, Egypt, Saudi Arabia etc., were found to delay in work inspection and approval (Dosumu and Iyagba, 2013; Alaghbari et al., 2007; Long et al., 2004; El-Razek et al., 2008).

Inadequate Constructability Analysis (Impractical Design)

Sometime A/E teams provide impractical design without proper constructability analysis which is not possible to construct in the site due to many reasons such as site restrictions, government rules and regulations, structural safety, or limitation of techniques and technologies in the work area. When this difficulty arises at site, design document is sent to the consultant for redesign. For that reason, effective time of schedule is reduced. This factor of delay found in Turkey, Nigeria, Malaysia, Vietnam etc. (Gündüzet al., 2013; Dosumu and Iyagba, 2013; Memon et al., 2011; Long et al., 2004).

2.4.5 Manpower and Resources

The basic components of construction project are money, equipment/machineries, material, and manpower. Construction manager has to emphasize on the specific management of those components. The term manpower means skilled and non-skilled workers, technical personnel, and the management team. In addition, resources include equipment, materials, energy (i.e. fuel, oil, gas, electricity etc.) and other indirect goods necessary for construction. From literature review, 13 causes of delay under manpower and resources category are identified, for instance, lack of skilled workers, unskilled operator/technical person, escalation of resources price, lack of modern equipment in national market, equipment failure, shortage of equipment, material changes in types and specification during construction, material shortage, material damage, delay in material procurement, slow delivery of material and equipment, and delay in importing materials and equipment, transportation problem (Faridi and El-Sayegh, 2006; Assaf and Hejji, 2006; Sambasivan and Soon, 2007; Sweis et al., 2008; and Hwang et al., 2012).

Lack of Skilled Worker

There are two types of worker according to their skill, such as, skilled worker and unskilled worker. Both of them are required in construction project. If a country or region has shortage of manpower and depends on expatriates, there are a lot of opportunities of delay to mange sufficient work force. For example, United Arab Emirate (UAE), Saudi Arabia, Jordan, Singapore etc. have lack of skilled/unskilled laborers in construction industry and this factor has been identified as one of the major causes of schedule overrun (Faridi and El-Sayegh, 2006; Assaf and Hejji, 2006; Sambasivan and Soon, 2007; Sweis et al., 2008; and Hwang et al., 2013). Some other countries like India, Pakistan, Bangladesh etc. have lack of skilled laborers (Doloi et al., 2012; Haseeb et al., 2011; Salam et al., 2001).

Unskilled Operator/ Technical Person

Skilled operator is required to operate the construction machines or equipments. If the operators do not have sufficient knowledge, their productivity will be lowered and the probability of accidents will be increased. Besides, construction industry needs skilled technical person to check fitness of the equipments regularly and repair, if necessary. Therefore, unskilled operator/technical person was identified as the factors of delays in India, Jordan, Saudi Arabia, UAE, Bangladesh, etc. (Doloi et al., 2012; Sweis et al., 2008; Assaf and Hejji, 2006; Faridi and El-Sayegh, 2006; Salam et al., 2001).

Escalation of Resources Price

Increase of the prices of goods and services in project period is defined as escalation of resources prices. It increases the end cost of the project. For this reason, the project may

fail to achieve the target in terms of cost and schedule. Studies in Malaysia, India, Nigeria, Bangladesh etc., have discovered this factor as important cause of delay (Rahman et al., 2013;Doloi et al., 2012; Omoregie and Radford, 2006; Salam et al., 2001).

Lack of Modern Equipment in National Market

Modern equipment for construction is necessary to complete the work quickly with good quality. But if the equipment is not available in national market and need to export from foreign market, it may take unusual time to reach at the project site. Particularly some long lead items require to order before starting the construction to get at proper time. Thus, due to improper plan or other external causes, sometimes the equipment does not available in schedule and delays the overall project. Many countries such as Vietnam, Nepal, and Lebanon had lack of modern equipment for construction which was an important cause of delay. (Long et al., 2004; Manavazhi and Adhikari, 2002; Mezher and Tawil, 1998).

Equipment Failure

Equipment failure can be defined as breakdown of normal operation. If frequent failure is occurred at construction site, it delays the schedule and increases the accident rate. Construction project in developing countries like Egypt, Ghana, Bangladesh, etc. are frequently facing this difficulty (El-Razek et al., 2008; Frimpong et al., 2003; Salam et al., 2001).

Shortage of Equipment

Equipment shortage is a common problem in construction industry in many countries, such as Palestine, Egypt, Iran, Zambia, Ghana, Bangladesh etc. (Mahamid et al., 2012; El-Razek et al., 2008; Pourrostam and Ismail, 2012; Kabila et al., 2009; Frimpong et al., 2002; Salam et al., 2001) . Construction work is the combination of man and machine. If the company has shortage of own equipment, it cannot deliver the project on time. Besides, some contractors have excessive workload than their capacities in terms of equipment and labor. Thus, this factor discovered as the causes of delay in construction project.

Material Changes in Types and Specification during Construction

During construction, any change order interrupts the schedule. Material changes in type and specification can be for owner demand or design error. Due to conflict or error in drawing and specification, contractor becomes confused and the material might be changed in revise design. Besides, material mentioned in the specification may not be available in the national market and to bring from international market usually consume long time. Furthermore, owner may prefer to use different quality or type of material that mentioned in contract documents. All these factors afterward increase the project time. Gunduz et al.(2013), Apolot and Tindiwensi(2013), El-Razek et al. (2008),Faridi and El-Sayegh (2006) etc. found this factor of delay in construction project in Turkey, Uganda, Egypt, and UAE respectively.

Material Shortage

Due to improper material management, sometime material can be damaged or expired before use. In such case, both cost and schedule overrun may occur. Particularly, cement is damaged by careless storing at site. Other material, for example mild steel may be corroded due to store in outdoor environment. When these materials are needed urgently but it is found that stored materials are damaged, this situation causes delay of work. Assaf and Hejji (2006) found this factor as cause of delay in Saudi Arabian construction project.

Delay in Material Procurement

Procurement is a process of obtaining goods or services. It has different steps to complete whole task such as planning, demand calculation, preparation of specifications, value analysis, market survey, price negotiation, inventory analysis, distribution to the sites according to the requirement etc. Thus, it is a system which requires proper administrative works and failure to take steps on time will loss the schedule. Construction projects in many countries for example, India, Turkey, Uganda Malaysia etc. are suffering by this factor of delay (Doloi et al., 2012;Kazaz et al., 2012; Apolot et al., 2011; Memon et al., 2011).

Slow Delivery of Material and Equipment

If the required material and equipment for construction did not reach in the site within specific period, the work will be delayed. Although this factor can delay works by few days or weeks but continuity of such problem has great impact on schedule overrun. For slow delivery of material and equipment, first of all, vendors are most responsible parties.

They can behave like this way due to their self characteristics of having no responsibility, or late supply from manufacturers, and delay of payment by the owner or contractor etc. Construction industries in Singapore, Malaysia, India, Turkey, Ghana (Hwang et al., 2013; Rahman et al., 2013;Salunkhe and Patil, 2014; Gunduz et al., 2012; Fugar and Agyakwah-Baah, 2010) etc. are frequently experiencing of schedule breakdown by this factor.

Delay in Importing Materials and Equipment

Many countries don't have enough supply of different types of construction materials and equipments in their national markets and they need to import the resources from international markets. The process of importing material is a complex task and obviously time is a crucial factor in this regard. Many events are responsible for delay of importing material and equipment from other countries. Therefore, it has direct impact on time overrun of a project. This factor of delay found in Malaysia, Nigeria, Palestine, Iran etc. (Rahman et al., 2013; Akanni et al. 2014;Mahamid et al. 2012; Asnaashari et al., 2009).

Transportation Problem

Transportation problem, due to road blocking, repairing, or other reason, is also common cause of failure to achieve schedule in developing countries (Manavazhi and Adhikari, 2002; Enshassi et al., 2009; and Haseeb et al. 2011).

2.4.6 Project

Characteristics of construction projects vary from one project to another is which another critical issue of this industry. Thus proper investigation for an individual project, based

on past experience instead of speculation, is strongly recommended or even mandatory in some cases. Some project related problem such as inaccurate site investigation, site constraints, change in site condition, obsolete construction methods and technologies, lack of constructability analysis, delay in site clearance etc. were identified as the causes of delay by previous studies (Kazaz et al., 2012). All the factors are briefly discussed in the following sub-sections.

Inaccurate Site Investigation

All the data that are found by site investigation should be accurate and reliable. If the site investigation is inaccurate, selection of the foundation type, working techniques, planning and scheduling, budget for the project etc. will be wrong. It creates hazard for the workers, neighboring structures and consequently for the owners. For this reason, any project starts with improper site investigation will fail to achieve the targeted cost and schedule (Telford, 1991). Doloi et al. (2012), Meng (2012) and Azhar et al. (2008) have found this factor of delay in construction projects in India, UK, and Pakistan respectively.

Site Constraints

Site constraints can be defined as the limitation of work scope, space and facilities in the site of the project. Noise level, traffic load, working hour limitation, and other social, political, or environmental constraints etc. are the factors of site constraints. If these factors do not consider in preparing work schedule due to the lack of proper site investigation by contractor, the schedule will be ineffective to complete the project. This factor of delay found in the construction project in Zambia, and Thailand (Kaliba et al., 2009; Toor and Ogunlana, 2008).

Change in Site Condition

It means of finding different condition in the site than the investigated result or what usually known by previous records. This unusual condition can be discovered at the beginning of the project work or any phase. Mansfield et al. (1994) found "changes in site conditions" as third major problem in Nigeria. Researchers in Vietnam, and UK also found this factor of construction delay in their study (Le-Hoai et al., 2008; Lim and Mohamed, 2000).

Obsolete Construction Methods and Technologies

The term obsolete means "out of date", or "old-fashioned", therefore, obsolete construction methods and technologies is the means of constructing the project by very conventional and out dated ways where so many limitations exists. For example, manual way of soil excavation and site protection, scaffolding by simple wood and bamboo, concrete poring physically, no use of roof waist or tower crane to lift the materials etc. Construction companies of many developing countries have such types of limitations, so the rate of productivity of work is found very slow than designed value which leads to schedule delay. For example, Malaysia, India, Vietnam, etc. found this issue as one of the important factor of delay (Hameed et al., 2013; Doloi et al., 2012; Le-Hoai et al., 2008).

Lack of Constructability Analysis

Some projects have ambiguity of work scopes and the design documents are unrealistic due to improper constructability analysis. The analysis means to check or investigate whether the design work is applicable in the field considering all the potential constraints. Thus, if this issue arises during construction, then the work will be delayed to revise the

design or specification. This factor has been identified as the cause of delay in the construction projects in Vietnam, and Kuwait (Long et al., 2004; Al-Tabtabai, 2002).

Delay in Site Clearance

It is owner's responsibility to clear the site and handover to the contractor by the assigned date according to the contract. Due to many reasons, owner frequently fails to liberate the site for contractor. Delay also may occur by contractor to reach at site with laborers, materials and equipments, which is defined as delay in site mobilization. Studies in many countries for example, Pakistan, Taiwan, Vietnam etc. found this factor to cause schedule and cost overrun (Nawaz et al., 2013;Yang et al., 2010; Long et al., 2004).

2.4.7 Managerial

Management is a common term and it is mandatory to make any project successful. There are vast scopes of work by a good management team in construction project such as site management, material management, labor management, coordination among parties, contract management, equipment management, risk and uncertainty management etc. An experienced and competent professional project manager (PPM) can solve those frequently encountered causes of delays in construction industry all over the world (Kazaz et al., 2002). Managerial problem was found as most severe causes of delay in Nigeria, Malaysia, India, Turkey, Saudi Arabia, and Singapore (Mansfield et al., 1994; Sambasivan and Soon, 2007; Doloi et al., 2012; Kazaz et. al., 2012; Mitra and Tan, 2012; Hwang et al., 2012). Besides, most of the individual factors under this group were found as one of the major factors of delay in construction industry which was tabulated by Kazaz et al. (2012) for quick view of researchers in construction management fields. The

factors of this group are lack of experience construction manager, poor site management, contractors' excessive workload, poor contract management, conflicts between the parties in the site, poor material management at site, poor coordination among parties, contract related dispute/claim, insufficient communication between the owner and designer in design phase etc. All these factors are briefly discussed below:

Lack of Experience Construction Manager

A project manager has many duties and responsibilities to make a successful project. He has responsibility for the realistic project planning, execution of the plan, work monitoring and control according to the plan and finally successful closure of the project. If the project manager has lack of experience, he will not capable to provide these services and the project will be unsuccessful to achieve the contract schedule and price. This factor of delay is very common in different parts of the world, for instance, Saudi Arabia, Iran, Vietnam, Malaysia etc. (Mitra and Tan, 2012; Asnaashari et al., 2009; Long et al., 2008; Alaghbari et al., 2007).

Insufficient Communication between the Owner and Designer in Design Phase

To develop a desired plan and design for the owner is very important to reduce change order during construction. For this purpose, sufficient communication is essential to share owner's ideas and requirements by several programs at the pre-design phase. Then continuous follow up and information sharing is also necessary in the design phase to come up with a desire solution. If there is a gap of communication between A/E and owner, this will lead to other causes of delay in construction phases. Thus many studies

have identified this issue as one of the cause of delay in Malaysia, Egypt, Saudi Arabia etc. (Ramanathan et al., 2012; El-Razek et al., 2008;Assaf and Hejji, 2006).

Poor Site Management

Site management is monitoring and supervising "day-to-day on site running of a construction project" (Site manager/Wikipedia). Basic objectives are to keep the project work within defined quality, schedule and cost. The site manager will coordinate and communicate among the parties, record up-to-date information about the work progress and resources requirements for periodic time and cost analysis. Thus, very good site management is necessary for a successful project. This factor delayed schedule of the construction project in many countries, e.g., India, Ghana, Iran, Malaysia, Vietnam, Hong Kong etc. (Doloi et al., 2012; Fugar and Agyakwah-baah, 2010;Asnaashari et al., 2009; Sambasivan and Soon, 2007; Long et al., 2004; Chan and Kumaraswamy, 1997).

Contractors' Excessive Workload

Many contractors are interested to award more and more projects beyond their capacity. It is also managerial problem because good management team knows how much works they can perform accurately. Also, they know the consequences of failing to achieve the contract time and cost. When contracting organization involved in excessive workload, they cannot manage the resources and time constraints due to lack of experience managerial services which leads to schedule delay. Therefore, this factor was identified as one of the major problem in Qatar, Kenya, and Iran (Jarkas et al., 2013;Mbiti et al., 2011; Asnaashari et al., 2009).

Poor Contract Management

Contract management means to manage all sorts of things to provide the services according to the agreement, i.e. it is the process to provide all goods and services within specified time period by the agreed parties. If there is poor management system, the process will be failed to ensure the services on time and thus, it will be identified as one of the important factor of delay. Poor contract management was found one of the very high important causes of delay in Iran, Malaysia, Ghana, Jordan etc. (Pourrostam and Ismail, 2011; Sambasivan and Soon, 2007; Frimpong et al., 2003; Odeh and Battaineh, 2002).

Conflict between the Parties in the Site

If the parties do not provide services according to the agreement, conflict in the construction site may arise. Then it will delay the project or even the work can be suspended for certain time. This problem found in India, Saudi Arabia, UAE Kuwait etc. (Doloi et al., 2012; Assaf and Hejji, 2006; Faridi and El-Sayegh, 2006; Koushki et al., 2005).

Poor Material Management at Site

Material management is to administer material storage and order such that the process will be cost and time effective but without sacrificing quality. It means no shortage, damage, or abandon of material. Sometime material dumping at space restricted site blocks the working space and consumes effective hours or day. Besides, late order also delays the work due to material shortage. Thus, good material management is necessary task at site; alternatively, poor material management is responsible to delay the project.

This factor of delay was identified in India, Malaysia, Ghana, Nigeria etc. (Doloi et al., 2012; Memon et al., 2011; Fugar and Agyakwah-baah, 2010;Aibinu and Odeyinka, 2006).

Poor Coordination among Parties

Since multi-parties involve in construction projects, coordination among them is essential to reach at the goal point of the project. At design phase, coordination between A/E and owner is essential to reflect owner's requirements in the design and specification. During construction, sufficient coordination and communication among A/E, owner, and contractor is obvious to run the project in accordance with contract. If there is poor coordination among parties, the project will be delayed. This factor causes delay in construction in India, Ghana, Egypt, Jordan etc. (Doloi et al., 2012; Fugar and Agyakwah-Baah, 2010; El-Razek et al., 2008; Odeh and Battaineh, 2002).

Contract Related Disputes/Claim

When any controversy develops regarding understanding of payment, service quality, time, or project cost etc. due either party involved in a contract, such situation is defined as dispute. Afterward, unsolved dispute leads to a claim as formal request for a lawsuit (Levin, 1998; Bramble and Cipollini, 1995). Dispute and claim can be directed to long term delay of a project. This factor was identified as frequent and important cause of delay in Malaysia, Ghana, Jordan etc. (Zakaria et al., 2013; Fugar and Agyakwah-baah, 2010; Al-Momani, 2000).

2.4.8 Rules and Regulation

Building construction activities regulated by public works department (PWD), housing authority, civil aviation, fire safety department, department of environment, some services departments to provide connections of electricity, gas, water, etc. of a country. Previous studies found that building permits and approval process, obtaining permits from municipality, and safety rules from municipality are the main causes of delay in this group (El-Razek et al., 2008; Sweis et al., 2008; Alaghbari et al., 2007). These factors are briefly discussed below:

Building Permits and Approval Process

Most cases, developing countries have not own building construction codes which would be feasible for regional perspective rather copied from developed countries like UK, or USA. Most of times, permission and approval processes are very much prolonged by bureaucratic complexity. Besides, private investors are very unconscious to submit the design documents to the respective departments with satisfying all construction requirements according to government rules. Moreover, frequent change in rules also responsible to delay the approval and permission process which subsequently delays the project schedule (Odeh and Battaineh, 2002; and Alaghbari et al., 2007). If the building codes is newly developed or revised, it also takes time to adopt the constructing personnel with those changes.

Obtaining Permits from Municipality

If the construction work is inside the municipal area, permission is needed particularly from municipal authority. There are numerous reasons to delay the permission process,

for example, lack of information to the draftsman who prepares the documents for submission, frequent change in rules and regulation, late response or carelessness by the administrative persons, corruption among them etc. Thus, delay in obtaining permits from municipality also increase the pre-defined time of the project. This problem found in Zambia, Ghana, UAE, Saudi Arab etc. (Mukuka et al., 2013; Fugar and Agyakwah-baah, 2010;Faridi and El-Sayegh, 2006; Assaf and Hejji, 2006).

Safety Rules

Safety issue is another most important causes of delay because in developing countries, few construction companies are followed the safety system accurately. Thus accidents like fatal to minor in the project site are frequent event which also the important factor of time delay (El-Razek et al., 2008; Sweis et al., 2008).

2.4.9 Environmental

Good working environment is the precondition to provide satisfactory productivity of manpower and equipment. If the site condition become bad enough to work, the project may suspends for unlimited time and cause schedule delay. The environmental factors of delays are flood, heavy rainfall, and extreme temperature/cold, windy or storm, unforeseen ground condition etc. (Kazaz et al., 2012, Odeh and Battaineh, 2002; Alaghbari et al., 2007; Sweis et al., 2008; Ahsan and Gunawan, 2010; Haseeb et al., 2011). Besides, regional socio-cultural and political issues such as strike, abduction, boarder close etc. also consider as environmental factors of construction delay (Enshassiet al., 2009; El-Razek et al., 2008). Some of them are discussed below:

Adverse Weather Conditions

Where bad weather is very common and predictable, schedule can be planned considering weather effect to make sure that the project will be finished at due time. But unpredictable climatic changes are considered as the factors of delay in this regard. Since this factor is very uncertain and unknown, it consumes the effective time of the project schedule. It is a common problem in Turkey, Scotland, Pakistan, Bangladesh etc. (Hampton et al., 2012; Kazaz et al., 2012; Haseeb et al., 2011; Salam et al., 2001).

Strike or Other Political Problem

Strike or other political violation is common problem in many countries and at the time of such incidence transportation system collapses. That is why, materials, or labors cannot reach at the site and works is stopped. Therefore, construction industries in some countries like Pakistan, Palestine, Bangladesh etc. are facing difficulties by this factor of delay (Choudhry et al., 2014; Enshassiet al., 2009; Salam et al., 2001).

Work Accident

Many types of accidents may occur in construction site. It would be fatal or minor injury. Depends on the severity and frequency of accident, the construction progress might be delayed. There are various causes of work accident, for instance, lack of site safety, personal safety, and awareness of individual character, building height, space constraints for construction equipments etc. Construction projects were delayed by this factor in India, Ghana, Saudi Arabia etc. (Doloi et al., 2012; Fugar and Agyakwah-baah, 2010;Assaf et al., 2006).

2.5 CONSTRUCTION DELAYS IN DEVELOPING COUNTRIES

Assaf and Hejji (2006) studied for identifying the causes of delays in construction in Eastern Province of Saudi Arabia. They listed 73 causes of delay under nine groups like as Project, Owner, Contractor, Consultant, Design, Materials, Equipment, Labors and External factors. The study revealed that shortage of labors, unqualified work force, inadequate contractor's experience, difficulties in financing project by contractor, ineffective planning and scheduling of project by contractor, low productivity level of labors, delay in progress payments by owner were severe causes of delays observed by both owner and consultant. In addition, they also found that rework due to errors during construction, very short duration of contract, late delivery of material, poor site management and supervision by contractor, type of project bidding and award, poor qualification of technical staff etc. were also the most sever causes of delay in Saudi Arabian.

Frimpong et al. (2003) have studied to identify the main factors of delay in construction of groundwater projects in Ghana. They tabulated twenty six factors responsible for project delays but they did not categorize the factors in main groups. Within the 26 factors, both consultants and contractors, commented that monthly payments difficulties are the most severe factors of delay, although poor contractor management is claimed by owners as the most important factor. Besides, material procurement, poor technical performances, escalation of material prices have influenced in project delay.

Problems of large construction projects in Vietnam were studied by Long et al. (2004) and 62 factors were identified into four principle categories such as "organizational (i.e. Financier, Owner, Contractor, and Consultant), project attributes, coordination, and environmental". This study ranked the problems depends on their frequency of occurrences and weight of influences. Research revealed top three causes e.g., i.e. inaccurate time estimating, slow site clearance, and excessive change orders have high occurrences. On the other hand, slow site clearance, slow government permits, and inaccurate time estimating were top three factors based on high influence. Thus, inaccurate time estimate, and slow site clearance are major factors considering both high occurrence and influence. Long et al. (2004) found five major factors, among them, incompetent designers/contractors were ranked first followed by poor estimation and change management; social and technical issues; site related issues; and improper techniques and tools.

Aibinu and Odeyinka (2006) studied to assess the causes of delays by interviewing project participants and considering external factors governed in Nigerian construction projects. The study identified forty four causes of delays in construction projects and grouped them into nine major categories such as "Client, Quantity surveyor, Structural engineer, Service engineer, Contractor, Subcontractor, Suppliers related and External factors". Among 44 factors, top ten factors of delay were "contractors' financial difficulties, clients' cash flow problem, architects' incomplete drawing, delayed in material delivery, incomplete structural drawings, contractors' planning and low mobilization, equipment breakdown and maintenance problems, suppliers' late delivery scheduling problems, price escalation, and subcontractors' financial difficulties".

Faridi and Sayegh (2006) discovered maximum rate of building per square kilometer is constructed in Emirate of Dubai compared to all over the World. They also mentioned the delays in construction affect both construction industries and country's (UAE) economy, for example, 14% of GDP earned from this sector. They have studied to identify and rank the significant causes of delay in construction project from the perspective of contractors and consultants. The important causes of delays in construction projects in UAE were late authorization of drawings, insufficient early planning, slow decision-making of owner, lack of labor, improper supervision and site management, poor productivity of labor, unskilled manpower, late delivery of materials, delay in getting government permission, and insufficient cash flow by contractor.

Sambasivan and Soon (2007) stated delays in the construction as an international problem. They found this problem extensively in Malaysian construction sector. To overcome these situations, they studied to find the delay factors and its impacts on project completion. They revealed most important causes for time-overrun were inappropriate planning and site management, inexperience contactors, financial problem and delay in periodic payments by owner during construction, too many subcontractors, lack of labor, shortage of material and equipment, poor coordination among parties etc.

This scenario was slightly different in Nepal. Study disclosed poor organization, late delivery of material and equipment by supplier, nonexistence of good transportation system and regulation imposed by government were the main factors of delay in construction projects (Manavazhi and Adhikari, 2002).

El-Razek et al. (2008) carried out research to identify the main causes of delay in construction projects in Egypt based on the opinions of contractors, consultants, and owners. They selected thirty two causes of delays which were exclusively related to Egyptian construction industry. According to their study, the most important causes were financial problem of owner and contractor, change order in design, incomplete payments throughout construction, and absence of expert construction manager.

According to Sweis et al. (2008), construction projects in Jordan were facing frequent delays in schedule performance and they conducted research to know the key causes of delay with subsequent impacts of housing projects. Project engineers, owners and contractors were participated in this study. They found contractor's poor planning and scheduling as well as financial difficulties were the most critical causes of delay by both owners and consultants. However, contractor claimed that change orders by owner, and manpower shortage were the most important causes.

Enshassi et al. (2009) studied to obtain leading causes of delays in construction projects at Gaza Strip. They classified the causes of time overrun into 12 major categories namely "project-related; contractors' responsibilities; consultants' responsibilities; owners' responsibilities; professional management; design and documentation; materials; execution; labor and equipment; contractual relationship; government relations; and external factors" (p. 129). Research found that group factor related with materials was ranked first by respondents like client, consultant and contractor. This situation was significantly different from other developing countries, because of instability of political condition at Gaza Strip. According to Enshassi et al. (2009), public demonstrations, military action and frequent close of border, materials shortage and late supply at site,

scarcity of fund, improper site management, work postpone by contractor or owner were the major problems.

Similar to other developing country, Zambia is facing so many difficulties regarding cost and schedule variances in construction projects. The situation is depicted by the study of Kaliba et al. (2009) where their objective was to identify cause and effects of time and cost overrun of road construction projects in Zambia. The study found delay in progress payments, economic problem of owner and contractor, changes in agreement, procurement of materials, change order, shortage of equipment and labor; poor site management and supervision etc. were the principle causes of time overrun in Zambia.

Haseeb et al. (2011) studied to find out the causes and effects of project delay in Pakistan. The study found natural calamities (i.e. earthquake flood, etc.), delay in financial and payment procedure, inappropriate planning, inefficient management at site, lack of knowledge, equipment and materials shortage etc. were frequently occurred factors of delays.

Kazaz et al. (2012) identified 34 factors of time overruns in construction projects and classified in seven groups such as “environmental, financial, labor-based, managerial, owner-based, project-based and resource-based” in Turkey. Among them financial group was acknowledged as most influential causes of delay followed by labor, managerial and owner-based factors. However, in case of individual causes of delay, design and material change was the top most factor of delay. The other important factors were delay payments, cash flow problems, contractor’s financial problems, poor labor productivity,

estimation problems, lack of feasibility studies, construction defects, unbalanced number of workers and fluctuation in material price.

Kikwasi (2012) studied to assess causes, effects and disruptions of construction projects. Research found that design changes, delays in payment to contractors, information delays, funding problems, poor project management, compensation issues and disagreement on the valuation of finished work were the main causes of delays in construction projects in Tanzania.

According to Pourrostam and Ismail (2012), delay recognized as one of the major problems in construction projects and it has significant impact on project out come. Their study found ten most significant factors of delays in Iranian construction projects, those were delay in periodic payment, frequent changes in drawing and material at the time of construction, inefficient site management, slow decision making, and late approval of submittals by owner, shortage of liquid money, poor coordination with subcontractors, error in planning and scheduling by contractor, careless design by consultant, and natural action.

Doloi et al. (2012), recommended construction projects in India are experiencing widespread delays. The study identified forty five causes of delays in Indian construction projects. They performed factor analysis and regression modeling to evaluate the severity of causes of delay. According to them, the most important factors of delays were poor commitment, ineffective coordination and management at site, inadequate planning, poor communication, and imperfect agreement.

Hwang et al. (2012) stated, since demand of public housing increased, government of Singapore has taken initiative for reducing the delivery time of future projects. To implement government's decision, project needs to complete in scheduled date. To reduce delay in housing projects, Hwang et al. (2012) identified the critical factors causing delay and found that site management, coordination among various parties, and design changes by owner during construction were the major causes of schedule overrun. Besides, resource related factors such as availability of laborers on site, availability of material, and availability of staff to manage projects were the top three causes of delays of the projects financed by Housing and Development Board in Singapore.

However, there is no research for large building construction projects in Bangladesh to analyze the factors affecting schedule overrun and its subsequent impacts on the project. But it is very much important to know the delay factors to complete the project in specified time, predefined quality, and budgeted cost. Therefore, this research has merit to study as its expected outcomes are finding most frequent and significant causes of delays to enhance secured investment for the national or international individual or group entrepreneurs in construction industry of Bangladesh.

2.6 EFFECTS OF DELAYS IN CONSTRUCTION PROJECTS

There are numerous consequences of construction delays. Delays have influence on project performance (Kikwasi 2012). Haseeb et al. (2011) thought that the impacts of delay are varying with respect to parties view for example owner think delay means loss

of revenue and lack of services, alternatively contractor considers it as loss of money. The delay in construction projects has enormous impacts such as time overrun and cost overrun (Sambasivan and Soon 2007; Haseeb et al., 2011; Pourrostam and Ismail, 2012). Many researchers found that improper planning, lack of experience and poor site management by contractor as well as change order and delay in progress payment by owner are the most important factors that directly force to time overrun (Assaf and Hejji, 2006; El-Razek et al., 2008; Kikwasi, 2012; Pourrostam and Ismail, 2012; Haseeb et al., 2011 etc.). Delay also create caustic situation between owner and contractor such as dispute, ligation, arbitration, and some time total abandonment of the project (Pourrostam and Ismail 2012; Haseeb et al. 2011; Sambasivan and Soon 2007). However, cost overrun is considered as the most significant effect which may suspend or even terminate the project before completion. Enshassi et al. (2009) found that increase of material prices, supply of raw materials and equipment, project monopoly by some suppliers, fluctuation in the cost of building materials and unsettlement of local currency with dollar are the most important causes of cost overrun which also the consequences of delay.

2.7 RECOMMENDATIONS TO REDUCE CONSTRUCTION DELAYS

Since delays are common phenomena all over the world specifically for developing countries, many studies have been done with the aim of finding frequently occurring causes of delays in construction projects. But, most of the studies did not provide proper guide line that how to minimize the time and cost overrun in this circumstance. Some

studies such as Frimpong et al. (2003), Aibinu and Odeyinka (2006), Assaf and Hejji (2006), Faridi and Sayegh (2006), Sambasivan and Soon (2007), Enshassi et al. (2009), Kaliba et al. (2009), Haseeb et al. (2011), Pourrostam and Ismail (2012) etc. were provided constructive guidelines to overcome delays in construction project. Frimpong et al. (2003) recommended that total project cost should be calculated accurately before construction by contractor side to avoid delay of payment for workers, arrange regular training to improve managerial competence for introducing up-to-date knowledge about modern management system, procurement of material and equipment need to be effective and efficient, and allocate sufficient contingency to cope increase cost of material during construction period. Aibinu and Odeyinka (2006) thought that integrated procurement, integrated team structure, establishment of a national agency (to coordinate the affairs of the industry and to facilitate the use of innovative management methods), and establishment of construction bank may solve financial problem and subsequently the delay in construction project.

To reduce delay in construction project, owner should timely pay the contactor's progress payment, minimize change order during construction, avoid delay in approving design, and check capabilities of bidder before awarding (Assaf and Hejji 2006, Sambasivan and Soon 2007, Enshassi et al. 2009). Assaf and Hejji (2006) added that contractor should ensure about project finance and cash flow, sufficient labor and their productivity, timely update planning and scheduling, appoint such management team to achieve specified completion time without compromising quality and cost. In addition, consultants have to review and approve submittals without intentional delay before construction, as well as to

evaluate work request by contractor for controlling delay (Assaf and Hejji 2006, Sambasivan and Soon 2007).

To minimize delays in construction, projects professionals (consultants, contractors etc.) must have agreed schedule and have to follow the schedule strictly; schedule requirement and control should include in contract documents; specialist companies of construction management need to involve; require regular training for the employees; and contractor should conscious to get permission and approval earlier from different agencies of government (Faridi and Sayegh 2006). According to Sambasivan and Soon (2007), the consultant should incorporate contract duration, process for solving disputes and assessing the causes of delay, prepare risk management plans at the time of contract between owner and bidder. Haseeb et al. (2011) emphasize to reduce change order (related to owner or A/E) at construction phase; increase the productivity of labors, introduce modern equipments and technologies in construction by contractor. Beside contractor should ensure sources of finance for uninterrupted cash flow, appoint competent staff to reduce delay in construction projects (Haseeb et al. 2011, Enshassi et al. 2009). Materials shortage during construction is the special problem for Gaza, for this reason, Enshassi et al. (2009) suggested to contractor for purchasing materials at the starting of the project work and also emphasized to make time schedule for delivering material at site. Proper planning and scheduling, enough expertise to do construction work, competent project manager and adequate economic support are the pre-requisite for contractor to reduce construction delay (Sambasivan and Soon 2007). Pourrostam and Ismail (2012) thought that good procurement of material, improvement of human resources with sufficient finance by contractor may reduce construction delay. Kaliba et

al. (2009) recommended in detail to reduce construction delay. According to their study, construction works need to plan and schedule considering weather condition, scope of work should be defined clearly in contract document to avoid any claim. Besides, accurate cost estimation to ensure project financing for both owner and contractor are required to minimize delay. In addition, they also commented that efficient communication, skilled employees for all parties, capacity building and appropriate legislation (i.e. owner, contactor and consultant) may reduce most of the factors related to cost and time overrun.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents all the necessary steps of the methodology and describes briefly how to achieve the objectives of the study. This study has been carried out by four independent phases (figure 3.1). These are literature review, questionnaire design, data collection, and data analysis. After these, the results of the data analyses are discussed in chapter 4. Based on the results, the study concludes the outcomes and recommends some actions to reduce construction delay. Literature review is discussed in chapter two. Other phases and corresponding steps of methodology are described in the following sections.

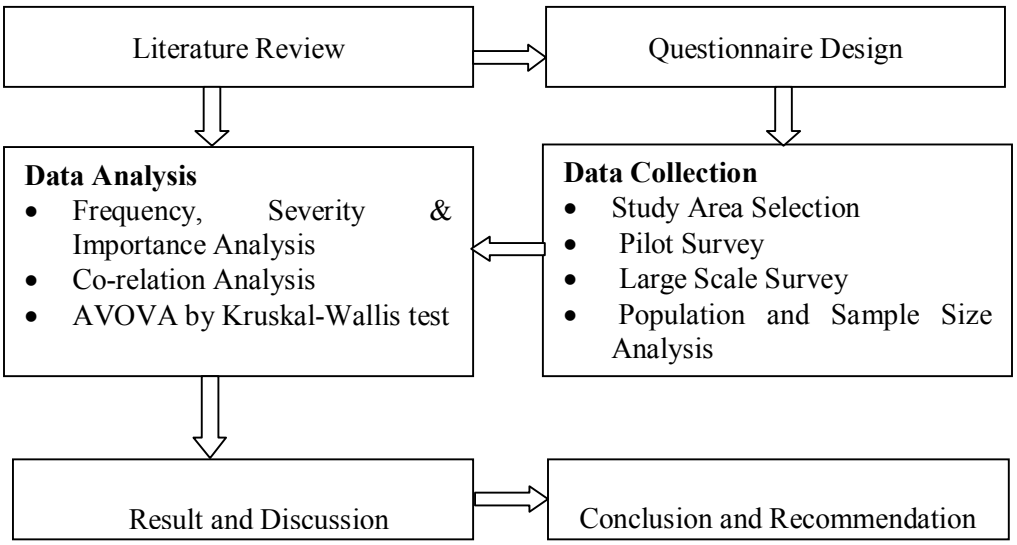

Figure 3-1Flow-chart of the Research Methodology

3.2 QUESTIONNAIRE DESIGN

Since construction delay is a common problem all over the developing world, this study first identified the common nature and types of delay in construction industry (CI) by doing literature review. Review of literature usually provides necessary instructions and information regarding identified problems as well as methods of doing research in any field (Rahman et. al. 2006). Besides, study of related published articles also very helpful for developing questionnaire to conduct interview survey to collect research data. This study reviewed good number of articles published in different journals which represents the research outputs of many countries and accumulated the causes of delay frequently found in growing countries with respect to infrastructure development. In addition, the studies have been done by Assaf et al. (2006), and Kazaz et al. (2012) were regarded as the principle thrust of this study because of the detailed discussion about major and sub-factors of delays. After reviewing the articles, this study have been identified 109 causes of delay in CI; then these delay factors were divided into 9 major categories such as financing, owner, contractor, consultant, manpower and resource, project, managerial, rules and regulation, and environment related problems which are already discussed in literature review section. The list of factors was structured in a questionnaire form for pilot survey and show in table A1 in appendix A. Questionnaire was redesigned for large scale survey addressing the outcome of pilot survey. The details questionnaire for large scale survey is shown in table A2 in appendix A. The questionnaire had two parts such as frequency and severity of the causes of delays. Both frequency and severity were divided into 1 to 4 point scale. In frequency analysis, respondents were asked to give response

against each factor whether it was found in rare, sometimes, often, or always by the point of 1, 2, 3, and 4 respectively. On the other hand, for severity factor of delay, they were also asked to response in regards of little, moderate, great, or extreme and the point scale was similar to that of frequency (i.e. 1 to 4). Besides, data analysis procedures like as index calculation for frequency, severity, importance of the causes, correlation among the respondent parties, variance analysis etc. have been found from literature review. Both types of survey are discussed in data collection part.

3.3 DATA COLLECTION

Discussion about data collection is divided into four parts such as study area selection, pilot survey, large scale survey, and population and sample size analysis. On the basis of necessity, this study was selected an important metropolitan city of Bangladesh as study area. Then designed questionnaire, as an outcome of literature review, was justified by pilot survey, and finally, large scale survey has been done for the collection of research data. The number of data was also examined by population and sample size analysis to know how many data are required to make statistical inference for this study. All the steps are discussed in the following sub-sections.

3.3.1 Selection of study area

Before starting data collection section of study area is very much necessary. Sylhet, the north eastern part of Bangladesh, was selected as the study area. Red zone in the figure 3.2 shows the Sylhet region. The city has been declared by Bangladesh Government as city

cooperation area since 2001. Currently the city has almost 500,000 people in its 26.5 square kilometer area and one of the dense cities (about19, 000 per sq. kilometer) in Bangladesh. After declaring Sylhet as “Metropolitan City”, the area is termed as business boom and so many investors are financing in this region in construction industry instead of manufacturing industries. The trend of population growth was very high (i.e. 8.25%) and 41% buildings developed in last 10 years in this city which is highly significant numbers to show the demand of building construction projects and need great concern about its management system (Sharmin, 2013).In addition, there are very limited numbers of industries, factories, or any other business opportunities in Sylhet, which have been influencing building constructions for commercial, residential and multipurpose spaces. Since the city has limited land area and the cost of the land are rising rapidly, the developers mostly focus in constructing high rise (over 6-storied) building in city area at present time. But, the observation survey found that good numbers of constructions are terminated before ending according to the design due to limitation of fund and mismanagement which are the result of improper economic feasibility study and lack of competent project manager. Besides, although the development of this city is very fast in presence of huge foreign remittance of the city dwellers, but it is peripheral area and most of the cases, developers do not find competent or experienced consultants and contractors with modern equipment and technologies rather depends on traditional or conventional systems for construction. All those things were taken into consideration to select this particular region to study for delay analysis in construction industry of Bangladesh.

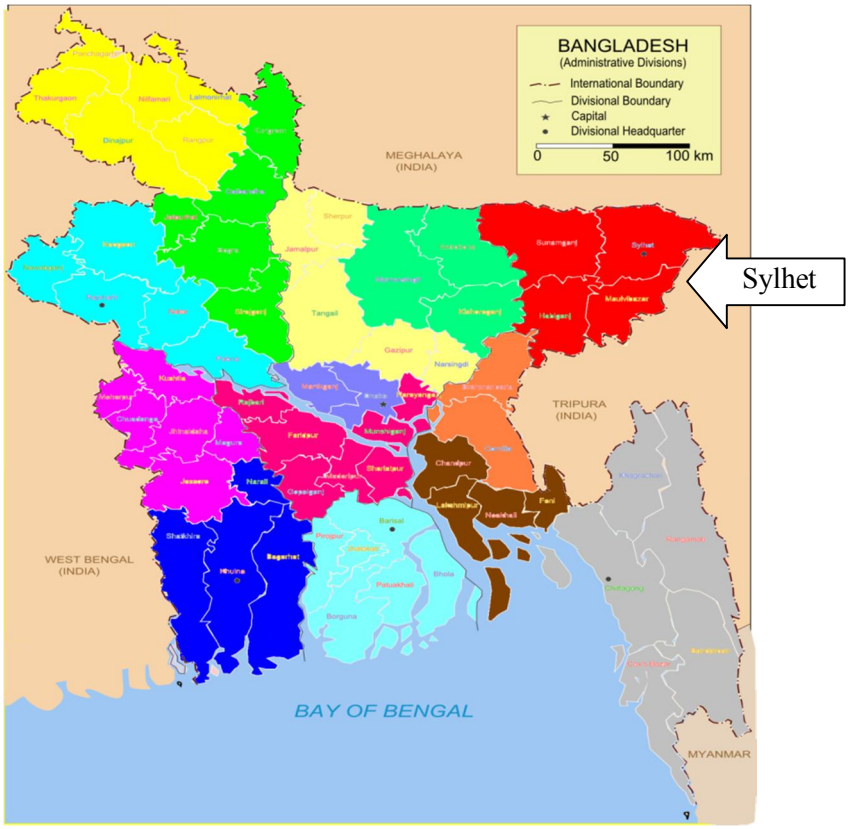

Figure 3-2 Study area in the map of Bangladesh

3.3.2 Pilot Survey

Although there are several types of survey for example questionnaire sending by web-mail or postal mail, interview, or telephone survey among groups or individual experts, non-expert, or mass people; one to one structured interview survey was selected for this study within the construction professional or experts. This interview survey was conducted in two phases such as small scale or pilot phase and large scale phase where pilot survey was done by meeting with the 10 experienced engineers based on the questionnaire developed by literature review. The purpose of this survey was to select the causes of delay related with Bangladeshi construction projects. After the pilot survey, the

study found the causes of delays that were usually encountered in construction projects and new questionnaire was developed for large scale survey.

3.3.3 Large Scale Survey

The respondents were owner, consultant, and contractor, who are the major role makers of the construction project from its inception to delivery phases. There are about 45 consultants or A/E farms, and 100 contactors (all categories) are working for design, construction or both services of building construction project in Sylhet City (reported by Public Works Department, Sylhet, Bangladesh). The contractors are defined as first class, second class, and third class according to their organization size and funding capacity. But those who are first class contractors and have 5 years or more experience of large building constructions, were asked for this interview survey. Same attributes was considered for selection of consultant or engineer regarding experience. The survey was conducted within 20 professional consultant engineers, and 30 contractors. However, although there is an association name Real Estate Housing Authority of Bangladesh (REHAB) for real estate and housing business but the member from Sylhet city is very few and most of the business owner or groups in CI are attached with Sylhet Chamber of Commerce and they are doing multi-criteria business beyond building development. Thus, exact number of developers was very difficult to find. That is why the list of owners, who constructed at least one high-rise building, for interview survey was selected with the help of information given by the consultants. By this way, 20 owners were interviewed where many of them are repeated builders and few of them are first time builders.

3.3.4 Population and Sample Size Analysis

Due to limitation of time, it is quite impossible to study among all the population of the parties; thus, sample size setting is obvious for any study. The sample size requirement is depended on some criteria such as mean, standard deviation, level of severity, maximum standard error allow for the research etc. To reflect 95% confidence level and to take statistical inference on surveyed data, the equations for sample size calculation in a specified condition are as follows (Krish, 1995):

$$n_0 = \frac{p\,(1-p)}{E^2} \tag{3.1}$$

$$n = \frac{n_0}{1+\frac{n_0}{N}} \tag{3.2}$$

Where n_0, p, E, n, and N denotes the sample size from infinite population, targeted proportion from population, maximum standard error considered, sample size, and population size respectively. Since there is lack of previous records, usual statistical guideline is followed here. Thus, this research considered the values of p is 0.5 and, standard error equal to 10%. Besides, N is found from field survey for different parties such as 45 for engineering firms, 100 for contractors, but no exact number of owner's. If N is taken 100 and all the values are substituted in the above equations, the sample size (n) will be 20. Thus, considering 20 owners, and engineers, as well as 30 contractors for interview survey are justified.

3.4 DATA ANALYSIS

Data analysis was done by three basic ways such as analysis of frequency, severity, and importance of the causes of delay by index values; analysis of relationship among the parties by Spearman's rank correlation; and analysis of variance by Kruskal-Wallis test. These are discussed one by one briefly in the following subparagraphs.

3.4.1 Ranking of Causes of Delay

The study was collected two types of data for example frequency of causes of delay and the influence of these causes on schedule overrun which is called severity. Thus by using equations mentioned below, frequency and severity indices were calculated. In addition, the importance index of the causes of delay was calculated by another equation to find their importance on time overrun of a project. The analysis of data was done with the approaches used by Assaf et al. (2006) in their study which was conducted for finding the causes of delays in Saudi Arabian construction projects. The statistical processes to calculate frequency index (FI), severity index (SI) and importance index (IMP.I) are as follows:

$$\text{Frequency Index (\%)} = \sum a \left(\frac{n}{N}\right) * 100/4 \qquad (3.3)$$

Where, "a" means the weight of the response in 1 to 4 points, n is the number of responses, and N is the total number of responses for a particular cause of delay. This index ranks the causes of delay with respect to the frequency of causing time overrun of

construction project. The largest value of FI indicates that the specific factor is most frequently found in construction industry and so on.

$$\text{Severity Index (\%)} = \sum a \left(\frac{n}{N}\right) * 100/4 \quad (3.4)$$

Where, "a" is the numerical value indicates weight of the response from 1 to 4 point regarding how severe the factor to cause delay respectively, n is the number of responses, and N is the total number of responses. Like FI, severity index (SI) also indicates the rank of the factors of delay regarding its severity of how many days the project schedule will be delayed by the factor. The largest number of SI for any cause is ranked 1 and followed by descending order.

$$\text{Importance Index (IMP.I) (\%)} = \text{RFI (\%)} * \text{RSI (\%)} / 100 \quad (3.5)$$

The value of importance index is the product of relative frequency index (RFI) and relative severity index (RSI), because importance of a cause of delay is the function of both frequency and severity. The indices will also be used for ranking and categorizing the factors of delay according to the consequence of causing schedule overrun.

3.4.2 Spearman's Correlation among the Parties

Correlation among three parties was measured based on their answer against each factor of delay. The analysis has been done by Spearman's rank correlation for rank or order of the factors by two parties of respondents. This method was chosen because it is a non-parametric test which means distribution free test where no assumption like homogeneity

of variance is required (Assaf et al. 2006). This system of correlation uses median instead of means which eliminate the influencing error of outlier if any present in the data set. The correlation searched for the answer of the question i.e. is there any relation or similarity among the respondents? Although, this study has been conducted among three parties but Spearman's rank correlation is applicable between any two parties. The range of correlation by this way is +1 to -1 where more close to +1 shows strong positive relation between two parties and the similarity of the understanding about any factor of delay between the parties and vice versa. The formula of calculating Spearman's rank correlation coefficient is as follows:

$$r_{s'} = 1 - \frac{6\Sigma d_i^2}{n(n^2-1)} \tag{3.6}$$

Where, d_i means difference between the rank of two parties for specific factor of delay and n means the number of factors.

3.4.3 Kruskal-Wallis test for ANOVA among Parties

One way analysis of variance (ANOVA) is very much essential to know the relationship of the independent variables. For this analysis, some assumptions are needed e.g., the scale of measurement of the dependent variable must have equal interval scale, the number of samples will be independent and randomly selected from source, the population (s) source will suppose to be followed normal distribution theory, and the numbers of samples have to be approximately equal variances. But if the sample size is different, the data is on the qualitative rating scale, nominal but ordinal, and more than two independent variables exists, then Kruskal-Wallis test is the appropriate non-parametric alternative instead of one-way independent samples ANOVA. The Kruskal-

Wallis test is applied to test the null hypothesis whether all populations are identically distributed against the alternative hypothesis which means minimum two of the samples or all differ only with respect to median. It has no restriction that the populations to be normally distributed. SPSS software is used to analysis the data for Kruskal-Wallis test. The mathematical expression of this test is as follows:

Sum of square deviates, $SS_{bg\,(R)} = \sum \frac{T_g^2}{n_g} - \frac{T_{all}^2}{N_a}$ (3.7)

Kruskal-Wallis statistics, $H = \frac{SS_{bg\,(R)}}{N\,(N+1)/12}$ (3.8)

Where, T_g is the sum of each group, T_{all} is the sum of all groups, n_g is the number of variables for a single group, and N_a is the total variables. H is very close to chi-square value with degree of freedom, df = k-1, where k means sample size. The chi-square ($\mathcal{X}_\alpha^2$)value is then calculated and checked the level of significance (α) to hypothesis test, whether null hypothesis rejected or not. Besides, confidence level can be found by subtracting α from 1 i.e. confidence level = 1-α. This procedure is applied by the help of SPSS to analyze all the variables (72 factors) against three groups (i.e. owner, contractor, and consultant) together to testify the judgments of the respondent whether identical or varied. The hypothesis in this case is as follows:

H_0: No significance difference exists between mean ranks of the parties (owner, A/E, contr.)

H_a: significance differences exist between mean ranks of the parties (owner, A/E., contr.)

If the α value (right-tail probability) is less than 0.05 (95%confidence level), null hypothesis is rejected and alternative hypothesis accepted, which means there is significance difference exist between the ranks of the groups for each factors of delay.

All the data were analyzed by the help of SPSS, and excel.

CHAPTER 4

DISCUSSIONS OF RESULTS

4.1 INTRODUCTION

This chapter describes and discusses the results of the study found from data analyses. The results are found as characteristics of the respondents, frequency, severity, and important indices of the individual factors of delay as well as group causes of delay. The correlations between the two respondent groups separately are shown by Spearman's correlation theory. Besides, Kruskal-Wallis correlation is also presented to justify whether significance differences exist among three parties all together. The following sections are discussed about the findings of data analyses.

4.2 CHARACTERISTICS OF THE RESPONDENTS

The construction projects are managed mainly by three parties which are owner, contractor, and consultant. As the playmakers they are the experts who can actually give the answer of the questions raised regarding construction schedule delay. That is why this study conducted a questionnaire survey among them by structured interview. To take interview, 20 owners, 30 contractors, and 20 engineers were selected. Before presenting the result of the data analysis, it is important to know the characteristics of experts such as their age, education level, experiences, and expertise of works which are influential

parameter for accepting their judgments. Next sections discuss briefly about the characteristics of these three stakeholders of construction industry.

The characteristics of the respondent are important to justify their expertise in the corresponding field. In this study, the working experience like how many years they have been working in construction industry as well as what numbers of high-rise structures they constructed, supervised, or developed as contractor, engineer, or owner respectively, were considered during interview survey. Besides, the individual's educational level was also taken into concern because of their understanding about the delay factors. Since the study had three categories of respondents, their characteristics are discussed below separately based on different parameters.

4.2.1 Working Experience

Figure 4.1 shows the number of respondents of different groups and their working experience. Out of 20 owners who were interviewed, 9 owners are involved in construction project less than five years, 9 owners have 5 to 10 years and the other 2 owners have 10 or more years of experience.

Figure 4-1 Respondents working experience (yr)

Among 20 engineers, 3 of them have less than 5 years, 6 have 5 to 10 years and 11 have 10 years of experience to work in construction consultancy and management fields. Most of the respondents from contractors group were highly professional such as 18 of them have been working 10 or more years where rests of them have been working below 10 years. None of them have experience below 5 years. Thus, among the interviewed persons, contractors have found more experienced than others.

4.2.2 Level of Education

The bar diagram (figure 4.2) shows the education levels of the respondents. The survey result shows that educational qualification of contractors in Bangladesh is very poor and most of them don't have Bachelor degree where almost 50% (14 out of 30) are below secondary level of education. Almost similar case is found for owner, for instance, 15 owners are high-school graduate and one of them is university graduate. However, every consultant has bachelor degree except one who is diploma engineer but working more than 10 years as the part of consultant team to supervised construction works.

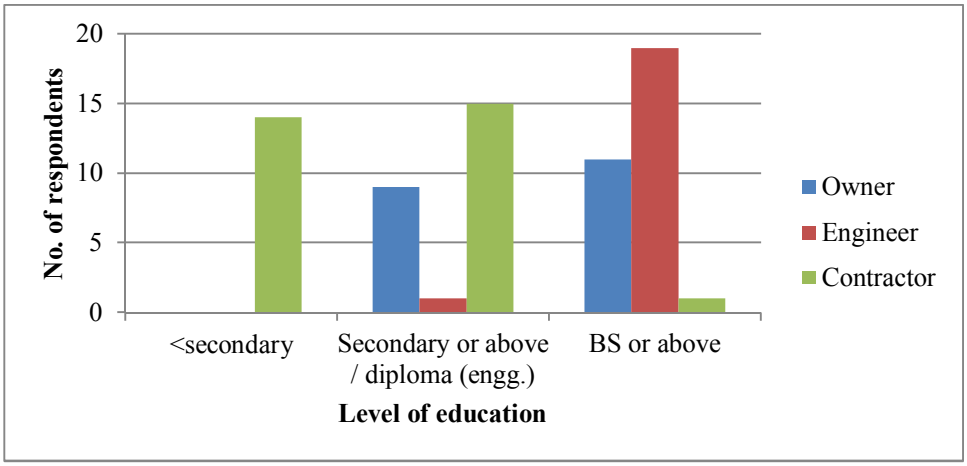

Figure 4-2 Respondent's level of education

4.2.3 Experience in Large Building Construction

Construction experience in large building project was the main focus of the study. That is why, during data collect, it was kept in mind to take interview of the project personnel who have experienced in large project. In this case, finding owner was little bit difficult which lead to choose them as the experienced person of at least completion of one project. Thus, this study took interview of 9 owners having single project experience. Rest of the owners have experienced of developing 5 projects or more. Few of them (4 out of 20) are well established developers and highly professional in respective field. Unlike owners, selected engineers are highly experienced in this field and maximum engineers e.g. 11 out of 20, have management experiences of high-rise building construction projects. Only one data collected from an engineer who has single project experience. Contractors group in this aspect was more advanced such as 22 of them were constructed 5 or more large building and 8 of them were worked less than 5 projects but none of them have single project experience.

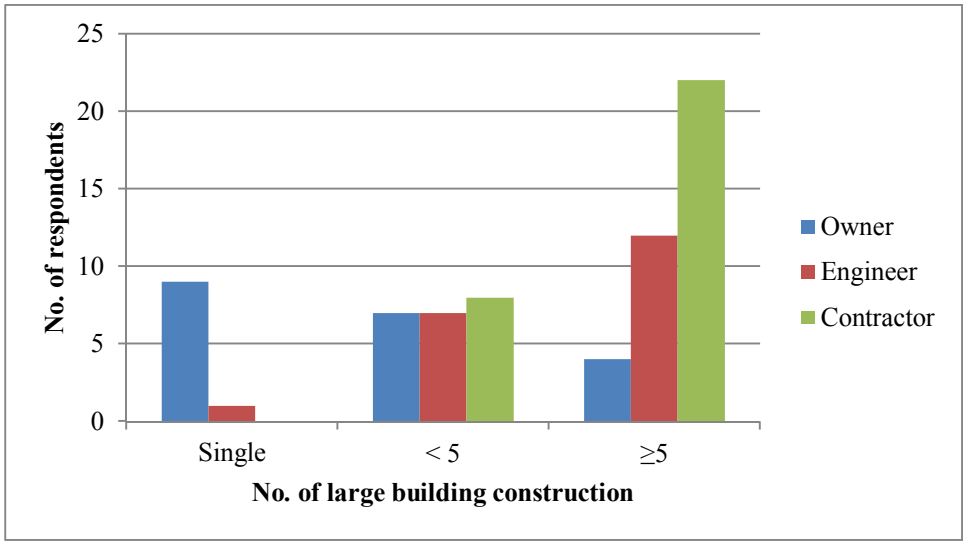

Figure 4-3Respondent's experience in large building construction

4.3 FREQUENCY OF CAUSES OF SCHEDULE DELAYS

This section discusses the delay factors based on the frequency found from the data analysis. To make it clearer, owner, engineer, contractor and all the respondents are grouped and analyzed separately. Since there were 9 factor groups and 79 individual factors of schedule delay, these groups and in individual factors were discussed in distinctly. However, missing data and questions were not answered by at least 70% of the respondents, were excluded from this analysis. Thus, total numbers of factors related questions were reduced into 72. All the factors first ranked based on the calculated frequency index (FI), then FI of a single group which is the mean of sub-factors within the group was calculated. The factors were ranked in two ways such as inside the same group and then among all the individual factors. Based on the indices, causes of schedule delay are classified as always, often, sometime, and rare respectively by the scale of 100

to above 75, 75 to above 50, 50 to above 25, and 25 to less. Following are the details of frequency analysis of the causes of schedule overrun found by the expert interviews.

4.3.1 Owner

It is mentioned above that 20 owners were participated in interview survey and based on their responses in support of frequency of the factors the analysis was done to calculate the frequency index. The results of the analysis are discussed below.

Group factors

Table 4.1shows the frequency indices of 9 group factors. It is found that rules and regulation group has highest 68.58 index value which ranked first followed by contractor, managerial, financing, owner, project, consultant, manpower and resources, and environmental. Among these groups analysis, frequency indices of managerial, financing, and owner groups are very close to each other (i.e. 57.26, 56.3, and 55.13 respectively). Besides, consultant, manpower and resources, and environmental categories also have scored very tight. Category of frequency indicates by the index of each is also shown in the table 4.1. It is discovered that most of the group factors are often to cause delay and three groups for example consultant, manpower and resources, as well as environmental groups are less frequent and sometime claimed for schedule overrun.

TABLE 4-1 Frequency analysis of group factors by owners

Factor group	Index	Rank	Category of frequency
Rules and Regulation	68.58	1	Often
Contractor	62.21	2	Often
Managerial	57.26	3	Often
Financing	56.3	4	Often
Owner	55.13	5	Often
Project	51.29	6	Often
Consultant	47.58	7	Sometime
Manpower and resources	46.89	8	Sometime
Environmental	45.94	9	Sometime

Among the individual group, factors are also ranked by their FI value which is shown in table4.2.Fluctuation in material prices under financial group are recognized as most occurrence causes of delay and its FI is 66.18. Funding shortage by owner, contractor's cash flow problem during construction, and high interest rate/economic rescission/inflation were ranked by the respondent almost same for instance 63.75, 62.50, and 61.25 of FI successively. However, the FI values of other two were considerably lower than their group mates. In owner category, lowest bidder selection is ranked as number one depending on the FI value (i.e. 72.50) followed by lack of proper management, improper feasibility study, mistake in competent consultant selection, frequent change order during construction period, and owner poor contract management etc. In accurate cost estimation found as the top most frequent causes of schedule overrun in contractor group which has FI value 75.00. Besides, improper planning and scheduling, improper progress monitoring and cost control, poor sire management, lack of modern equipment etc. regularly found as the factors in descending order caused by contractors for making project delay. Consultants are alleged by their lack of

responsibility as most frequent cases of delay and FI found 55.00 based on owner responses. Some other common causes of delays in this group are lack of experience, delay in work inspection and approval, error in design, delay in response etc. in downward order. Escalation of resources price is found as number one factor of delay in manpower and resources group whose FI value is 69.12. Other top ranked causes are lack of skilled workers, unskilled operator/technical personal, lack of modern equipment in national market, poor productivity of worker etc. Important note here is that all these factors of manpower and resource group have high index value than factors of consultant, and environmental group. Understanding of project condition is very much important to reduce delay risk in anywhere of the world. In this group site constraints problem is found as the most common causes of delay and its index value is 71.05 which is the biggest figure among the group causes. Other factors such as lack of constructability, obsolete technology, and delay in site clearance in project group are found far away from first one for contributing in schedule delay. Managerial weakness for project management is found as very common in which lack of experience construction manager is ranked top most causes of delay and the index value is also highest 77.50 comparing all the factors. Contractor's excessive workload, conflicts between parties in the site, poor site management, poor contract management are some other stop factors in order of this group according to the owner.

TABLE 4-2 Frequency indices and ranks of top factors under each group by owners

Group factor	Factors	Index	Rank
Financing	Fluctuation in material prices	66.18	1
	Funding shortage by owner	63.75	2
	Contractor's cash flow problem during construction	62.50	3
	High interest rate/Economic rescission/Inflation	61.25	4
	Interference in owner's decisions	44.12	5
	Delays in contractor's progress payment by Owner	40.00	6
Owner	Lowest bidder selection	72.50	1
	Lack of proper management	67.50	2
	Improper feasibility study	61.25	3
	Mistake in competent consultant selection	55.00	4
Contractor	Inaccurate cost estimation	75.00	1
	Improper planning and scheduling	70.00	2
	Improper progress monitoring and cost control	68.06	3
	Poor site management	65.00	4
	Lack of modern equipment	65.00	5
	Lack of relationship between labor and management	64.58	6
Consultant	Lack of responsibility	55.00	1
	Lack of experience	52.50	2
	Delay in work inspection and approval	50.00	3
	Conflict of the drawing and specification	39.29	8
Manpower and Resources	Escalation of resources price	69.12	1
	Lack of skilled workers	66.25	2
	Unskilled operator/technical personal	64.06	3
	Lack of modern equipment in national market	62.50	4
Project	Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	71.05	1
	Lack of constructability	52.78	2
	Obsolete (old) construction methods and technologies to site investigation	52.27	3
Managerial	Lack of experience construction manager	77.50	1
	Contractor's excessive workload	68.75	2
	Conflicts between the parties in the site	63.89	3
	Poor site management	59.62	4
	Poor contract management	55.00	5
Rules and Regulation	Safety rules	77.50	1
	Building permits approval process	65.00	2
	Obtaining permits from municipality	63.24	3
Environment	Adverse weather conditions	62.50	1
	Strike or other problem	46.25	2

Safety is another most frequent issue violated in daily construction activities proved by owner opinion and ranked first in rules and regulation group. Safety factor for construction delay has been found 77.50 FI value as the apex among 72 factors. This group has other two factors followed by building permits approval process, and obtaining permits from municipality and their indices are 65 and 63.24 respectively. Adverse weather conditions are found as the most common cause of delay in environmental group whose index value is 62.50. However, others factors in this group are not much more common regarding frequency value.

Individual factors

Ranking among all 72 causes of delay were done and top 15 factors are presented in the table 4.3based on the frequency index. It is found that lack of experience construction manager, building permits approval process, and safety rules scored same and the FI value is peak of 77.50 and ranked the top most ones. These factors are always found in the sites to cause delay. Inaccurate cost estimation was found as the fourth factor with respect to FI value (75.00) followed by lowest bidder selection by owner, site constraints, improper planning and scheduling, lack of database for estimating activity duration and resources requirement by contractor, escalation of resources price, contractor's excessive workload etc. Next 10 top most frequent factors have found nearest indices value within their couples in order, for example, improper progress monitoring and cost control, and lack of proper management by owner have approximately 68.00 FI value; then lack of skilled workers, and fluctuation in material prices have index value about 66.00 and so on. All these factors are classified as often in frequency scale. Detail results of frequency analysis for all 72 factors are presented inthetable1, appendix B.

TABLE 4-3 Top 15 frequent causes of delay by owner group of respondents

Factor	**Group**	**FI**	**Rank**	**category**
Lack of experience construction manager	Managerial	77.50	1	Always
Building permits approval process	Rules and Reg.	77.50	2	Always
Safety rules	Rules and Reg.	77.50	3	Always
Inaccurate cost estimation	Contractor	75.00	4	Often
Lowest bidder selection	Owner	72.50	5	Often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	71.05	6	Often
Improper planning and scheduling	Contractor	70.00	7	Often
Lack of database for estimating activity duration and resources	Contractor	69.44	8	Often
Escalation of resources price	Man. & Res.	69.12	9	Often
Contractor's excessive workload	Managerial	68.75	10	Often
Improper progress monitoring and cost control	Contractor	68.06	11	Often
Lack of proper management-owner	Owner	67.50	12	Often
Lack of skilled workers	Man. & Res.	66.25	13	Often
Fluctuation in material prices	Financing	66.18	14	Often
Lack of modern equipment	Contractor	65.00	15	Often

FI- Frequency Index

Besides, frequency of top 30 factors are extracted from all the factors under each group and presented in the following bar diagram (figure 4.4). It is very much clear that contractor group is more responsible for delay and 9 causes of this group placed in top 30 most common factors of delay. Then 2nd important group is manpower and resources which has 5 factors in top ranked slot followed by financing, and managerial, owner, and rules and regulation, project, and environmental group where each two groups have same number such as 4, 3, and 1 respectively in this group. No factors of consultant group found in this top rendered delay factors.

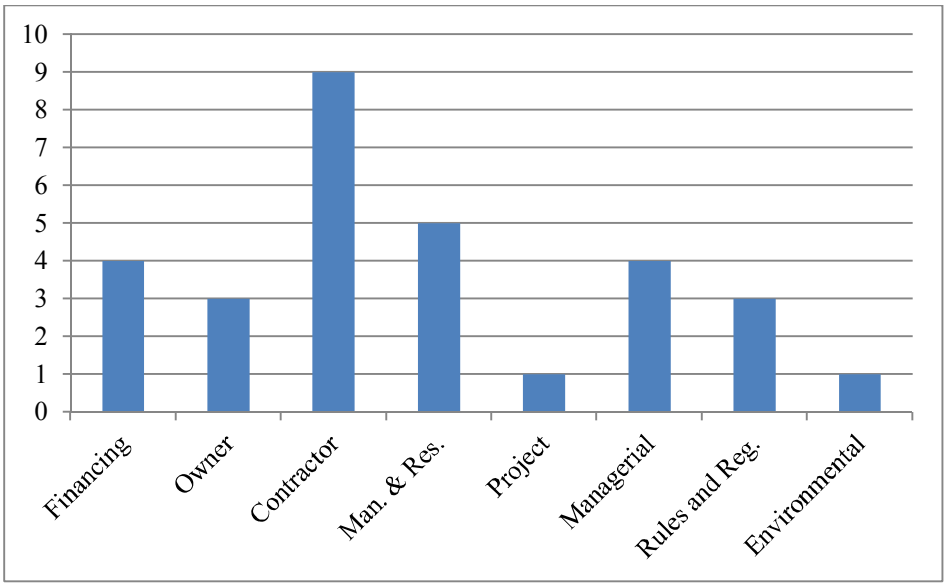

Figure 4-4 Frequency per group from top 30 factors by owner

4.3.2 Engineer

Data found by the interview among 20 engineers were analyzed and calculated the frequency index to rank the variables among the groups and individual factors to find the top frequent causes of delay. Like owner groups, two types of ranking such as factors within the group itself and considering all the factors together have been done. The following sections are briefly discussed the analysis outcomes found by the engineers responses.

Group factors

Table 4.4represents the group frequency index and their positions in order. It is found that contractor group is in the highest rank with 69.06 FI followed by rules and regulation, managerial, owner, financing, project, environmental, manpower and resources, and

consultant. The index value of 2nd to 4th ranked groups have found very close frequency indices and 6th to below groups also have seen almost nearest FI values.

TABLE 4-4 Ranking and category of group factors by engineers responses

Group	**F I**	**Rank**	**Category of the frequency**
Contractor	69.06	1	Often
Rules and Regulation	67.08	2	Often
Managerial	66.67	3	Often
Owner	65.54	4	Often
Financing	63.49	5	Often
Project	56.67	6	Often
Environmental	55.63	7	Often
Manpower and resources	54.91	8	Often
Consultant	54.06	9	Often

All factors under each group is also listed according to the order by their indices and shown in table 4.5.In financial group, interference in owner's decisions are found as high frequent causes of delay and it's index value found 70.96 and fluctuation in material prices is just behind it (FI vale 70.00). Other important causes of delay are fund shortage by owner, contractor's cash flow problem during construction etc. Lowest bidder selection in owner group found as the number one cause of schedule overrun with 81.25 FI, followed by very poor consultancy fee, lack of proper management, improper feasibility study etc. and all of these causes have indices above 70.00. Top five causes of contractor group have very high indices i.e. above 70.00 in which first one is poor site management with same frequency index 81.25 like lowest bidder selection of owner group. Some other top ranked causes of contractor group are lack of modern equipment, improper progress monitoring and cost control, improper planning and scheduling, lack

of appropriate and modern techniques in construction etc. Inaccurate cost estimation and lack of relationship between labor and management have same frequency index like 68.75 and raked at 6th and 7th. Unlike contractor group, most of the factors in consultant group have lower indices. For instance, lack of experience is ranked first with only 63.75 FI, equal to the factor incompetent project team which is ranked 8th in contractor group. Other causes of delay in consultant group in descending order are delay in preparation of shop drawing, conflict between drawing and specification, delay in response, lack of responsibility etc. In manpower and resources group, lack of skilled workers has been scored highest 75.00 FI followed by unskilled operator/technical personal, lack of modern equipment in national market, poor productivity of worker, material changes in types and specification during construction etc. are the frequent causes of delay. Site constraints in project group scored 72.50 FI as highest one and others are not so much frequent in this group. Managerial factors are always found as frequently encountered causes of delay. Lack of experience construction manager has been found as top most common delay with FI value 81.25 in this group and defined as always encountered delay according to the FI scale. Poor site management, contractor's excessive workload, poor coordination among parties etc. are other common causes of delay in descending order. Like owner opinion, engineers also supported the safety issue as number one frequent factor of delay followed by building permits and approval process, and obtaining permits from municipality in rules and regulation group. In environmental group, engineers are coincided on the strike or other political problems as the most frequent causes of schedule overrun and adverse weather conditions positioned just below of it.

TABLE 4-5 Frequency indices and ranks of top factors under each group by engineers

Group factor	Factor	Index	Rank
Financing	Interference in owner's decisions	70.96	1
	Fluctuation in material prices	70.00	2
	Funding shortage by owner	68.75	3
	Contractor's cash flow problem during construction	61.25	4
Owner	Lowest bidder selection	81.25	1
	Very poor consultancy fee	80.00	2
	Lack of proper management	76.25	3
	Improper feasibility study	71.25	4
	Mistake in competent consultant selection	68.75	5
Contractor	Poor site management	81.25	1
	Lack of modern equipment	77.50	2
	Improper progress monitoring and cost control	76.25	3
	Improper planning and scheduling	73.75	4
	Lack of appropriate and modern techniques in construction	72.50	5
	Inaccurate cost estimation	68.75	6
Consultant	Lack of experience	63.75	1
	Delay in preparation of shop drawing	61.25	2
	Conflict of the drawing and specification	56.25	3
Manpower and Resources	Lack of skilled workers	75.00	1
	Unskilled operator/technical personal	67.50	2
	Lack of modern equipment in national market	65.00	3
Project	Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	72.50	1
	Obsolete (old) construction methods and technologies to site investigation	56.25	2
	Inaccurate site investigation	55.00	3
Managerial	Lack of experience construction manager	81.25	1
	Poor site management	73.75	2
	Contractor's excessive workload	72.50	3
Rules and Regulation	Safety rules	77.50	1
	Building permits approval process	62.50	2
	Obtaining permits from municipality	61.25	3
Environment	Strike or other problem	61.25	1
	Adverse weather conditions	60.00	2
	Work accidents	52.50	3
	Abduction/terror force	48.75	4

Individual factors

Ranking based on frequency index by engineer's responses has been done among all 72 delay factors which are show in table 2, appendix Band top 15 factors are shown in the table4.6.Lack of experience construction manager, lowest bidder selection, and poor site management by contractor have been scored highest 81.25 FI. Very poor consultancy fee paid by owner to the consultant has been identified as the most frequent causes of delay and scored just behind them for example 80.00 FI. Similar case like first three causes, occurred for lack of modern equipment, building permits and approval process, and safety issue and they have same frequency index e.g., 77.50. Lack of proper management, and improper progress monitoring and cost control also have same FI of 76.25, and lack of skilled workers got 10th position by scoring 75 according to the engineers judgment. Furthermore, top 9 factors are recognized as always encounter causes of delay in project sites and others are often found.

TABLE 4-6 Top 15 causes of schedule delay by engineer group of respondents

Factors	Group	FI	Rank	Category

Lack of experience construction manager	Managerial	81.25	1	Always
Lowest bidder selection	Owner	81.25	2	Always
Poor site management by contractor	Contractor	81.25	3	Always
Very poor consultancy fee	Owner	80.00	4	Always
Lack of modern equipment	Contractor	77.50	5	Always
Building permits approval process	Rules and Reg.	77.50	6	Always
Safety rules	Rules and Reg.	77.50	7	Always
Lack of proper management	Owner	76.25	8	Always
Improper progress monitoring and cost control	Contractor	76.25	9	Always
Lack of skilled workers	Man. & Res.	75.00	10	Often
Improper planning and scheduling	Contractor	73.75	11	Often
Poor site management by manager	Managerial	73.75	12	Often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	72.50	13	Often
Contractor's excessive workload	Managerial	72.50	14	Often
Lack of appropriate and modern techniques in construction	Contractor	72.50	15	Often

Frequency analysis of the top 30 individual factors falling into main categories have been done and presented in bar chart below (figure 4.5). Like owner responses, engineers are also found contractor group as the highest one who has maximum 9 factors took position in the 30 most frequent causes of delay followed by owner, managerial, manpower and resources, financing, rules and regulation, and project group. Interestingly, environmental group has no factors in this slot and like owner responses no consultant related factor got position in this group.

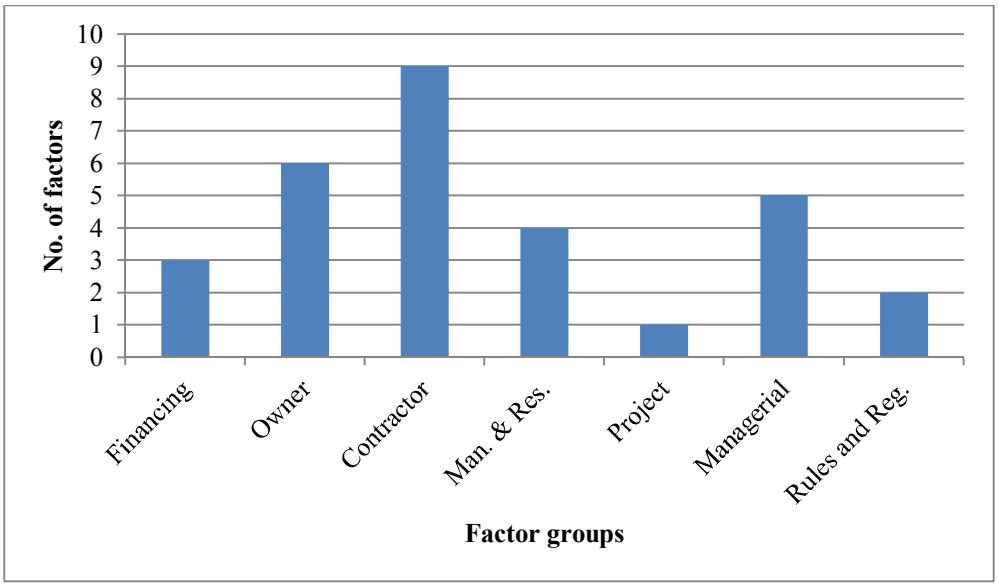

Figure 4-5 Frequency per group in top 30 factors by engineer

4.3.3 Contractor

For the study of construction project delay, 30 contractors of different age and experiences were asked for interview in response of the frequency of the claimed causes. Like owner, and engineer responses, this part was also calculated the frequency indices of the all the individual factors and group factors. Besides, the factors were ranked among them based on FI value and searched the top ranked delay factors and group as well. The following sections are discussed briefly the findings of data analysis response given by contactor in separate way.

Group factors

Frequency indices of the each group are listed in table 4.7. Financing group has been discovered as top most one by the contractors' opinion and its score is 61.23. Second highest group is rules and regulation which scored 58.47 FI, followed by owner,

managerial, contactor, project, manpower and resources, consultant, and environmental groups.

TABLE 4-7 Ranking and category of group factors by contractors' responses

Group	**Frequency Index**	**Rank**	**Category of frequency**
Financing	61.23	1	Often
Rules and Regulation	58.47	2	Often
Owner	57.59	3	Often
Managerial	56.48	4	Often
Contractor	53.70	5	Often
Project	53.31	6	Often
Manpower and resources	51.43	7	Often
Consultant	48.70	8	Sometime
Environmental	47.92	9	Sometime

In each group, individual factors are also ranked based on the frequency index found by contractors' responses and listed in the table 4.8. Among the factors in financing group, interference in owner's decisions for financing found as top ranked causes with FI 74.07. Other frequent factors are contractor's cash flow problem during construction, delay in contractor's progress payment by owner, fluctuation in material prices, fund shortage by owner etc. in order. Lowest bidder selection scored peak like 72.50 FI in owner group. Lack of proper management, very poor consultancy fee paid by owner, frequent change order during construction, mistake in competent consultant selection, poor contract management etc. are the most common factors of delay caused by owner. In contractor group top three causes scored very close such as 62.04, 61.67, and 60 FI respectively by lack of appropriate and modern techniques in construction, improper planning and scheduling, and incompetent project team. Lack of modern equipment and lack of skilled

sub-contractor have been scored same FI index for instance 58.33. Some other important causes of delay in contractor group in context of frequency are improper progress monitoring and cost control, inaccurate cost estimation, poor site management, contractor lack of experience etc. According to contractor responses, most frequent causes of delay in consultant group are lack of experience, delay in preparation of shop drawing, conflict of the drawing and specification, inadequate constructability analysis etc. in order and the FI of those factors are 55.83, 54.17, 54.17, and 52.50 respectively. Another important group is manpower and resources where lack of modern equipment in national market is recognized as the top ranked frequent causes of delay and the FI value has been found as 65.83. Others factors such as unskilled operator/technical person, lack of skilled workers, poor productivity of worker, material changes in type and specification during construction etc. were identified as top causes of delay in order. Site constraints scored highest 65.83 in project group and ranked first. Inaccurate site investigation, obsolete construction methods to site investigation, lack of constructability etc. discovered as most common causes of delay in this group. In case of delay factors in managerial group lack of construction manager scored very high like as 75.83 FI compare to the other factors. Nearest FI found 63.33 for the causes of contractor's excessive workload. Additional causes of delay in this group, for instance, conflict between the parties in the site, insufficient communication between the owner and designer in design phase have been scored same as 54.17 FI, besides, poor contract management, poor site management, and poor material management in the site also scored same like 53.33 FI.

TABLE 4-8 Frequency indices and ranks of top factors under each group by contractors

Group	Individual factors	Index	Rank
Financing	Interference in owner's decisions	74.07	1
	Contractor's cash flow problem during construction	67.50	2
	Delays in contractor's progress payment by Owner	62.50	3
	Fluctuation in material prices	59.17	4
	Funding shortage by owner	55.83	5
Owner	Lowest bidder selection	72.50	1
	Lack of proper management	67.86	2
	Very poor consultancy fee	65.83	3
	Frequent change order by owner during construction	61.67	4
	Mistake in competent consultant selection	57.50	5
Contractor	Lack of appropriate and modern techniques in construction	62.04	1
	Improper planning and scheduling	61.67	2
	Incompetent project team	60.00	3
	Lack of modern equipment	58.33	4
	Lack of skilled/experienced sub-contractor	58.33	5
	Improper progress monitoring and cost control	57.50	6
Consultant	Lack of experience	55.83	1
	Delay in preparation of shop drawing	54.17	2
	Conflict of the drawing and specification	54.17	3
	Inadequate constructability analysis (Impractical design)	52.50	4
Manpower and Resources	Lack of modern equipment in national market	65.83	1
	Unskilled operator/technical personal	60.00	2
	Lack of skilled workers	59.17	3
Project	Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	65.83	1
	Inaccurate site investigation	58.33	2
	Obsolete (old) construction methods and technologies to site investigation	56.03	3
Managerial	Lack of experience construction manager	75.83	1
	Contractor's excessive workload	63.33	2
	Conflicts between the parties in the site	54.17	3
Rules and Regulation	Obtaining permits from municipality	63.33	1
	Building permits approval process	56.25	2
	Safety rules	55.83	3
Environment	Adverse weather conditions	55.83	1
	Strike or other problem	51.67	2

Obtaining permits from municipality ranked first with frequency index 63.33 in rules and regulation group followed by building permits and approval process, and safety rules. Among the factors of environmental group, adverse weather conditions found as most frequent causes of delay. Another important cause of delay in this group is strike or other political issue. There are more two causes related to environment but not common like previous two causes.

Individual factors

Top 15 most frequent causes of delay are shown in the table 4.9 and all the causes of delay are listed in the table 3, appendix B, according to order on the basis of frequency index found by contactor's group of responses. Lack of experience construction manager scored highest 75.83 FI and positioned at the top. Other causes of delay in top ten are interference in owner's decisions, lowest bidder selection, lack of proper management, contractor's cash flow problem during construction, site constraints, very poor consultancy fee paid by owner, lack of modern equipment in national market, contractor's excessive workload, and obtaining permits from municipality successively. Among these ten, high ranked causes of delay 4th and 5th factors have very close FI such as 67.86 and 67.50. Besides, number 6th, 7th, and 8th have same FI like 65.83 as well as 9th and 10th factors have also same FI e.g., 63.33. According to the index scale, only lack of experience construction manager is found always in the industry to cause schedule delay. Other causes are identified as often category of frequency.

TABLE 4-9 Top 15 frequent causes of delay by contractor group of respondents

Individual factors	Group	FI	Rank	Category
Lack of experience construction manager	Managerial	75.83	1	Always
Interference in owner's decisions	Financing	74.07	2	often
Lowest bidder selection	Owner	72.50	3	often
Lack of proper management	Owner	67.86	4	often
Contractor's cash flow problem during construction	Financing	67.50	5	often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	65.83	6	often
Very poor consultancy fee	Owner	65.83	7	often
Lack of modern equipment in national market	Man. & Res.	65.83	8	often
Contractor's excessive workload	Managerial	63.33	9	often
Obtaining permits from municipality	Rules and Reg.	63.33	10	often
Delays in contractor's progress payment by Owner	Financing	62.50	11	often
Escalation of resources price	Man. & Res.	62.50	12	often
Lack of appropriate and modern techniques in construction	Contractor	62.04	13	often
Improper planning and scheduling	Contractor	61.67	14	often
Frequent change order by owner during construction	Owner	61.67	15	often

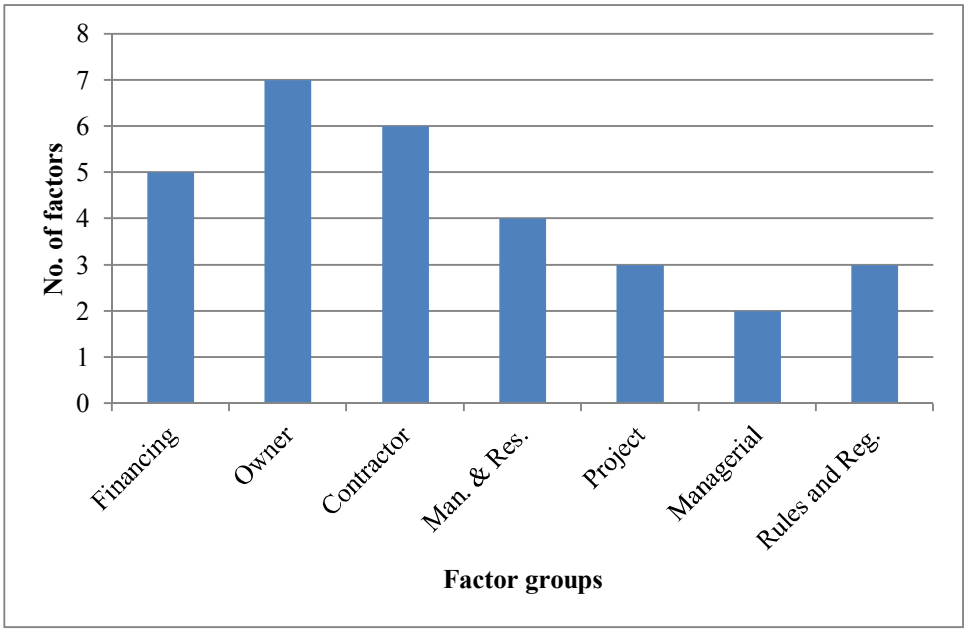

Figure 4-6 Frequency per group in top 30 factors by contractor

The frequency of factors of delay per group within the top 30 factors is presented by the bar chart in figure 4.6.Since at this point, the analysis was only depended on response of contractor, maximum 7 factors from owner group has been found in top 30 causes of delay. In addition, 6 factor from contractor, 5 from financing, 4 from manpower and resources, 3 from both project, rules and regulations groups, along with 2 from managerial groups were placed in this top ranked causes but no factors are found from environmental, and consultant groups.

4.3.4 All Respondent

All the questionnaires (i.e. 70) were analyzed together to find the frequently encountered causes of delay. The frequency indices of all the factors were calculated and the factors were ranked between the groups as well as among all the individual factors. The following sections are discussed the analysis output of all respondents. These parts of discussions also have been focused on both of the group and individual factors.

Group factors

Table 4.10 shows the group frequency index and the corresponding rank of each group. Among 9 groups, rule and regulation group stood first by scoring 63.60 FI, followed by contractor, owner, financing, managerial, project, manpower and resources, consultant and environmental group. It is noticed that the FI of contractor and owner groups are very tight together such as 61.34 and 61.20 respectively. Like them financing and managerial groups also have almost same index value for example 59.98 and 59.83 successively. Other lower frequent groups have been found much less FI than the top five groups.

TABLE 4-10 Ranking and category of group factors by all respondents' responses

Group	Frequency index	Rank	Category of frequency
Rules and Regulation	63.60	1	Often
Contractor	61.34	2	Often
Owner	61.20	3	Often
Financing	59.98	4	Often
Managerial	59.83	5	Often
Project	54.07	6	Often
Manpower and resources	53.12	7	Often
Consultant	51.45	8	Often
Environmental	49.55	9	Sometime

Within the group, individual factors are also raked based on the frequency indices and shown in table 4.11. In financing group, fluctuation in material prices positioned at the top with FI 68.02. Other factors in this group in order are contactor's cash flow problem during construction, funding shortage by owner, delays in contractor's progress payment by owner etc. with FI 66.09, 61.79, and 55.70 respectively. Lowest bidder selection in owner group found as top ranked delay factor and its frequency index strike to 75.00. Then, lack of proper management of this group also has very high FI such as 70.22 which is higher than the first ranked cause of financing group. Additional common causes of delay in owner group are very poor consultancy fee, improper feasibility study, mistake in competent consultant selection etc. Same FI (i.e. 75) found for lack of database for estimating activity duration and resources which is the factor of contractor group and recognized as the top ranked cause. 2nd to 5th causes of delay in this group are improper planning and scheduling, improper progress monitoring and cost control, lack of modern equipment, lack of appropriate and modern techniques in construction. Besides, it is

observed that the FI values of last 3 factors are almost same. Index values of 6th and 7th factors (62.86 and 62.50) of this group are higher than the 4th factor (61.79) of owner group. The top rated factor of consultant group is lack of experience which has FI 57.14 and others are delay in preparation of shop drawing, conflict of the drawing and specification, lack of responsibility etc. However, the 8th factor of contractor group has higher FI like 60.51 than the first one of consultant group. Lack of skilled workers found as the most frequent cause of delay in manpower and resources group and scored highest 65.71 FI and the second factor is escalation of resources price with FI 65.67, almost same to first one. Beyond these two factors, lack of modern equipment in national market, unskilled operator/technical person, poor productivity of worker etc. found as common causes of delay in this group. In project group, the most general factor is site constraint followed by obsolete construction methods and technologies to site investigation, inaccurate site investigation etc. Another important group who can solve many problems in construction projects is managerial group. Lack of experience construction manager has been found as the major cause of delay because due to absence of them proper management system does not exist in the construction project of Bangladesh. It has FI of 77.86, the highest score among all 72 factors. Some other important factors are contractor's excessive workload, poor site management, conflict between the parties in the site etc. in sequence. Although safety should be first to safe life and continuity of work but this is totally violated that is why safety issue in rules and regulation group identified as the first cause of delay with FI 68.21, followed by permits from municipality, and building permits and approval process.

TABLE 4-11 Frequency indices and ranks of top factors under each group by all respondents

Group	Factors	Freq. Index	Rank
Financing	Fluctuation in material prices	68.02	1
	Contractor's cash flow problem during construction	66.09	2
	Funding shortage by owner	61.79	3
Owner	Lowest bidder selection	75.00	1
	Lack of proper management	70.22	2
	Very poor consultancy fee	66.79	3
	Improper feasibility study	61.79	4
Contractor	Lack of database for estimating activity duration and resources	75.00	1
	Improper planning and scheduling	67.50	2
	Improper progress monitoring and cost control	65.81	3
	Lack of modern equipment	65.71	4
	Lack of appropriate and modern techniques in construction	65.23	5
Consultant	Lack of experience	57.14	1
	Delay in preparation of shop drawing	53.68	2
	Conflict of the drawing and specification	51.56	3
Manpower and Resources	Lack of skilled workers	65.71	1
	Escalation of resources price	65.67	2
	Lack of modern equipment in national market	64.84	3
	Unskilled operator/technical personal	63.26	4
Project	Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	69.20	1
	Obsolete (old) construction methods and technologies to site investigation	55.42	2
	Inaccurate site investigation	54.23	3
Managerial	Lack of experience construction manager	77.86	1
	Contractor's excessive workload	67.50	2
	Poor site management	61.11	3
	Conflicts between the parties in the site	60.29	4
Rules and Regulation	Safety rules	68.21	1
	Obtaining permits from municipality	62.69	2
	Building permits approval process	59.91	3
Environment	Adverse weather conditions	58.93	1
	Strike or other problem	52.86	2

Environmental group has always scored lower than other group and most like consultant group. Adverse weather condition is found as the top most frequent cause of delay and scored like 58.93. Other causes of delay in this group in order are strike or other political problem, work accidents, and terror force.

Individual factors

Top 15causes of delay are listed in the table 4.12according to the order based on the frequency index. Lack of experience construction manager in this case found as highest FI such as 77.86. Lowest bidder selection and lack of database for estimating activity duration and resources are ranked 2nd and 3rd with same FI (75.00). Lack of proper management, site constraints, building permits approval process, safety rules, fluctuation in material prices, improper planning and schedule, and excessive workload are other top causes of delay in order. However, analysis found that 6th and 7th factors have been scored same FI like 68.21 and 9th and 10th also scored equal of 67.50 FI. Some other top ranked causes of delay are very poor consultancy fee, contractor's cash flow problem during construction, improper progress monitoring and cost control, lack of modern equipment, lack of skilled workers, escalation of resources price etc. and they are in the position of 11th to 16th respectively. The details of frequency analysis of the causes by all respondents are presented in the table 4, appendix B.

TABLE 4-12 Top 15 frequent causes of delay by all respondents

Individual factors	**Group**	**FI**	**Rank**	**Category**
Lack of experience construction manager	Managerial	77.86	1	Always
Lowest bidder selection	Owner	75.00	2	Often
Lack of database for estimating activity duration and resources	Contractor	75.00	3	Often
Lack of proper management	Managerial	70.22	4	Often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	69.20	5	Often
Building permits approval process	Rules and Reg.	68.21	6	Often
Safety rules	Rules and Reg.	68.21	7	Often
Fluctuation in material prices	Financing	68.02	8	Often
Improper planning and scheduling	Contractor	67.50	9	Often
Contractor's excessive workload	Managerial	67.50	10	Often
Very poor consultancy fee	Owner	66.79	11	Often
Contractor's cash flow problem during construction	Financing	66.09	12	Often
Improper progress monitoring and cost control	Contractor	65.81	13	Often
Lack of modern equipment	Contractor	65.71	14	Often
Lack of skilled workers	Man. & Res.	65.71	15	Often

In addition, frequency of factors of each group in top 30 individual causes were sorted and presented in the bar chart (figure 4.7). Among these most frequent causes of delay, maximum 8 factors are from contractor group, followed by owner, managerial, manpower and resources, financing, rules and regulation, and project group. It is noticed that financing, as well as rules and regulation groups have same number of factors ranked into top 30 causes of delay. Besides, none of the factor of consultant, and environmental groups has such high frequency index to get position into these most common causes of delay.

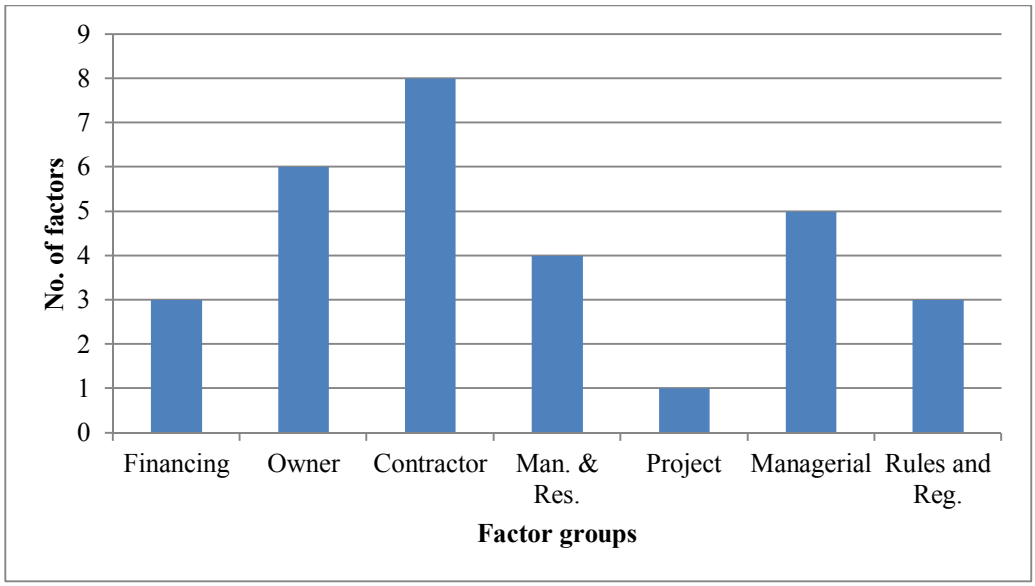

Figure 4-7 Number of factors per group in top 30 frequent factors

4.3.5 Comparison among the Different Respondent Groups

Ranking of different factor groups by the responses of owner, engineer, contractor, and all respondents are presented in the table 4.13. Almost top five factors according to the judgment of both owner and engineer groups are found as similar except little rearrangements such as factors in rules and regulation group is the most common problem and stood at first and engineer group identified this as the 2nd common group of causes of delay. However, in both respondents found managerial as 3rd most frequent causes of delay. Owner and financing related factors of delay found 4th and 5th ranks by owner group and engineer group recognized these factors as just altered the positions. Project and 'manpower and resources' groups have been found as same position as 6thand 8th successively by both groups of respondents, but other two groups such as consultant and environmental found as the change of the position for instant, 7th and 9thvice versa. Both similarity and dissimilarity are found by the ranking of engineer and contract group

of respondents such as both groups recognized rules and regulation factors as 2nd common causes of delay but they are far away from each other to identify the frequency of contractor group of delay e.g., engineers are marked this group of factors as the first or most frequent causes but contractors mentioned their problems as the 5th common factors of delay. Likewise, engineers thought that financing factors are 5th ranked causes but contractors identified this group as the most frequent causes of delay and ranked first according. However, both groups have been indentified that project factors have the same frequency regarding the cause of schedule overrun. Beside, ranking by all respondents group is more similar with owner, and engineer groups. For instance, top five group causes are found more or less same by the three respondent groups with very little disorder. Moreover, it is noticed that the FI which are calculated by the answers of the respondent like owner, engineer, and all respondents found very close to each other for individual groups but contractor group scored comparatively lower than others.

TABLE 4-13 Ranking of group causes based on different categories of respondents

Group	**Owner**		**Engineer**		**Contractor**		**All respondent**	
	F I	Rank	F I	Rank	F I	Rank	F I	Rank
Rules and Regulation	68.58	1	67.08	2	58.47	2	66.37	1
Contractor	62.21	2	69.06	1	53.7	5	61.34	2
Managerial	57.26	3	66.67	3	56.48	4	59.83	4
Financing	56.3	4	63.49	5	61.23	1	59.68	5
Owner	55.13	5	65.54	4	57.59	3	61.12	3
Project	51.29	6	56.67	6	53.31	6	54.07	6
Consultant	47.58	7	54.06	9	48.7	8	51.45	8
Manpower and resources	46.89	8	54.91	8	51.43	7	53.55	7
Environmental	45.94	9	55.63	7	47.92	9	49.55	9

Figure 4.8 shows the overall scenario of group causes according to the FI and comparison of different respondent groups at a glance. Bar chart demonstrates that the engineer group of respondents was scored highest all of the causes groups beyond rules and regulation. Other respondent's judgments were fluctuating with respect to the causes of schedule delay. For example, rules and regulation group has the highest average score of more than 60.00 and contractor, managerial, financing, and owner groups have been scored most likely as close to 60.00. Furthermore, project along with manpower and resources group have FI on average 55. Environmental and consultant groups have FI just below 50 and got lowest position unanimously.

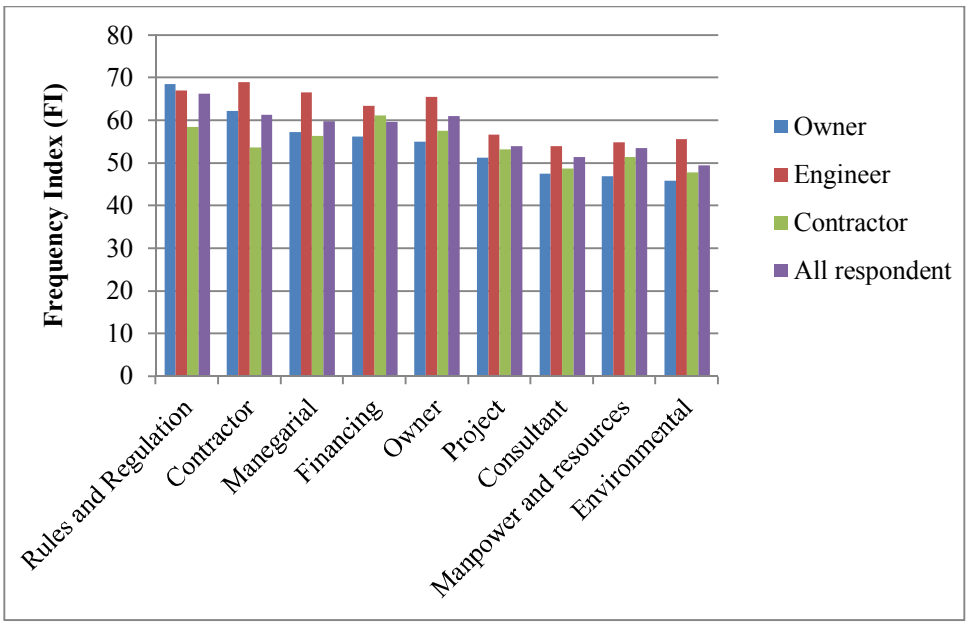

Figure 4-8 Group FI based on different respondents

4.3.6 Finding summary as the categories of the causes regarding frequency

The frequency of the factors of delay was classified as always, often, sometime, and rare give by the point of 4, 3, 2, and 1 respectively during the questionnaire survey and asked the respondent to mark the factors according to the weight of frequency they encountered in the field. In this section the causes of delay also are also categorized like survey question as always, often, sometime, and rare but in different scale like as 100 to just above 75, 75 to just above 50, 50 to just above 25, and 25 to 0 in order to conclude about the factors of delay based on the frequency index found by data analysis. Since the data were analyzed for 4 groups such as owner, engineer, contractor, and all respondents, the findings are also presented for all the groups in the bar chart below (figure 4.9). The figure shows as the percentage of causes of delay fallen in different categories with respect to the judgment of different groups. The analysis shows that most of the causes are often frequent in the field to cause the schedule overrun regardless of respondent groups. For instance, according to all respondents, 79.17% of causes are often claimed for delay. Other groups such as engineers identified 77.46%, contractor 67.61%, and owner 54.17% of causes as often frequent. There are some causes of delay which are always disturbing project schedule and the percentage of such causes is maximum 12.68% experienced by the contractor but other groups found very poor percentage like 1 to 4%. Owner experienced about 40% of factors and contractor thought 30% of factors are sometime frequent as the causes of delay, however, engineers found these category of causes of delays are very few like 10%. Considering all the respondents, this category of delay found approximately 20%. Very few percentages of factors recognized as always

frequent say 1 to 5% by different groups and only exception found by the engineer responses, they thought about 13% of delay factors are fallen in this group.

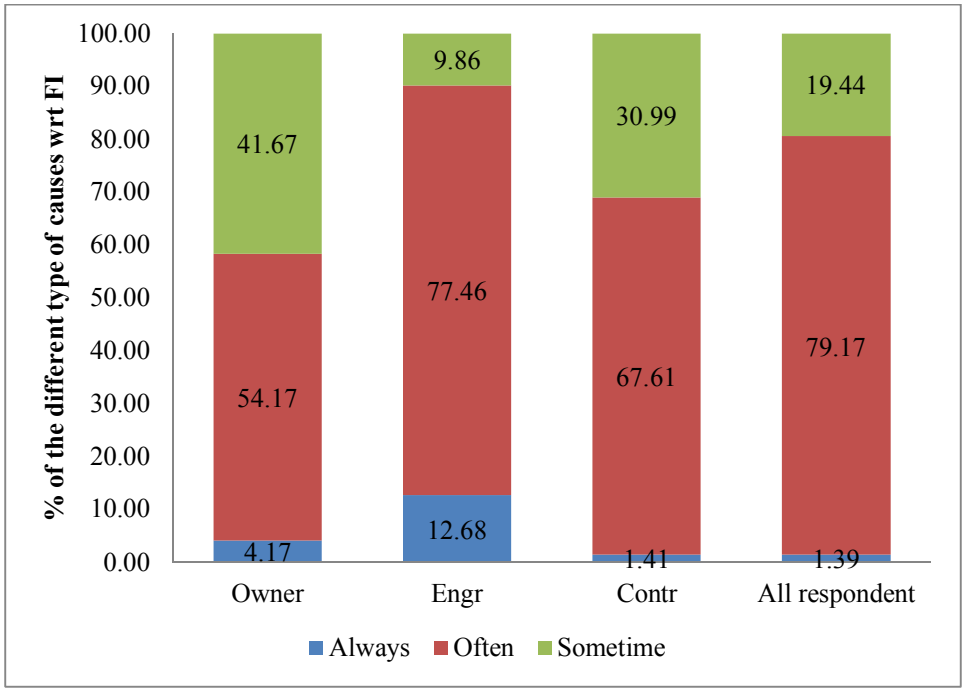

Figure 4-9 Different category of frequent causes by respondent groups (%)

4.4 Severity of Causes of Schedule Delays

Severity regarding level of impact to schedule overrun by the factors was determined also by analyzing quantitative value of the data found the interview survey. Like frequency, during severity analysis, data were clustered into four ways such as owner, engineer, contractor, and all respondents group of responses. Separate examination has been done to quantify the severity indices (SI) of all the factors of delay and subsequently for the groups. Then the individual causes of delay were ranked in descending order by the SI value in two ways such as among all the factors and within the group itself. Besides, main categories of delay also were arranged in descending order based on the SI of the group

causes. The severity index is defined by the scale like extreme, great, moderate, and little for 100 to just above 75, 75 to just above 50, 50 to just above 25, and 25 to 0. The following sections briefly discuss the outcomes of the data analysis.

4.4.1 Owner

To find out the severity of the causes of delay, survey data of 20 owners were analyzed together by using the equation mentioned in the methodology part of this study. By this analysis severity index of individual causes as well as each group factors were determined. Then the factors were ranked according to the order. Followings are the brief details of the results of data analysis.

Group factors

Table 4.14 shows the severity index and the corresponding rank of each group. Contractor group of causes was acknowledged to the most significant one with scoring 68.49 SI followed by Rules and regulation, managerial, financing, project, owner, consultant, manpower and resources, and environmental group. Among them, rules and regulation, managerial, and financing groups have been scored nearly same severity indices of 66.50 to 67.00; Project and owner groups scored close to 64.50; consultant, as well as manpower and resources groups also scored very similar like 58.35. Environmental group is the lowest sever factor according to SI and its score is 57.81.

TABLE 4-14 Ranking and category of group factors by owners' responses

Group factors	**Index**	**Rank**	**Category of severity**
Contractor	68.49	1	great
Rules and Regulation	66.99	2	great
Managerial	66.36	3	great
Financing	66.35	4	great
Project	64.68	5	great
Owner	64.42	6	great
Consultant	58.42	7	great
Manpower and resources	58.27	8	great
Environmental	57.81	9	great

Within each group, factors are ranked in order to the largest index to the smallest and shown in table 4.15.In such case, funding shortage by owner found as the top most significant cause of delay in financing group and its SI is 81.25. It means funding shortage by owner in this group has the highest records of causing schedule delay. It can be suspended or even terminated the work in its incomplete stage. The next serious cause of delay related to financing is high interest rate/economic rescission/inflation which scored 73.75 SI. Other important causes of delay are contractor's cash flow problem during construction, fluctuation in material prices, and interference in owner's decisions if there is multiple owners exist etc. Lowest bidder selection found as the most sever cause of delay in owner group with SI of 72.50. Besides, lack of proper management, improper feasibility study, mistake in competent consultant selection, frequent change order etc. in order are the top causes of delay from owner side. Inaccurate cost estimation, improper planning and scheduling, improper progress monitoring and cost control, poor site management, lack of modern equipment etc. in descending order found as the most significant causes of delay which are happened by contractor. Like frequency indices, the

causes of consultant group also have the less severity indices on average. In this group lack of constructability is recognized as the top most factor of delay followed by lack of experience consultants, delay in work inspection and approval etc. If the construction raw materials are mostly imported and the national economy is fallen down, escalation of resource price is a common phenomenon. Besides, there are peaks and off-peak seasons for laborers and materials. High demand of these manpower and resources leads to scarcity and subsequently raises the price. At that time most of the investors in this field influence the contractor to slow the work. Thus, owner group of respondents found that escalation of resources price is the number one factor of extending the project schedule and its SI is 69.12 in manpower and resource group. The other significant factors of this category in downward order are lack of skilled worker, unskilled operator/technical person, lack of modern equipment in national market, poor productivity of worker etc. In project group, site constraints is found as the most significant factor of delay and its SI value 71.50 which is so larger than other factors of this group. Good project manager is unfortunately very few in Bangladesh, proved by the expert's opinion because, lack of experience construction manager in managerial group scored enormously high i.e. 77.50, compare to any other factors. Besides, contractor excessive workload, conflicts between parties, poor site management, poor contract management etc. are the most significant factors in this group and these problems can be solved by professional project manager (PPM). Although, "safety first" is a common slogan in construction project all over the world but this are mostly violated by the contractors in Bangladesh. Thus owners identified this issue as one of the top causes of delay and top ranked cause in rules and regulation group.

TABLE 4-15Severity indices and ranks of top factors under each group by owners

Group	Individual Factor	Index	Rank
Financing	Funding shortage by owner	81.25	1
	High interest rate/Economic rescission/Inflation	73.75	2
	Contractor's cash flow problem during construction	65.00	3
Owner	Lowest bidder selection	80.00	1
	Lack of proper management	73.68	2
	Improper feasibility study	70.00	3
	Owner's poor contract management	65.91	4
	Mistake in competent consultant selection	65.00	5
Contractor	Inaccurate cost estimation	82.50	1
	Lack of experience	79.17	2
	Improper planning and scheduling	75.00	3
	Improper progress monitoring and cost control	70.83	4
	Lack of relationship between labor and management	70.83	5
	Lack of modern equipment	70.00	6
Consultant	Lack of responsibility	70.00	1
	Inadequate constructability analysis (Impractical design)	69.23	2
	Lack of experience	68.75	3
	Delay in response	58.82	4
Manpower and Resources	Transportation problem	81.25	1
	Escalation of resources price	76.47	2
	Lack of skilled workers	68.75	3
	Unskilled operator/technical personal	65.63	4
	Poor productivity of worker	65.63	5
Project	Obsolete (old) construction methods and technologies to site investigation	79.55	1
	Lack of constructability	77.78	2
	Change in site condition (i.e, soil report is found different when starting work)	63.89	3
Managerial	Lack of experience construction manager	77.50	1
	Poor site management	73.08	2
	Poor material management at site/procuring	67.86	3
	Poor contract management	67.50	4
	Poor coordination among parties	66.07	5
Rules and Regulation	Safety rules	68.75	1
	Building permits approval process	67.50	2
	Obtaining permits from municipality	64.71	3
Environment	Adverse weather conditions	71.25	1
	Work accidents	55.00	2

Other factors important factors in this group are building permits and approval process, and obtaining permits from municipality. It is noticed that the SI of all the factors in this group are so high like 77.50, 65, and 63.24 respectively. Adverse weather condition in environmental group is considered as the most significant cause for schedule overrun and scored 62.50. Other factors under environment have very low SI values and not so important to cause delay.

Individual factors

Table 4.16shows the severity indices of top 15individual factors of delay and the corresponding ranks according to order where table 5 in appendix B shows the list of all factors. Inaccurate cost estimation found as the top most causes of delay with SI of 82.50. Funding shortage by owner, and transportation problem have been scored 81.25 SI and kept in position 2nd and 3rd. Besides, lowest bidder selection, obsolete construction methods to site investigation, lack of experience, lack of constructability, lack of experience construction manager, escalation of resources price, and improper planning and scheduling are the top ten causes of construction delay.

TABLE 4-16 Top 15severe causes of delay by owner

Factors	Group	SI	Rank	Category of severity
Inaccurate cost estimation	Managerial	82.50	1	Extreme
Funding shortage by owner	Financing	81.25	2	Extreme
Transportation problem	Man. & Res.	81.25	3	Extreme
Lowest bidder selection	Owner	80.00	4	Extreme
Obsolete (old) construction methods and technologies to site investigation	Project	79.55	5	Extreme
Lack of experience	Contractor	79.17	6	Extreme
Lack of constructability	Project	77.78	7	Extreme
Lack of experience construction manager	Managerial	77.50	8	Extreme
Escalation of resources price	Man. & Res.	76.47	9	Extreme
Improper planning and scheduling	Contractor	75.00	10	Great
High interest rate/Economic rescission/Inflation	Financing	73.75	11	Great
Lack of proper management	Owner	73.68	12	Great
Poor site management by manager	Managerial	73.08	13	Great
Adverse weather conditions	Environmenta l	71.25	14	Great
Improper progress monitoring and cost control	Contractor	70.83	15	Great

All these factors have SI value more than 75 which mean they are identified as extreme causes and may terminate or suspend the project work for certain period of time. Moreover, all other causes beyond last three have SI in the range of 75 to above 50 and indicated as the great significant factors of delay.

The top 30 factors are categorized in their respective group and a bar diagram is presented below (4.10) based on the frequency of the factors. Above figure shows the most significant factors exist in the contractor group. There were 13 factors in this group from where 8 factors are in the top 30 causes of delay. Then the managerial group which has 5 factors in this top ranked cluster followed by manpower and resources (4), owner,

consultant (3 for each), financing, project, rules and regulation (2 for each) and environmental group. However, only one factor of environmental group such as adverse weather condition is found in these most significant causes. Thus contractors involvement causes have been identified most sever to delay the predefined schedule experienced by owner.

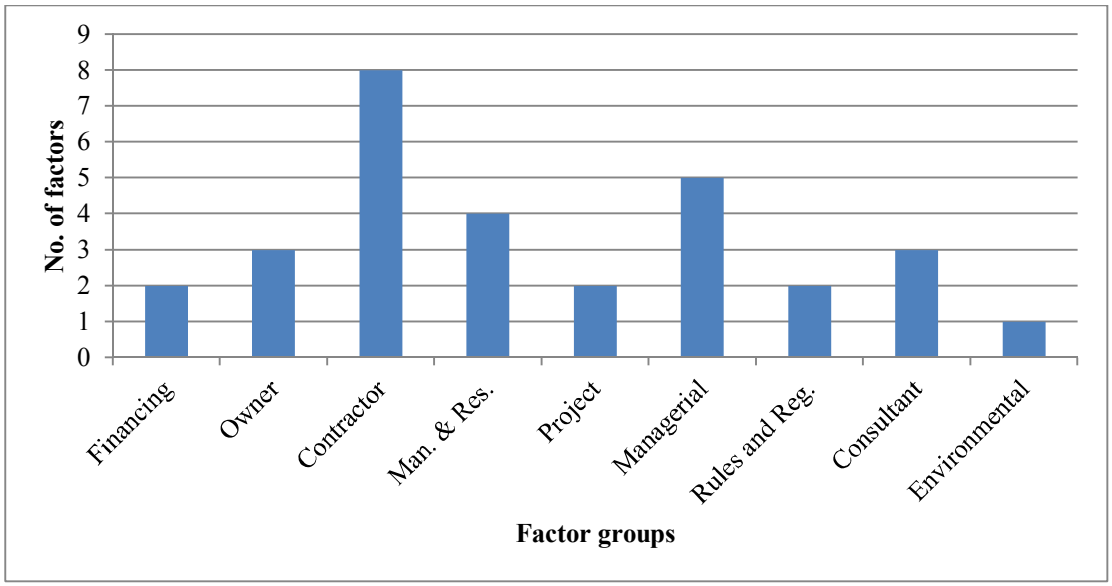

Figure 4-10 Number of factors per group in top 30 severe factors by owner

4.4.2 Engineer

Like frequency analysis, severity of the causes of delay also has been analyzed for the data found by engineer's interview. Severity index of all the factors were calculated and then SI of each group factor also determined. Based on these indices, ranking among the group factors as well as the individual factors have been done. For individual factors, two types of ranking are presented such as within in the same group and among all the factors. The following sections are briefly discussed the findings of engineers judgment regarding severity analysis.

Group factors

Table 4.17showsthe SI of each group causes and the ranks according to order. In this regard, contractor group has the highest SI of 65.31 followed by managerial, financing, owner, rules and regulation, project, manpower and resources, environmental, and consultant. Among these groups managerial, financing, and owner have almost similar indices like 64.72, 64.39, and 64.29 respectively. Hence, all the group causes are "great severe" according to the index scale.

TABLE 4-17 Severity analysis of group factors by engineers responses

Group factors	**Index**	**Rank**	**Category of severity**
Contractor	65.31	1	great
Managerial	64.72	2	great
Financing	64.39	3	great
Owner	64.29	4	great
Rules and Regulation	62.08	5	great
Project	58.96	6	great
Manpower and resources	55.36	7	great
Environmental	54.38	8	great
Consultant	53.44	9	great

Severity indices of the individual factors under the each group also enlisted in the table 4.18.It also shows the rank of the causes in the single group. In financing group, funding shortage by owner is the top severe factor with a very large SI 86.25 and this score is defined as the extreme to cause the schedule overrun. Other factors in this group are interference in owner's decisions, contractor cash flow problem during construction, delays in contractor's progress payment by owner etc. and these factors have SI within the range of over 50 and 75 which means they have great impact on schedule break. Next group owner, in which lowest bidder selection is the top most factors of delay and it's SI

78.75,and it is meant extremely significant in the construction industry due to project delay. Lack of proper management, very poor consultancy fee, improper feasibility study, mistake in competent consultant selection etc. is also important causes of delay in order. These causes have very high SI like 70 to 75 which demonstrated that the factors have great impacts on schedule delay. Rest of the factors in this group are also scored above 50 SI except the last one like delay to deliver owner furnished properties which has SI 40.91. Thus, most of the factors of the group are very sever in this aspect. Improper planning and scheduling is scored maximum 75 in contractor group followed by improper progress monitoring and cost control, lack of experience, poor site management, lack of modern equipment, lack of appropriate and modern technique in construction etc. in descending order. These are also categories as great in severity of delaying the project. It is noticed that the last three causes have same SI of 66.25. Besides, all other causes in this group have more than 50 SI which indicates the consequence of causing project delay by this group. Not only that, its maximum factors are in the range of 60 to 70 severity indices which ensured the importance of this party (contractor) to take special consideration for solving delay issue. Lack of experience consultant is a common problem found by the engineers themselves and this factor has highest SI of 63.75. Other factors of delay in this group have the score of near about 50. Although these figures indicates great impact according to the index scale but not so much like previously discussed group. Some other important causes in this group are delay in preparation of shop drawing, delay in response, conflict of the drawing and specification etc. Lack of skilled workers in manpower and resources group is found the number one cause and it has the largest SI e.g., 77.50 and having this score indicates the factor is extremely significant to do project

delay. Unskilled operator/ technical person, material shortage, lack of modern equipment in national market are some other important causes of delay in this group which have SI range of 60 to 65 and can be defined as the type “great severe” for schedule delay. In project group, site constraints scored highest of 67.50 followed by inaccurate site investigation, lack of constructability etc. All the factors in this group have great significance with an exception of delay in site clearance. Managerial causes of delay are very much significant because proper management team may solve so many problem of construction industry. Lack of professional construction manager in this group found as extreme factor of delay with a SI of 78.75. Poor site management and poor contract management have same SI such as 68.75 and took position of 2nd and 3rd. Besides, all other factors in this group have SI of more or slightly less 60.0. This situation of high average score showed the great severity of the causes of delay by managerial factors. All the three factors of rules and regulation group scored almost same like 61 to 64 and are fallen into great severity class. Adverse weather condition of environmental group found as the biggest SI value of 66.25 within the same group and work accident is also considerable factors of delay here. But other two factors in this group are not so severe of making delay at construction project.

TABLE 4-18 Severity indices and ranks of top factors under each group by engineers

Group	Individual Factor	Index	Rank
Financing	Funding shortage by owner	86.25	1
	Interference in owner's decisions	66.32	2
	Contractor's cash flow problem during construction	62.50	3
	Delays in contractor's progress payment by Owner	60.00	4
Owner	Lowest bidder selection	78.75	1
	Lack of proper management	75.00	2
	Very poor consultancy fee	70.00	3
	Improper feasibility study	70.00	4
	Mistake in competent consultant selection	68.75	5
Contractor	Improper planning and scheduling	75.00	1
	Improper progress monitoring and cost control	72.50	2
	Lack of experience	67.50	3
	Poor site management	66.25	4
	Lack of modern equipment	66.25	5
Consultant	Lack of experience	63.75	1
	Delay in preparation of shop drawing	56.25	2
	Delay in response	53.75	3
Manpower and Resources	Lack of skilled workers	77.50	1
	Unskilled operator/technical personal	65.00	2
	Material shortage	62.50	3
	Lack of modern equipment in national market	61.25	4
	Material changes in types and specification during construction	57.50	5
Project	Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	67.50	1
	Inaccurate site investigation	62.50	2
	Lack of constructability	58.75	3
Managerial	Lack of experience construction manager	78.75	1
	Poor site management	68.75	2
	Poor contract management	68.75	3
	Conflicts between the parties in the site	65.00	4
Rules and Regulation	Obtaining permits from municipality	63.75	1
	Safety rules	61.25	2
	Building permits approval process	61.25	3
Environment	Adverse weather conditions	66.25	1
	Work accidents	51.25	2
	Strike or other problem	50.00	3

Individual factors

Table6 in appendix B shows the outcome of the severity analysis where individual factors of delay are arranged in descending order based on the severity indices and table 4.19 shows the most 15significance causes of delay. It is discovered that funding shortage by owner has the maximum SI of 86.25. After this, the two consecutive factors such as lack of experience construction manager, and lowest bidder selection have found same index e.g., 78.75. Problem like lack of skilled works also has been encountered in the running project to delay schedule which has very high SI. All these causes have indices more than 75 which means extremely severe for schedule overrun.

TABLE 4-19 Top most severe causes of delay by engineers

Factor	**FI**	**Rank**	**Group**	**Category**
Funding shortage by owner	86.25	1	Financing	Extreme
Lack of experience construction manager	78.75	2	Managerial	Extreme
Lowest bidder selection	78.75	3	Owner	Extreme
Lack of skilled workers	77.50	4	Man. & Res.	Extreme
Lack of proper management	75.00	5	Owner	Great
Improper planning and scheduling	75.00	6	Contractor	Great
Improper progress monitoring and cost control	72.50	7	Contractor	Great
Very poor consultancy fee	70.00	8	Owner	Great
Improper feasibility study	70.00	9	Owner	Great
Poor site management by contractor	68.75	10	Contractor	Great
Mistake in competent consultant selection	68.75	11	Owner	Great
Poor contract management	68.75	12	Managerial	Great
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	67.50	13	Project	Great
Lack of experience	67.50	14	Contractor	Great
Interference in owner's decisions	66.32	15	Financing	Great

Moreover, lack of proper management by owner, improper planning and scheduling by contractor, improper progress monitoring and cost control, very poor consultancy fee paid by owner, improper feasibility study at the project development phase, and poor site management by contractor are some other top ten causes of delay. These factors have severity indices on average 70. Other causes of delay specifically those are in the position up to 43 they have the SI of more than 60 which clearly demonstrated the great severity to contribute project delay. Besides, except last 10 causes of delay, rest of the factors have the SI 51 to 60 and these factors are also severe and need to take attention for successful project.

Another analysis is done for top 30 causes of delay such as frequency of the individual factors fall into each category of main group is counted and present by the bar chart shows in figure 4.11. It is found that contractor group has highest 10 factors in this top 30 causes. Owner, managerial, along with manpower and resources group have good number of causes in this category for example, 6, 5, and 3 factors respectively. Other groups have one or two factors and they are comparatively less severe than top 4 groups.

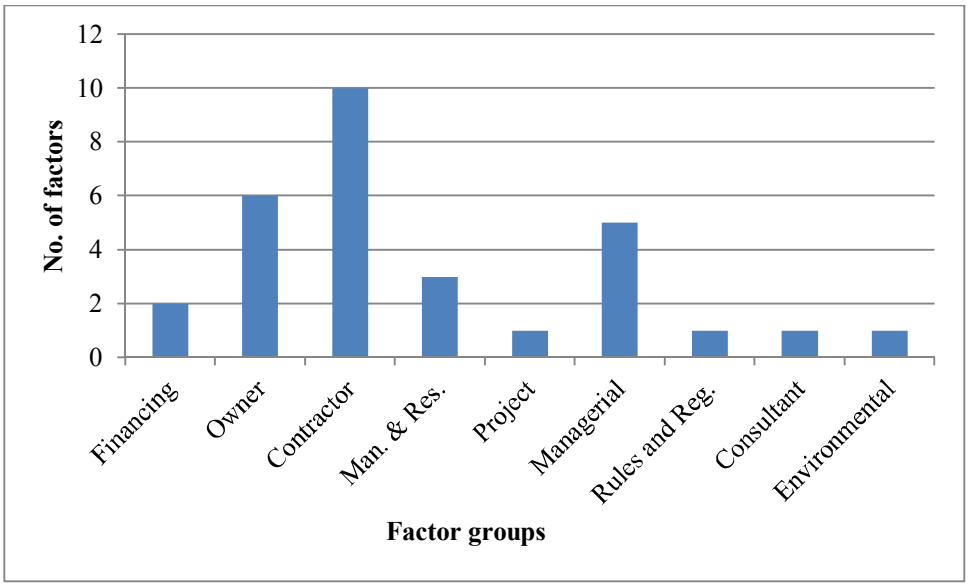

Figure 4-11 Number of factors per group in top 30 significant factors

4.4.3 Contractor

Like frequency, severity analysis also has been done for contractor group of responses. Severity indices for all factors were calculated and then arranged according to the order. In this case, the ranking has been done in both ways like as within the group and among all the factors. Based on the index, the factors are also classified as extreme, great, moderate, and little severe and the scale for this grouping is defined earlier. The following sections discuss the result of the analysis by two ways such as group factors and individual factors.

Group factors

Severity index of each group of causes of delay is calculated as an average of the factors of the group and then arranged according to order which is shown in the table4.20.Contractorsdiscovered financing group is the most severe causes of delay and the average score is 69.13. Managerial group is in second position followed by owner,

project, rules and regulation, contractor, manpower and resources, environmental, and consultant. Interestingly, all the groups have SI of above 50 but below 75, which means all the groups have great impacts on schedule overrun according to the scale. However, environmental and consultant groups have considerably lower SI than others. Besides, the groups in the rank of 3 to 7 have very similar indices and claimed great severe to delay the projects.

TABLE 4-20 Severity analysis of group factors by contractors' responses

Group factor	**Index**	**Rank**	**Category of severity**
Financing	69.13	1	great
Managerial	63.33	2	great
Owner	58.74	3	great
Project	58.01	4	great
Rules and Regulation	57.34	5	great
Contractor	57.33	6	great
Manpower and resources	56.58	7	great
Environmental	53.13	8	great
Consultant	52.99	9	great

Individual factors are arranged among the group itself and shown in table 4.21. In financing group, funding shortage by owner is found as top most one with SI 86.67 followed by interference in owner's decisions, contractor's cash flow problem during construction, delays in contractor's progress payment by the owner etc. The first two causes in this group have SI more than 75 which can be defined as extremely severe to cause schedule break and all other factors in this group have more than 50 SI, recognized as great severity by the contractor's evaluation. In owner group, improper feasibility study and lowest bidder selection are the most severe causes of delay and their indices are 70.83, and 70, very close each. Some other important causes in this group are lack of

proper management, very poor consultancy fee, frequent change order, owner's poor contract management etc. Only two causes in owner group has the SI of 50 or lower and there is no cause with SI above 75.Thus, findings indicate that most of the factors in this group have great but not extreme impacts on schedule expansion. Top 8 causes of delay in contractor group have the SI of near about 60 in which improper planning and scheduling is the top most one with SI 63.33. Other severity causes of delay in this group are lack of modern equipment, inaccurate cost estimation, lack of appropriate and modern techniques in construction, lack of experience etc. Lack of experience also found major cause of delay in consultant group having severity index 61.67 where for same cause, contractor's index was 60.83. Thus it is recognized as the great severity cause for both groups for delay. Delay in preparation of shop drawing, inadequate constructability analysis, conflict of the drawing and specification etc. successively identified as some other most significant causes of delay in consultant group. Top five causes of manpower group are lack of modern equipment in national market, lack of skilled workers, unskilled operator/ technical personal, material change in type and specification during construction, and shortage of equipment in downward order and the severity indices for these factors are in the range of 57 to 71. For these high severity indices, the factors are identified as the great significant for delay. Besides, at least first 12 causes of this group have above 50 SI, therefore this group can be claimed as most severe to contribute schedule enlarge. Site constraints, obsolete construction methods and technologies to site investigation, lack of constructability found as the top causes of delay in project group and they have average severity indices of 60. The most severity factor of managerial group is lack of experience construction manager and score highest of 78.33 followed by

contract related disputes, contractor excessive workload, poor contract management etc. The first factor is considered as the extreme cause and all other factors in this group have indices between 50 to75 and have to be credited as great severity for delay. Furthermore, all causes of rules and regulation group have SI greater than 50 but less than 60 and this condition can also be defined as great severe to project delay. Adverse weather conditions in environmental group have largest index value e.g., 65.83 and its nearest factor (SI 52.50) is strike or other political problem, causing schedule delay for the construction project. Both of these factors also severe and should have to consider in project schedule.

TABLE 4-21 Severity indices and ranks of top factors under each group by contractors

Group	Individual Factor	Index	Rank
Financing	Funding shortage by owner	86.67	1
	Interference in owner's decisions	84.80	2
	Contractor's cash flow problem during construction	70.00	3
Owner	Improper feasibility study	70.83	1
	Lowest bidder selection	70.00	2
	Lack of proper management	64.29	3
	Very poor consultancy fee	61.67	4
Contractor	Improper planning and scheduling	63.33	1
	Lack of modern equipment	62.50	2
	Inaccurate cost estimation	62.50	3
	Lack of appropriate and modern techniques in construction	61.11	4
	Lack of experience	60.83	5
Consultant	Lack of experience	61.67	1
	Delay in preparation of shop drawing	60.83	2
	Inadequate constructability analysis (Impractical design)	60.00	3
Manpower and Resources	Lack of modern equipment in national market	70.83	1
	Lack of skilled workers	67.50	2
	Unskilled operator/technical personal	65.00	3
	Material changes in types and specification during construction	58.33	4
Project	Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	67.50	1
	Obsolete (old) construction methods and technologies to site investigation	60.34	2
Managerial	Lack of experience construction manager	78.33	1
	Contract related disputes/claim	69.17	2
	Contractor's excessive workload	68.33	3
	Poor contract management	63.33	4
	Conflicts between the parties in the site	62.50	5
Rules and Regulation	Obtaining permits from municipality	58.33	1
	Safety rules	58.33	2
Environment	Adverse weather conditions	65.83	1
	Strike or other problem	52.50	2
	Work accidents	50.00	3

Individual factors

Based on the frequency index, all individual factors are arranged according to the descending order and ranked which is shown in the table 7, appendix B, and top 30 significant causes are listed in the table 4.22.Funding shortage by owner, interference in owner's decisions, lack of experience construction manager, lack of modern equipment in national market, improper feasibility study, lowest bidder selection, contractor's cash flow problem during construction, contract related disputes/claim, contractor's excessive workload, and site constraints are the top 10 causes of delay in order. Among the factors, first three have SI of more than 75, means the factors are extremely severe to cause schedule delay of the project. Beyond these factors, up to the rank of 30, the enlisted causes of delay have SI range 60 to 70; next 35 factors have the index value of 50 to just below 60, and last 6 factors having indices of 40 to just below 50. This overall scenario of severity indices discovered that most of the factors fall in the category of great severity level by the contractor's judgment and very few causes have moderate effects on project time extension. It is noticed that none of causes in this group have little effects.

TABLE 4-22 Top most severe causes of delay by contractors

Individual	FI	Rank	Group	Category

Funding shortage by owner	86.67	1	Financing	Extreme
Interference in owner's decisions	84.80	2	Financing	Extreme
Lack of experience construction manager	78.33	3	Managerial	Extreme
Lack of modern equipment in national market	70.83	4	Man. & Res.	Great
Improper feasibility study	70.83	5	Owner	Great
Lowest bidder selection	70.00	6	Owner	Great
Contractor's cash flow problem during construction	70.00	7	Financing	Great
Contract related disputes/claim	69.17	8	Managerial	Great
Contractor's excessive workload	68.33	9	Managerial	Great
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	67.50	10	Project	Great
Lack of skilled workers	67.50	11	Man. & Res.	Great
Escalation of resources price	65.83	12	Man. & Res.	Great
Adverse weather conditions	65.83	13	Environmenta l	Great
Unskilled operator/technical personal	65.00	14	Man. & Res.	Great
Lack of proper management	64.29	15	Owner	Great

Furthermore, the study clustered top 30 causes and frequency of the factors in each group from these high ranks are counted and presented on the bar diagram below (figure 4.12).The figure above shows that managerial group has the maximum factors of delay in the top 30 most severe causes. Both owner and contract groups have 5 factors in this class; financing, and manpower and resources group have also same of 4 factors. Others such as consultant, project, and environmental groups have 3, 2, and 1 factor respectively in this high severity cluster of delay. Thus managerial, contractor, and owner groups should have to get first priority areas to reduce delay issue of construction project.

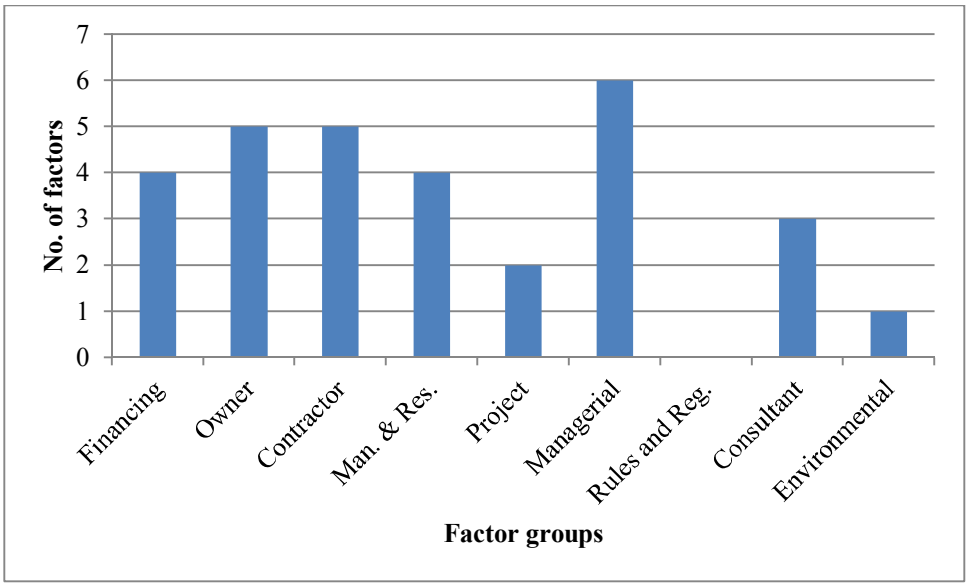

Figure 4-12 Number of factors per group in top 30 significant factors by contractors

4.4.4 All Respondents

Severity analysis has been done for the questionnaire data of all respondents (i.e. 70) to find most significant causes of delay. The severity index of the factors were calculated and the factors are then arranged according to order by the SI. Index value of group factors also found out and ranked in descending order. The following sections discuss the finding of the severity analysis of the all respondents in details.

Group factors

Table 4.23shows the group causes with the severity indices and the ranks in order. According to the SI, financing group is found as the high severity for causing delay and the index value is 65.79. The managerial group is in second position followed by owner, contractor, rules and regulation, project, manpower and resources, consultant, and environment groups. It is important to mention that all the groups have average indices

more than 50 but less than 75, that is why, as groups causes, all of these groups can be defined as great severity to make the project delay. Among them first 5 groups have in the range of 60 to 65 and ensure their severity strong enough to take concern to resolve project delay issue in construction industry. But, it also important to notify, not all the causes of an individual group have great severity but extreme and moderate as well with few exception of little severe according to the index scale defined earlier. It will be clearer from the brief discussion of the group causes.

TABLE 4-23 Severity analysis of group factors by all respondents

Group factor	**Index**	**Rank**	**Category of severity**
Financing	65.79	1	great
Managerial	64.34	2	great
Contractor	62.6	3	great
Rules and Regulation	61.06	4	great
Owner	59.24	5	great
Project	59.15	6	great
Manpower and resources	58.2	7	great
Consultant	56.13	8	great
Environment	54.82	9	great

Table 4.24 shows the severity index and the rank of all individual causes under each category of delay. Financing group, for example, has an extreme severe cause namely funding shortage by owner with 85.00 SI. Contractor's cash flow problem during construction, fluctuation in material prices, delays in contractor's progress payment by owner etc. in order are the great severe causes of delay and these have indices of 60 to 70. However, rest two causes in this group also have high SI e.g. 59.64, and 58.65. Thus this group as a whole is very severe to schedule overrun. Lowest bidder selection in owner

group also has more than 75 SI and recognized as the extreme cause of delay. Other important causes of delay in this category are improper feasibility study, lack of proper management, very poor consultancy fee, owner's poor contract management etc. Besides, these factors have the indices of upper limit of great severity like near about 70.00 and some other causes have more than 60 SI which strongly support the factors of the group for great causes of delay. Contractor group in this aspect has not any extreme cause but all the factors have SI of in the range of greater than 50 to 70. Some most significant causes of delay in this group are improper planning and scheduling, lack of experience, inaccurate cost estimation, improper progress monitoring and cost control, poor site management etc. which have high SI of 65 to 70 and fall into upper limit of great severity class. In consultant category, lack of experience is found as the most significant cause of delay with SI 64.29 and other causes of delay have on average 55 SI except last one, delay in work inspection and approval has only 49.21 SI, thus, it can be defined as moderately severe regarding project delay. Almost same scenario is found in manpower and resources group where top 4 causes have the indices of 65 to 70, then up to 8th 55 to 60. Thus, at least top 8 causes are very severe due to delay. Besides, according to the scale of SI, all the causes in this group beyond last two are in the great severity category of factors. Some significance causes in this group are lack of skilled workers, escalation of resources price, lack of modern equipment in national market, unskilled operator etc. Another important group with respect to delay is "project", where site constraints is found as the top cause of delay and it's SI 65.94, followed by obsolete construction methods and technologies, lack of constructability etc. The causes of this group can be identified as the great severity except the last one having SI of 49 only. One of the high

index group is managerial and its average index 64.34. Most of the causes (7/9) have scored more than 60 and one of the causes like lack of experience construction manager has SI of 78.21 and discovered as the extreme causes of delay. Some others are poor contract management, poor site management, contractor's excessive work load etc. and these three have about 65 SI. Safety rules found as the top cause of delay in rules and regulation group. All the causes in this are classified as great severity with average 61 SI. Adverse weather condition discovered as the top significant causes in environmental group with SI of 67.50, and rest of the causes like work accidents, strike or political problem also need to consider for solving delay issue.

TABLE 4-24 Severity indices and ranks of the factors under each group by all respondents

Group	Individual Factor	SI	Rank
Financing	Funding shortage by owner	85.00	1
	Contractor's cash flow problem during construction	68.29	2
	Fluctuation in material prices	61.92	3
	Delays in contractor's progress payment by Owner	61.26	4
Owner	Lowest bidder selection	75.36	1
	Improper feasibility study	70.36	2
	Lack of proper management	70.15	3
	Very poor consultancy fee	64.18	4
	Owner's poor contract management	62.07	5
Contractor	Improper planning and scheduling	70.00	1
	Lack of experience	67.65	2
	Inaccurate cost estimation	66.25	3
	Improper progress monitoring and cost control	66.18	4
	Poor site management	66.07	5
Consultant	Lack of experience	64.29	1
	Inadequate constructability analysis (Impractical design)	58.73	2
	Error in design	58.46	3
Manpower and Resource	Lack of skilled workers	70.71	1
	Escalation of resources price	68.28	2
	Lack of modern equipment in national market	65.63	3
	Unskilled operator/technical personal	65.15	4
Project	Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	65.94	1
	Obsolete (old) construction methods and technologies to site investigation	62.92	2
	Lack of constructability	61.02	3
Managerial	Lack of experience construction manager	78.21	1
	Poor contract management	65.83	2
	Poor site management	65.48	3
	Contractor's excessive workload	65.00	4
Rules and regulation	Safety rules	62.14	1
	Obtaining permits from municipality	61.57	2
	Building permits approval process	59.48	3
Environment	Adverse weather conditions	67.50	1
	Work accidents	51.79	2
	Strike or other problem	51.79	3

Individual factors

All the factors are enlisted in table8, appendix B, according to descending order and ranked based on the SI. Then top 15 significant causes are shown in table 4.25. It is found that top three causes like funding shortage by owner, lack of experience construction manager, and lowest bidder selection have SI of over 75 which means these are in extreme group of severity. Some causes for example, lack of skilled workers, improper feasibility, lack of proper management, improper planning and scheduling etc. have almost 70 SI. Contactor's cash flow problem during construction, and escalation of resources price have almost same score e.g., 68.28 and raked 8th and 9th; lack of experience, and averse weather condition also have on average 67.50 SI and placed at 10th and 11th position. Other groups in top 20 are very close each other and the SI values found above 65 which prove their severity of causing delay. Next 20 factors have SI of 65 to 60, and up to 58th cause of delay the indices have 59 to 55. Besides, next 10 causes of delay have 55 to 50 SI and last 5 factors have less than 50. These scenarios of SI have demonstrated the level of severity of the causes.

TABLE 4-25 Top most significant causes of delay by all categories of respondents

Factor	Group	SI	Rank	category
Funding shortage by owner	Financing	85.00	1	Extreme
Lack of experience construction manager	Managerial	78.21	2	Extreme
Lowest bidder selection	Owner	75.36	3	Extreme
Lack of skilled workers	Man. & Res.	70.71	4	Great
Improper feasibility study	Owner	70.36	5	Great
Lack of proper management	Owner	70.15	6	Great
Improper planning and scheduling	Contractor	70.00	7	Great
Contractor's cash flow problem during construction	Financing	68.29	8	Great
Escalation of resources price	Man. & Res.	68.28	9	Great
Lack of experience	Contractor	67.65	10	Great
Adverse weather conditions	Environmental	67.50	11	Great
Inaccurate cost estimation	Contractor	66.25	12	Great
Improper progress monitoring and cost control	Contractor	66.18	13	Great
Poor site management	Contractor	66.07	14	Great
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	65.94	15	Great

Furthermore, frequency of the causes in each group among 30 top factors are sorted out and presented by the bar chart below (4.13).The above figure shows that contractor group is in highest position which has 7 factors in top 30 most severity causes of delay followed by managerial, owner, rules and regulation etc. The frequency of managerial group is 6, and next two groups have same 5 factors in this crest severity cluster. Other groups such as financing, and project have 2 factors in each, last three groups have only one factor in this top list.

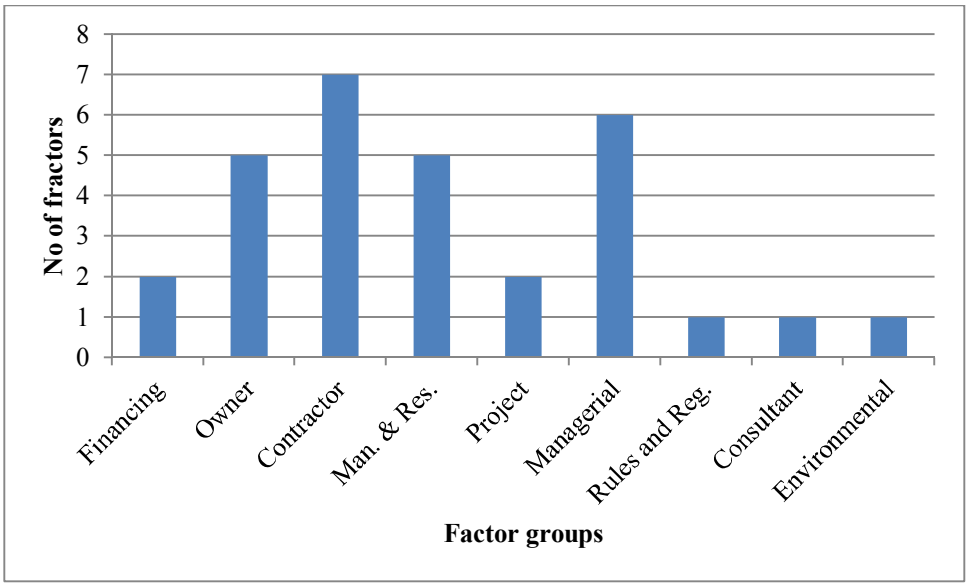

Figure 4-13 Number of factors per group in top 30 significant factors

4.4.5 Comparative discussion among the different respondent groups

The table 4.26 shows SI of each group and the corresponding ranks depends on the data analyses in four ways like as owner, engineer, contractor, and all respondents. It shows the different views of each category of respondents, for example, owner group thought that contractor related causes are the most severe causes of delay, and engineer's judgment is also same as them, however, contractor believe that financing is the principle cause of schedule overrun which also found by analyzing all data together. Besides, all group of construction professionals have more or less similar understanding that there is a serious lack of expert construction manager, if it is, then most of the management related issue might be solved which subsequently would reduce the delay. That is why, this managerial cause found as 2nd great severe factors according to the engineer, contractor, and all respondents, as well as owner identified this problem as 3rd serious issue. Since building permits and approval process mostly related with owner, they faced this issue as

the time one of the most consuming tasks which delayed the work starting point from moths or even years, thus rules and regulation category is discovered as the 2nd severity cause group of delay according to their experience. But all other respondents did not think this group as severe like owners and they ranked it like 5th important group cause. In regards of financing, although contractor seems it as the top severity cause but engineer and owner have different opinions and they discovered this group as 3rd and 4th category of cause. Project related causes are experienced very likely by the respondents and ranked 4th to 6th severity causes among 9 groups. There are some causes happened by the owner itself, thus as an opponent respondents, contractor claimed these causes have great severity for schedule delay and ranked at 3rd group but according to engineer's experience it found just below contractor's responses, however, owner respondents argued that it does not such high rank cause but 6th out of 9. Other groups like consultant, manpower and resources, and environmental have varied ranks in the range of 7 to 9 by all types of data analysis.

TABLE 4-26 Severity ranking of group causes by different respondent groups

Group factor	**Owner**		**Engineer**		**Contractor**		**All respondent**	
	S I	Rank	S I	Rank	S I	Rank	S I	Rank
Contractor	68.49	1	65.31	1	57.33	6	62.6	4
Rules and Regulation	66.99	2	62.08	5	57.34	5	61.06	5
Managerial	66.36	3	64.72	2	63.33	2	64.34	2
Financing	66.35	4	64.39	3	69.13	1	65.79	1
Project	64.68	5	58.96	6	58.01	4	59.15	6
Owner	64.42	6	64.29	4	58.74	3	62.9	3
Consultant	58.42	7	53.44	9	52.99	9	56.13	8
Manpower and resources	58.27	8	55.36	7	56.58	7	58.2	7
Environmental	57.81	9	54.38	8	53.13	8	54.82	9

Similar of ranking, comparative presentation of severity index of each group for different respondents' data analysis has been done and shown in the figure 4.14 below. It is observed from the figure that financing and owner groups have maximum SI and the variance of responses is very little among the respondents which demonstrated the similar understanding of different categories of respondents about the factors of these two groups. Severity indices of financing and owner groups are about 65 and 62 respectively. Owner group is the third one with minimum variation among respondents and it has SI of about 61. Although contractor as well as rules and regulation groups have high SI by some project personnel but high variance exists in the outcome and the average SI of these groups are about 60. Project related causes also have similar output except owner judgment, engineer, contractor and then all respondents data analysis ensured that the average SI is about 58. Rest of the groups like consultant, manpower and resources, and environmental causes of delay found almost similar severity with about 55 SI but variation exists among their understanding and experience levels.

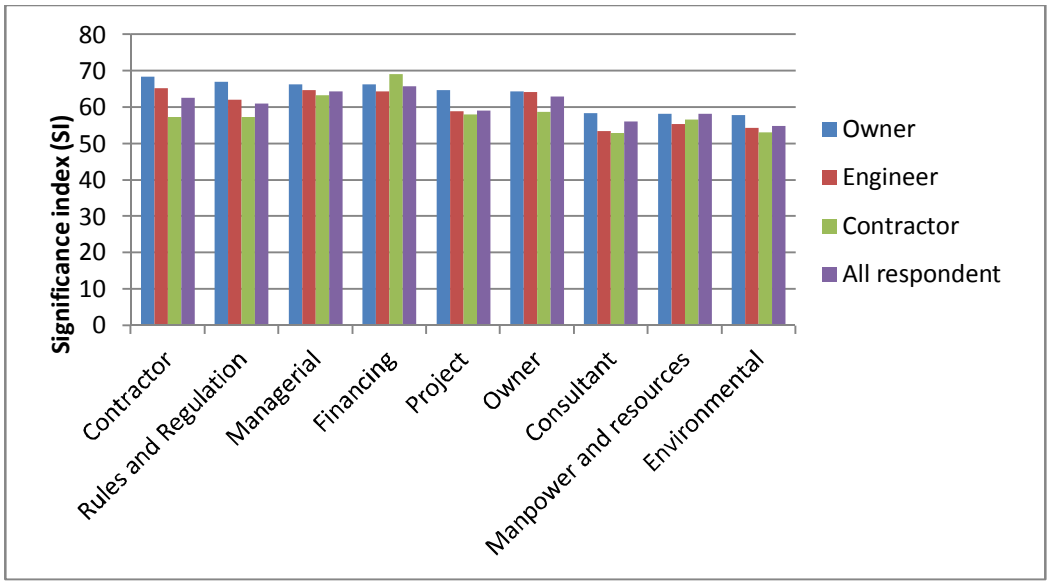

Figure 4-14 Group SI based on different respondents

4.4.6 Finding summary as the categories of the causes regarding severity

As mentioned earlier that the severity of the causes is scaled like extreme, great, moderate and little based on the indices of individual factors. The following bar chart shows the outcome as percentage found by the different categories of data analysis. Like frequency of the factors, maximum causes indices range found 75 to just above 50 which are recognized as the great severe causes. More clearly, on average 80% causes are fallen in this great impact group to cause schedule overrun unanimously by the all group of respondents and analysis. Good percentage like12.50% of causes found extreme for which the work might be suspended or terminated answered by the owner, and 4 to5% causes found by other groups. Maximum 15.50% factors are discovered as moderate severe by the contractor and about 13% engineer. But only about 4 to 7% of such causes identified by owner groups and all respondents data analyses. And none of the causes selected as little severe by any of the respondents.

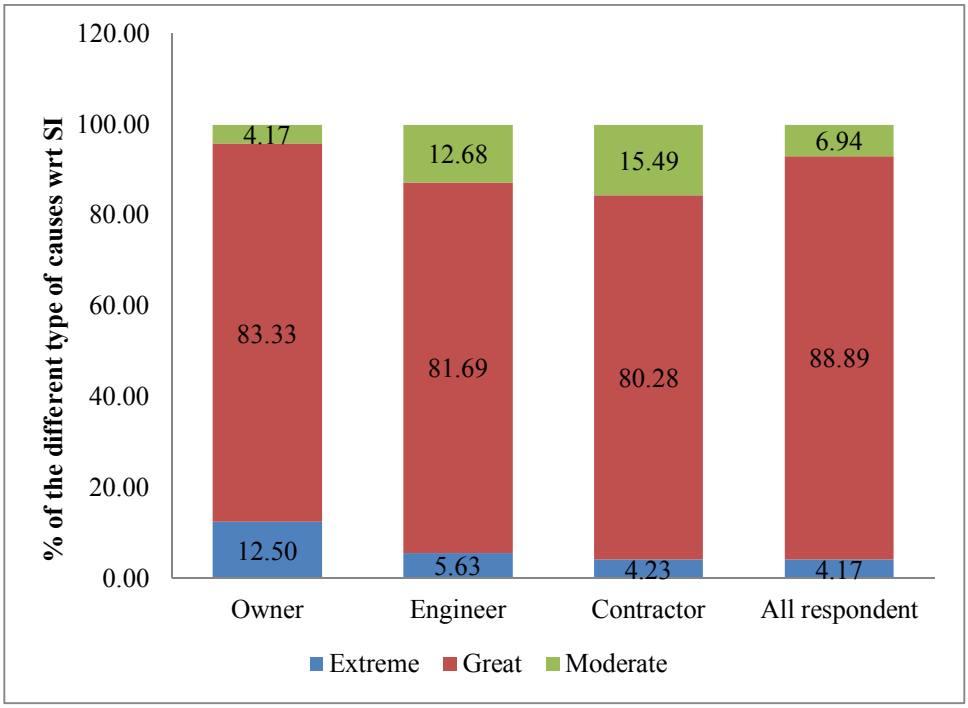

Figure 4-15 Different types of severe causes by different respondent groups (%)

4.5 IMPORTANCE ANALYSIS OF CAUSES OF SCHEDULE DELAYS

Like frequency and severity, importance of the causes of delay was also analyzed based on the owner, contractor, engineer and all respondents groups. First of all, relative importance index which is the multiplication of the relative severity and relative frequency index of a single factor was calculated for each type of respondents. All the factors are then ranked based on the relative importance index (RII). Then the factors are categorized like very high, high, medium and low on the basis of RII scale. The scale is defined as very high, high, fair, and low depends on the index range of 100 to above 75, 75 to above 50, 50 to above 25, 25 to 0 respective. The scale will very helpful to find

important causes of delay which need to be emphasized to resolve before starting the project or during construction to achieve predefined schedule. The following sections are discussed briefly about the result of importance analysis of the causes of delay.

4.5.1 Owner

Top 15 important causes are listed in the table 4.27.Top eleven factors are found very high to cause delay. These are inaccurate cost estimation, lack of experience construction manager, lowest bidder selection, safety rules, building permits and approval process, escalation of resources price, improper planning and scheduling, lack of proper management by owner, lack of data base for estimating activity duration and resources, improper progress monitoring and cost control, lack of skilled worker, site constraints, contractor's excessive workload, fluctuation in material prices and lack of modern equipment. Most of other causes are discovered as high importance causes and very few causes found as less importance. It is noticed that consultant and environmental causes of delay are identified as low important factors of delay.

TABLE 4-27 Top 15 important causes by owners

Factor	Group	RII	Rank	Category
Inaccurate cost estimation	Contractor	96.77	4	Very High
Lack of experience construction manager	Managerial	93.94	1	Very High
Lowest bidder selection	Owner	90.71	5	Very High
Safety rules	Rules and Reg.	83.33	3	Very High
Building permits approval process	Rules and Reg.	83.33	2	Very High
Escalation of resources price	Man. & Res.	82.67	9	Very High
Improper planning and scheduling	Contractor	82.11	7	Very High
Lack of proper management by owner	Owner	77.79	12	Very High
Lack of database for estimating activity duration and resources	Contractor	75.43	8	Very High
Improper progress monitoring and cost control	Contractor	75.40	11	Very High
Lack of skilled workers	Man. & Res.	71.24	13	High
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	68.72	6	High
Contractor's excessive workload	Managerial	65.86	10	High
Fluctuation in material prices	Financing	62.41	14	High
Lack of modern equipment	Contractor	61.72	15	High

RII-Relative Importance Index

Frequency of most important factors under each group found by owner's point of view is also shown in figure 4.16.It shows that contractor group is in the highest position with 8 causes in top 30 most important factors to delay the project period. Next three groups are financing, manpower and resources, and project have four causes in this top list.

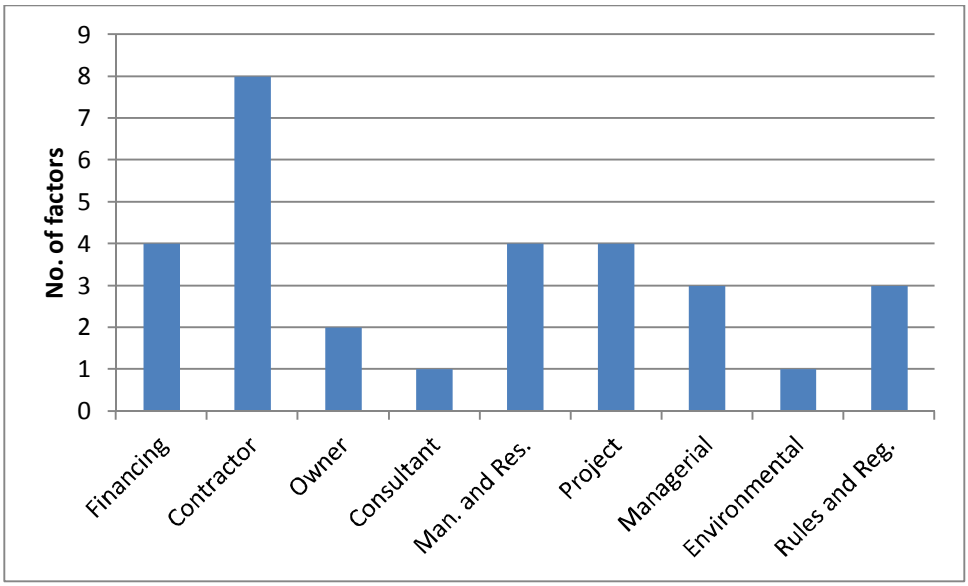

Figure 4-16 Frequency per group in top 30 factors by owner

Three factors in each of managerial, as well as rules and regulation group found very important in this aspect. It is important to notice here that only two causes indentified here related to owner by owner's judgment and one cause for consultant, and environmental group. Thus, according to owner, these three factor groups of delay is less important but the contractor, financing, and manpower or resources categories have to care more to get successful project in terms of time.

4.5.2 Engineer

Importance indices of all the factors by the responses of engineer group have also computed followed by the equation mentioned in methodology and then arranged by descending order in two ways like owner respondents. Besides, top 30 causes are selected as outcome of study and to emphasize for reducing the causes of project delay. The following discussions are based on the importance analysis of the delay causes depends on the questionnaire survey among engineers.

Top 15 causes are listed in the table28 in descending order based on the indices. Top eight factors are found as very high important causes of delay. The largest index e.g., 91.30 found for both of lowest bidder selection by owner and lack of experience construction manager. Other very high important causes in this list are lack of skilled workers, lack of proper management, very poor consultancy fee, improper planning and scheduling, improper progress monitoring and cost control, poor site management, lack of modern techniques in construction etc. Among top 30 factors, others are found in the high importance category of causes of delay. The following table shows that three factors of both contractor and owner groups identified as very high important causes of delay. Besides, one factor is found from managerial group and another factor from manpower and resources group. Thus, special attention is needed for both contractor and owner to reduce delay causes in Bangladesh.

TABLE 4-28 Top 15 important causes by engineers

Factors	Group	RII	Rank	Category
Lack of experience construction manager	Managerial	91.30	1	Very High
Lowest bidder selection	Owner	91.30	2	Very High
Lack of skilled workers	Man. & Res.	82.94	3	Very High
Lack of proper management	Owner	81.61	4	Very High
Very poor consultancy fee	Owner	79.91	5	Very High
Poor site management by contractor	Contractor	79.71	6	Very High
Improper planning and scheduling	Contractor	78.93	7	Very High
Improper progress monitoring and cost control	Contractor	78.89	8	Very High
Lack of modern equipment	Contractor	73.27	9	High
Site constraints	Project	69.83	10	High
Poor site management by manager	Managerial	69.72	11	High
Lack of appropriate and modern techniques in construction	Contractor	68.54	12	High
Building permits approval process	Rules and Reg.	67.74	13	High
Safety rules	Rules and Reg.	67.74	14	High
Contractor's excessive workload	Managerial	65.95	15	High

RII-Relative Importance Index

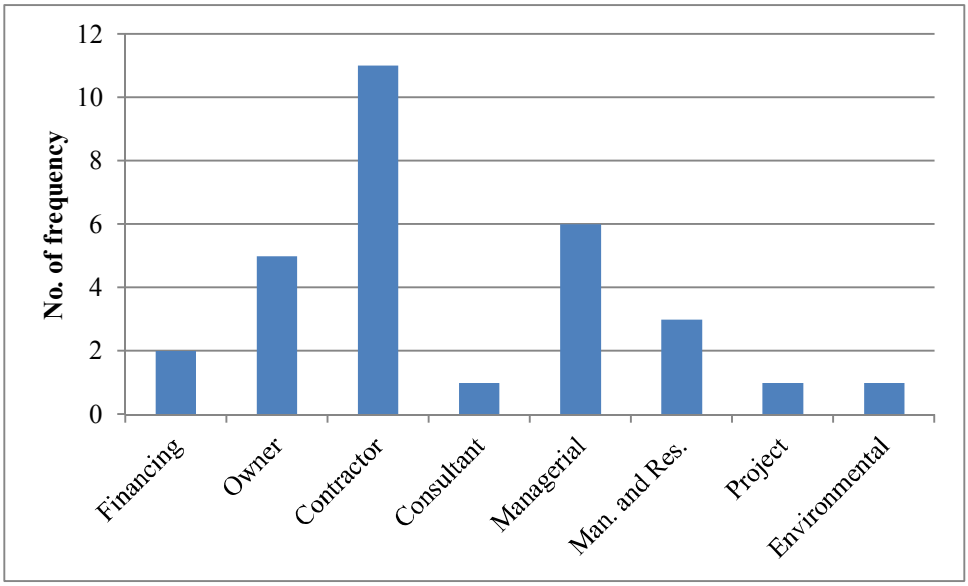

Figure 4-17 Frequency per group in top 30 factors by engineer

The importance of the group factors are then viewed by the frequency of the causes of each group in top 30 factors. Based on the frequency, following bar chart are drown where it is clear that contractor group has highest 11 factors in top 30, followed by managerial, owner, manpower and resources, financing etc. and the frequency of factors of these groups are 6, 5, 3 and 2 respectively. The other three groups have only one factor in this high importance class.

4.5.3 Contractor

Previously found frequency and severity index of each factor of cause of delay by analyzing the data from interview survey among 30 contractors are used to calculate importance indices. All the indices of individual factors are enlisted in descending order and their categories of importance are also mentioned. Top 15 important factors are show in the table 4.29 below according to the largest to smallest index. Among the 15 causes of delay in the table, only three are considered as very high important causes by contractors. These are interference in owners' decision for financing, lack of experience construction manager, and lowest bidder selection. Maximum numbers of factors are discovered as high importance causes by contractors. Some high importance causes of delays are fund shortage of owner, escalation of resource prices, lack of skilled worker, contractor's excessive workload, improper feasibility study, lack of proper management etc., in which, some of the causes found in very high importance category by the owners and engineers. Now top 30 causes are then analyzed for finding the frequency of factors in each group.

TABLE 4-29 Top 15 important factors of delay by contractors

Individual	**Group**	**RII**	**Rank**	**Category**
Interference in owner's decisions	Financing	95.57	1	Very High
Lack of experience construction manager	Managerial	90.39	2	Very High
Lowest bidder selection	Owner	77.22	3	Very High
Funding shortage by owner	Financing	73.63	4	High
Contractor's cash flow problem during construction	Financing	71.89	5	High
Lack of modern equipment in national market	Man. & Res.	70.95	6	High
Site constraints	Project	67.61	7	High
Lack of proper management	Owner	66.37	8	High
Contractor's excessive workload	Managerial	65.85	9	High
Escalation of resources price	Man. & Res.	62.61	10	High
Lack of skilled workers	Man. & Res.	60.77	11	High
Improper feasibility study	Owner	60.18	12	High
Unskilled operator/technical personal	Man. & Res.	59.34	13	High
Adverse weather conditions	Environmental	55.93	14	High
Contract related disputes/claim	Managerial	53.50	15	High

RII- Relative Importance Index

The figure 4.18 shows the frequency of the individual causes from 30 most important factors under main category. It is shown that owner and contractor groups have highest causes in this most important category, for example 7 causes in each. Financing is another important group which has 5 causes in top 30, followed by managerial, manpower and resources, and project where these groups have 4 and 2 causes respectively (last couple of causes are same) and other factor groups have only one.

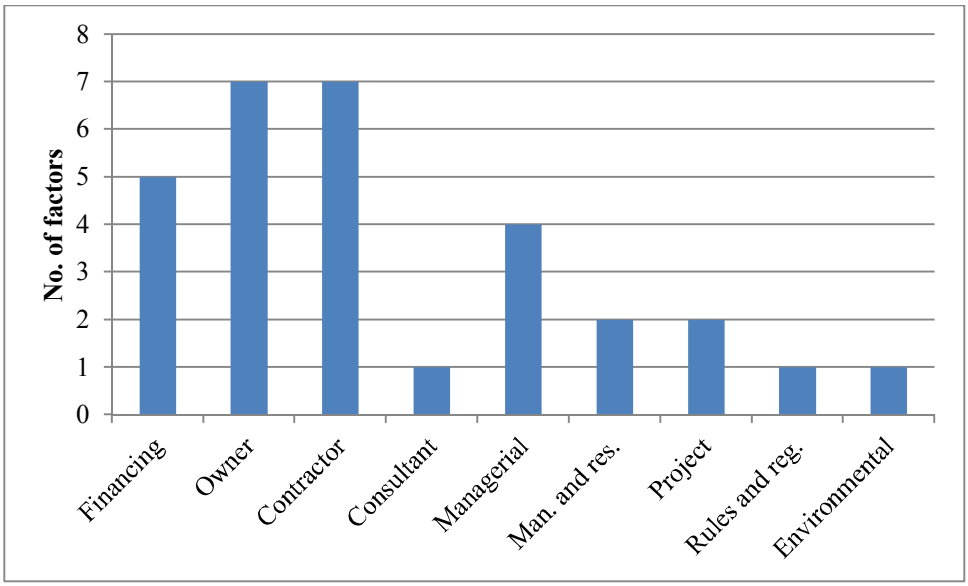

Figure 4-18 Frequency per group in top 30 factors by contractor

4.5.4 All Respondents

To find importance indices of the factors of delay, data of all respondents have been analyzed together. Then the factors are arranged according to the order among and ranked among all individual factors. Top 15causes are shown in the table 4.30 below. It shows that 5 factors have indices above 75 and identified as very high important causes. These causes can suspend or even terminate the project. These factors are lack of experience construction manager, lowest bidder selection, fund shortage by owner, lack of proper management, and improper planning and scheduling. All the managerial problems are created by the absence of professional construction manager, thus if the management is weak, it can malfunction the project at the site and office also. Some top high causes like lack of proper management, contractor's excessive work load, improper progress monitoring and cost control etc. also closely related with the managerial process. Lowest bidder selection is highly responsible for causing delay. Most of cases, if lowest bidder is

selected they do not provide good quality of work, don't have proper management, no cost control, and even shortage of cash flow during construction which itself an important cause of delay. These causes related to the lowest bidders lead to stop or suspend the project because they become unable to continue the work. Improper planning and scheduling, lack of skilled workers, site constraints, escalation of resources price etc. are also found as high important causes of delay.

TABLE 4-30 Top 15 important causes of delay by all respondents

Individual factors	**Group**	**RII**	**Rank**	**Category**
Lack of experience construction manager	Managerial	92.01	1	Very high
Lowest bidder selection	Owner	85.40	2	Very high
Funding shortage by owner	Financing	79.35	3	Very high
Lack of proper management	Managerial	79.50	4	Very high
Improper planning and scheduling	Contractor	76.15	5	Very high
Lack of skilled workers	Man. & Res.	70.22	6	High
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	68.95	7	High
Contractor's cash flow problem during construction	Financing	68.20	8	High
Escalation of resources price	Man. & Res.	67.76	9	High
Contractor's excessive workload	Managerial	66.30	10	High
Lack of database for estimating activity duration and resources	Contractor	66.11	11	High
Improper progress monitoring and cost control	Contractor	65.80	12	High
Improper feasibility study	Owner	65.68	13	High
Lack of modern equipment	Contractor	65.25	14	High
Very poor consultancy fee	Owner	64.77	15	High

RII- Relative Importance Index

Frequency analysis of top thirty causes under each group has been done and presented by following bar chart. The overall picture about frequency of individual causes in top 30 shows that contractor and owner are the two giant groups have been claimed for most of the causes of delay and 8 and 7 causes respectively are found under each group which are

in the most important factors class. Besides, managerial causes are in the 3rd position regarding schedule overrun, followed by manpower and resources, financing, rules ad regulation etc. Among these financial problem also mostly related with owner and contractor such as delay in progress payment, contractor's cash flow problem etc. Thus contractor, owner, and managerial aspects are highly responsible for project delay.

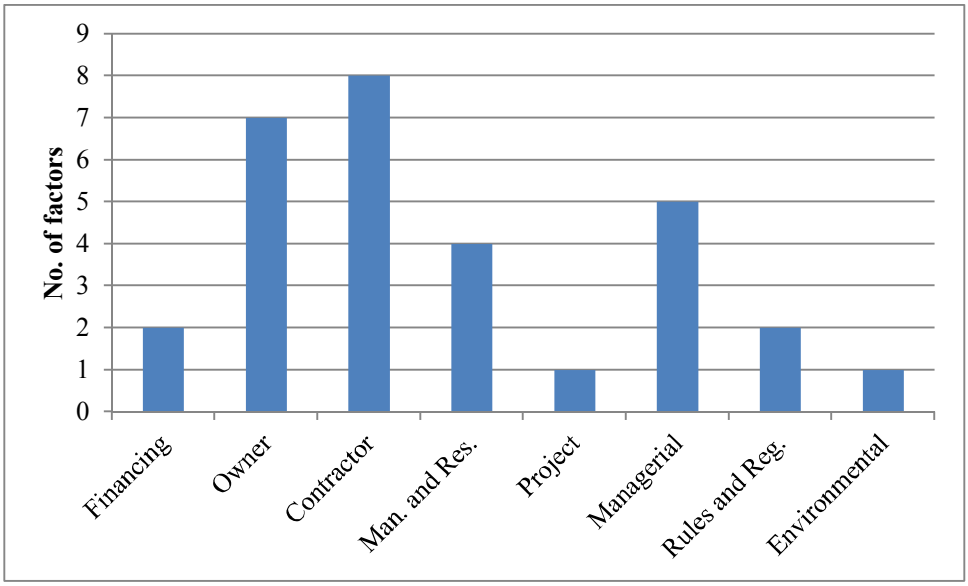

Figure 4-19 Frequency per group in top 30 factors by all respondents

4.5.5 Comparative discussion among different respondent groups

Table 4.31 shows a comparative ranking of group causes based on importance indices computed by data analyses of owner, engineer, contractor, and all respondent. Rules and regulation group is ranked first by owner but other groups ranked it at 4. Contractor group is discovered to owner as second high importance cause and engineers found it as the most important factor group. However, contractors themselves not thinking like other parties and marked this group as 6th important cause. Managerial problems are discovered

as 2nd influential group to the engineer and contractor, and owner experienced most likely with them and marked these causes as 3rd harmful group for causing delay. Financing during construction is found as the most leading group of causing delay according to the contractor where owner and engineer differ significantly such as they recognized it as 4th and 5th important group respectively. All other groups found as more or less same ranking by the experts in different parties. However, when all the data was analyzed together, it shows the result very similar to contractor groups.

TABLE 4-31 Importance ranking of group causes by different respondent groups

Group	Rank			
	Owner	**Engineer**	**Contractor**	**All respondent**
Rules and Regulation	1	4	4	4
Contractor	2	1	6	5
Managerial	3	2	2	3
Financing	4	5	1	1
Owner	5	3	3	2
Project	6	6	5	6
Manpower and resources	7	7	7	7
Consultant	8	9	8	8
Environmental	9	8	9	9

4.6 CORRELATION OF RANKING AND HYPOTHESIS TESTING OF THE CAUSES DELAY

Spearman's rank correlations between the pairs of groups have been done to establish the relationship between the parties. The limitation of this correlation is that it cannot explain relationship between more than two groups. Since this study had three groups of respondents, three steps of Spearman's correlation analysis have been performed such as

owner vs. contractor, contractor vs. engineer, and engineer vs. owner. Besides, hypothesis test has been conducted for justifying whether significance difference exists among the three respondent groups. In this case Kruskal-Wallis test is found best suited, and this is the way of analyzing multiple (more than two) group of independent respondents with different size of data. The results of both analyses are discussed below.

4.6.1 Spearman's Correlation

This is the type of correlation which assesses the relationship between two variables and describes by using a monotonic function. It works for ordinal data set where order of the variable is important. Since this study used nominal or qualitative data and presented as numeric value to the interviewers, and then by the analyses of all categories of data, ranks or order of the factors of delay have been found, thus, Spearman's correlation is one of the perfect uses to express the level of relationship between the parties. The rank coefficient rang is -1 to +1, where, -1 means strong negative relation, and +1 means true positive relation. Following is the brief details about the output of the Spearman's rank correlation analysis of different set of parties (variables).

Owner and Contractor

All 72 factors were taken to calculate the Spearman's rank coefficient between owner and contractor, thus the size of data, n=72. These factors are arranged in ascending order. From the table 4.32below,it is noticed that there are so much differences between their judgments such as interference in owner's decision was found as the number one cause by contractor but owner indentified this factor as 53rd. Besides, contractor's cash flow problem during construction discovered as 5th and 28th, improper progress monitoring and cost control as 26th and 9th, safety rules 33rd and 4th, escalation of resources price 57th and

5th respectively by contractor and owner. Although there are some similar findings by both groups to response some factors for example, lack of experienced construction manager, lowest bidder selection, lack of proper management, lack of skilled workers etc. and the ranks of these factors are 2, 3, 8, and 11 successively but the number of such factors are very few. However, between the ranks of most of the causes, they differ each other in large scale, thus the coefficient of Spearman's rank is found as very low like as 0.54 which indicates that there is very poor level of understanding between the two parties. One of reasons for this would be "the true opponents each other", because they are the two parties where owner ensures the continuous fund and contractor build-up the structure in perfect time, and quality. But they are claimed each other and both parties don't have proper management system. Cost estimation and funding are big issues and to ensure these, both parties have to aware. For example, owner claim that inaccurate cost estimation by contractor is the major problem for delay as a result, when they select lowest bidder for project, the contractor does not capable to finish the work. Subsequently, lowest bidder selection is discovered as third major factor of delay by both parties. However, for multiple owners, interference of owner's decision for funding is a common problem and contractor ranked it as number one because it delayed the decision of funding for any works of a project such as material procurements, contractor's progress payment, payment for management team etc. and it sloth the overall project performances. Thus, the expert views of both parties are different each other beyond some few causes and the relationship of understanding is very poor.

TABLE 4-32 Spearman's rank correlation between owner and contractor (sample)

Individual factors	**Imp. Index Owner**	**Imp. Index Contr.**	**Owner Rank**	**Contr. Rank**	**Diff**	**Diff^2**
Interference in owner's decisions	26.60	62.81	53	1	52	2704
Lack of experience construction manager	60.06	59.4	2	2	0	0
Lowest bidder selection	58	50.75	3	3	0	0
Funding shortage by owner	51.8	48.39	7	4	3	9
Contractor's cash flow problem during construction	40.63	47.25	28	5	23	529
Lack of modern equipment in national market	37.95	46.63	33	6	27	729
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	43.94	44.44	16	7	9	81
Lack of proper management	49.74	43.62	8	8	0	0
Contractor's excessive workload	42.11	43.28	20	9	11	121
Very poor consultancy fee	32.7	40.6	43	10	33	1089
Lack of skilled workers	45.55	39.94	11	11	0	0
Improper feasibility study	42.88	39.55	19	12	7	49
Improper planning and scheduling	52.5	39.06	6	13	-7	49
Unskilled operator/technical personal	42.04	39	21	14	7	49
Delays in contractor's progress payment by Owner	23	38.02	64	15	49	2401
Lack of appropriate and modern techniques in construction	41.78	37.91	23	16	7	49
Frequent change order by owner during construction	35.06	37.51	40	17	23	529
Obtaining permits from municipality	40.92	36.94	27	18	9	81
Adverse weather conditions	44.53	36.76	15	19	-4	16
Lack of modern equipment	45.5	36.46	12	20	-8	64
Contract related disputes/claim	30.38	35.16	46	21	25	625
Fluctuation in material prices	39.9	34.51	29	22	7	49
Lack of skilled/experienced sub-contractor	35.84	34.51	37	23	14	196
Lack of experience	36.09	34.43	35	24	11	121

Contractor and Engineer

Spearman's rank correlation between contractor and engineer also calculated for all individual factors and presented in the table4.33 below. There is strong correlation found between these two parties because the correlation coefficient is found 0.96. This can be observed by the rank list of individual causes given by contractor and engineer groups separately. For instance, the ranks of first five causes such as lack of experience construction manager, lowest bidder selection, fund shortage by owner, lack of skilled workers, and lack of proper management have very little difference between the two parties. Besides, maximum causes have rank differences less than 10 and few have unexpectedly very high. Thus, overall Spearman's ranking found tense to +1. This good relationship can be because of these two parties have long professional experiences and continuously doing this work but in different places and situations. They have good knowledge about the shortcomings of Bangladeshi construction companies, techniques and technologies, skills and quality of laborer and technicians, materials and resources, owner's issues etc. Moreover, they are sharing the knowledge and expertise in field each other and trying to find the solution for solving contemporary problems. Thus, the study proves very likely understanding about the causes of schedule delay by both contractor and engineer groups.

TABLE 4-33 Spearman's rank correlation between contractor and engineer (sample)

Individual factors	**Imp. Index contr.**	**Imp. Index engr.**	**Contr. Rank**	**Engr. Rank**	**Diff**	**Diff^2**
Lack of experience construction manager	59.40	63.98	2	1	1.00	1.00
Lowest bidder selection	50.75	63.98	3	2	1.00	1.00
Funding shortage by owner	48.39	59.30	4	3	1.00	1.00
Lack of skilled workers	39.94	58.13	11	4	7.00	49.00
Lack of proper management	43.62	57.19	8	5	3.00	9.00
Very poor consultancy fee	40.60	56.00	10	6	4.00	16.00
Improper planning and scheduling	39.06	55.31	13	7	6.00	36.00
Improper progress monitoring and cost control	34.02	55.28	26	8	18.00	324.00
Poor site management	28.27	53.83	49	9	40.00	1600.00
Lack of modern equipment	36.46	51.34	20	10	10.00	100.00
Poor site management	32.00	50.70	38	11	27.00	729.00
Improper feasibility study	39.55	49.88	12	12	0.00	0.00
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	44.44	48.94	7	13	-6.00	36.00
Lack of appropriate and modern techniques in construction	37.91	48.03	16	14	2.00	4.00
Safety rules	32.57	47.47	34	15	19.00	361.00
Mistake in competent consultant selection	34.07	47.27	25	16	9.00	81.00
Interference in owner's decisions	62.81	47.06	1	17	-16.00	256.00
Contractor's excessive workload	43.28	46.22	9	18	-9.00	81.00
Unskilled operator/technical personal	39.00	43.88	14	19	-5.00	25.00
Inaccurate cost estimation	33.85	43.83	29	20	9.00	81.00
Poor contract management	33.78	43.83	31	21	10.00	100.00
Conflicts between the parties in the site	33.85	43.06	28	22	6.00	36.00
Owner's poor contract management	34.02	42.23	27	23	4.00	16.00
Lack of experience	29.40	42.19	45	24	21.00	441.00
Inadequate site inspection	22.45	42.19	64	25	39.00	1521.00

Engineer and Owner

Table4.34shows the rank differences of the 72 causes of schedule delay and at the end Spearman's rank coefficient is found 0.73. This means there is moderate relationship exist between engineer and owner responses. Some similarities as well as dissimilarities are found between their knowledge of understanding regarding delay issue in Bangladeshi construction projects. Both parties are coincided about lack of experience construction manager which is actually the number one cause of delay discovered by all parties. Then very little rank variation is noticed between owner and engineer for some important causes such as lowest bidder selection by owner, improper planning and scheduling by contractor, fund shortage by owner, lack of proper management, improper progress monitoring and cost control, lack of skilled worker, lack of modern equipment, poor site management, safety rule, site constraints etc. Furthermore, there are some strong disagreement between them for example inaccurate cost estimation by contractor, escalation of resources price, high interest rate/inflation, very poor consultancy fee, obsolete construction methods and techniques in site investigation, mistake in competent consultant selection etc. where rank difference more than 20. It is followed that most of the issue are related to the bilateral relationship of owner and consultant; few are about contractor and economical aspect. Thus, overall correlation is identified as moderate level.

TABLE 4-34 Spearman's rank correlation between engineer and owner (sample)

Individual factors	**II by Engr.**	**II by Owner**	**Rank by Engr.**	**Rank by owner**	**Diff**	**Diff^2**
Inaccurate cost estimation	43.83	61.88	20	1	19	361
Lack of experience construction manager	63.98	60.06	2	2	0	0
Lowest bidder selection	63.98	58	1	3	-2	4
Safety rules	47.47	53.28	15	4	11	121
Escalation of resources price	28.88	52.85	58	5	53	2809
Improper planning and scheduling	55.31	52.5	7	6	1	1
Funding shortage by owner	59.3	51.8	3	7	-4	16
Lack of proper management	57.19	49.74	5	8	-3	9
Improper progress monitoring and cost control	55.28	48.21	8	9	-1	1
Lack of relationship between labor and management	42.11	45.75	26	10	16	256
Lack of skilled workers	58.13	45.55	4	11	-7	49
Lack of modern equipment	51.34	45.5	10	12	-2	4
High interest rate/Economic rescission/Inflation	28.89	45.17	56	13	43	1849
Poor site management	53.83	44.69	9	14	-5	25
Adverse weather conditions	39.75	44.53	33	15	18	324
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	48.94	43.94	13	16	-3	9
Building permits approval process	38.28	43.88	38	17	21	441
Poor site management	50.7	43.57	11	18	-7	49
Improper feasibility study	49.88	42.88	12	19	-7	49
Contractor's excessive workload	46.22	42.11	18	20	-2	4
Unskilled operator/technical personal	43.88	42.04	19	21	-2	4
Lack of experience	42.19	41.78	25	22	3	9
Lack of appropriate and modern techniques in construction	48.03	41.78	14	23	-9	81
Obsolete (old) construction methods and technologies to site investigation	32.34	41.58	47	24	23	529
Incompetent project team	41.44	41.25	28	25	3	9
Lack of constructability	32.31	41.05	49	26	23	529
Obtaining permits from municipality	39.05	40.92	35	27	8	64
Contractor's cash flow problem during construction	38.28	40.63	37	28	9	81

4.6.2 Kruskal-Wallis Test

Spearman's rank correlation has a limitation of comparing correlation between two variables only. Since this study has three groups of independent respondents, variance analysis by Kruskal-Wallis test is more relevant in this regard. It works as non-parametric system for the data of same distribution. Details analyses by this method for all the factors of delay have been done for both frequency and severity with the help of SPSS software and the results are shown in the table 24, appendix B. The tables show number of respondents, mean rank, chi-square value, level of severity (α), and the confidence level of each factor of schedule delay. Here the sample size is three and independent each other, thus degree of freedom (df) is two. Mean rank of every sample for each factor presented together which is very much clear to the reader to understand the expert's opinions at a glance. The chi-square shows the corresponding level of significance (α) and confidence level as well. The α value also is the indication of the acceptance or rejection of the null hypothesis (H_0), which means, there no significance difference between the respondents groups, alternatively significant relation exist among them. But, how is the relationship like as strong, moderate, fair, weak etc. can be defined by the severity level. We can divide the severity level like 0 to 0.25, greater than 0.25 to 0.50, greater than 0.50 to 0.75, o.75 to 1.0 which means weak, fair, moderate, and strong. Since this study has been done based on the sample of the data but decision has to take on the population of those data, for inference the level of significance should be .05 for very good data set and it means the confidence level 95%. However, some of the factors are satisfied 95% confidence level or more but there is considerable number of factors did

not reach that level but approximately in the range of 70% to 90% and few factors are fallen outside this confidence range.

Kruskal-Wallis test for frequency analysis of all parties

The table 4.35below shows the mean rank of top ten most important causes of delay according to the different groups of respondents, chi-square value, level of significance and result of hypothesis test. It is found that all the factors of delay have α value more than 0.05, thus no significance differences exist between the parties and H_0 accepted. But, the confidence level is not satisfactory, because only single factor reached above 95% which is statistically sound to consider that the correlation is very strong. Besides, based on our classification of relation according to the severity level, most of the factors are below 0.50 levels. Improper planning and schedule and resources price escalation have confidence level 0.533 and 0.598 respectively which is defined as moderate relationship among the parties for these factors. Lack of skilled worker has confidence level only 0.066 which indicates weak relation, and other factors have confidence level above 0.25 to 0.50 means fair relation. In this circumstance, mean rank for each factor by the respective group are noticeable. For instance, the first factor, lack of experience construction manager has almost equal mean i.e. 36 by owner and engineer but slightly reduced by contractor i.e. 34.81, therefore, the confidence level of 96.6% and recommended as very strong relation between the parties. In case of contractor's cash flow problem during construction, severity level found 0.598, and the mean rank by contractor, engineer, and owner are moderately close to each other such as 37.88, 32.33, 35.10, thus the relationship also in moderate level. If the mean rank differs, the chi-value will be increased proportionately and the level of severity will be decreased accordingly

and vice versa. This is the basic concepts of this test. For example, maximum chi-square is found for lack of skilled worker, and level of severity is 0.066, the lowest among ten groups. This happened because the differences between mean ranks are so high for this factor, such as 29.98, 42.75, and 36.52 respectively by contractor, engineer, and owner groups. For details about the outcome of Kruskall-Wallis test for all the factors, it is referred to the table10in appendix B.

TABLE 4-35 Kruskal-Wallis test result for frequency data of most importance factors

Factor of delay	Group	N	Mean Rank	Chi-square	Level of significance	Accept H_0 if $\alpha>0.05$
Lack of experience construction manager	Contractor	30	34.81			
	Engineer	20	36.02			
	Owner	20	36.00			
	Total	70		0.068	**0.966**	accepted
Lowest bidder selection	Contractor	30	33.15			
	Engineer	20	40.32			
	Owner	20	34.20			
	Total	70		1.815	0.403	accepted
Fund shortage by owner	Contractor	30	31.26			
	Engineer	20	40.52			
	Owner	20	36.82			
	Total	70		2.802	0.246	accepted
Lack proper management	Contractor	28	33.16			
	Engineer	20	38.45			
	Owner	20	32.42			
	Total	68		1.257	0.533	accepted
Improper planning and scheduling	Contractor	30	31.80			
	Engineer	20	38.92			
	Owner	20	37.62			
	Total	70		1.916	0.384	accepted
Lack of skilled workers	Contractor	30	29.98			
	Engineer	20	42.75			
	Owner	20	36.52			
	Total	70		5.425	0.066	accepted

N-Number of respondents

Correlation for severity analysis of all parties

Based on the severity data, Kruskall-Wallis test was done by SPSS software. The top ten important causes and corresponding results by this test is shown in the table 4.36 and details are shown in table 10 in appendix B. Lack of experience manager, the most important cause of delay, has been identified very consistent among the parties which proved through mean ranked by them such as 36, 35.05, and 34.78 respectively by contractor, engineer, and consultant. But this is only one factor like frequency analysis, which achieved 95% confidence level. Next important cause is lowest bidder selection achieved 62% confidence level and the ranking by respondent groups moderately close to each other. One of the financing group of cause like fund shortage by owner, has been scored by the respondent almost same as the above one and the confidence level found 0.731, which indicates moderate relation exist among the groups for this particular cause of delay. At the factor of site constraints, relationship also showed moderate and significance level found 0.526. The contractor and engineer groups are mostly coincided upon this issue such as mean rank by them is 36.50 app. But owner group differ from them and mean rank is 32. Thus the chi-square found 1.286 which decreased the significance level. Other causes, like as lack of proper management, improper planning and scheduling by contractor, lack of skilled worker, resource price escalation etc. found weak relationship because the significance level some cases less than or equal 0.25. It is because, the mean ranking of these factors for each party are not similar enough which support the inference.

TABLE 4-36 Kruskal-Wallis test result for severity data of most importance factors

Factor of delay	Group	N	Mean Rank	Chi-square	Level of significance	Accept H_0 if $\alpha>0.05$
Lack of experience construction manager	Contractor	30	36.28			
	Engineer	20	35.05			
	Owner	20	34.78			
	Total	70		0.096	0.953	accepted
Lowest bidder selection	Contractor	30	32.95			
	Engineer	20	38.13			
	Owner	20	36.70			
	Total	70		0.978	0.613	accepted
Fund shortage by owner	Contractor	30	37.10			
	Engineer	20	35.60			
	Owner	20	33.00			
	Total	70		0.627	.731	accepted
Lack of proper management	Contractor	28	29.39			
	Engineer	20	37.88			
	Owner	20	36.71			
	Total	68		3.00	0.222	accepted
Improper planning and scheduling	Contractor	30	30.37			
	Engineer	20	40.20			
	Owner	20	38.50			
	Total	70		3.86	0.145	accepted
Lack of skilled workers	Contractor	30	32.80			
	Engineer	20	41.40			
	Owner	20	33.65			
	Total	70		2.76	0.252	accepted
Contractor cash problem	Contractor	30	38.43			
	Engineer	20	31.65			
	Owner	20	34.95			
	Total	70		1.47	.479	accepted
Resource price escalation	Contractor	30	31.93			
	Engineer	20	31.15			
	Owner	17	41.00			
	Total	67		3.264	0.196	accepted
Contractor excessive workload	Contractor	30	38.63			
	Engineer	20	34.40			
	Owner	20	31.90			
	Total	70		1.624	.444	accepted

4.7 DISCUSSION

The study was done to find the causes of schedule overrun of Bangladeshi construction projects. After data analysis, the results are documented in the following sections. All the causes of schedule delays are listed in the tables shown in appendix B. Different stakeholders have distinct view and responded according to their self-judgments. Thus, variance of the finding in causes of delays among them is stark. In addition, the results obtained display some similarities as well as dissimilarities with important causes of delays in different countries identified by the literature review. The succeeding sections will briefly elaborate on the findings of the study.

4.7.1 Important Causes of Delay

Table 4-37 shows the most prominent causes of delay based on the perception of different respondents. Regarding the owner, the most important causes are inaccurate cost estimation by contractor, lack of experience construction manager, lowest bidder selection by owner, safety issue, escalation of resources price, improper planning and scheduling by contractor, fund shortage by owner, lack of proper management, improper progress monitoring and cost control, lack of relationship between labor and management, lack of skilled workers, lack of modern equipment, high interest rate, poor site management, and adverse weather condition. According to engineers' response, the results partially differed and the order of the cause's rearranged. They included some other factors in this important class such as very poor consultancy fee, improper feasibility study, site constraints, and lack of appropriate and modern techniques in construction. This difference may be rooted in their in-depth knowledge of the

construction field. To be more specific, engineers have a better understanding of the importance of conducting a feasibility study, which is actually performed before the commencement of the construction phase. If the feasibility study is done successfully and thoroughly, many problems like fund shortage by owner, lowest bidder selection, very poor consultancy fee, lack of proper management by owner, project site constraints etc. will be solved. Moreover, engineers discovered lack of appropriate and modern techniques in construction as one of the significant barriers to complete the project in a timely manner. But, it can be argued that contactors should have proper knowledge about their equipments and technical facilities, and, thus, prepare their schedule accordingly. With respect to this, both parties found improper planning and scheduling were the most important causes of delay. It was discovered that there were two reason behind these shortcomings, namely, lack of actual data base or records of their performance (i.e. unit of work/day/equipment or labor), and increasing the chance of winning the bid. The engineers asserted that very poor consultancy fee paid by owner was one of the major contributors to delay. The contractors also supported this view. Due to this problem of lack of fee, the consultant is incapable of preparing project design-documents, constantly delays in forming shop drawings, produces errors in design. Consequently, inaccurate cost estimation to check the bid price by consultant becomes a ubiquitous problem. As a result, the owner is incapable of forecasting the actual budget of the project which invariably leads to fund shortages.

TABLE 4-37 Comparisons among top important causes found by different respondent groups

Rank	Top factors by owner	Top factors by contractor	Top factors by engineers
1	Inaccurate cost estimation	Interference in owner's decisions	Lack of experience construction manager
2	Lack of experience construction manager	Lack of experience construction manager	Lowest bidder selection
3	Lowest bidder selection	Lowest bidder selection	Poor site management by contractor
4	Safety rules	Funding shortage by owner	Very poor consultancy fee
5	Escalation of resources price	Contractor's cash flow problem during construction	Lack of modern equipment
6	Improper planning and scheduling	Lack of modern equipment in national market	Building permits approval process
7	Funding shortage by owner	Site constraints	Safety rules
8	Lack of proper management	Lack of proper management	Lack of proper management
9	Improper progress monitoring and cost control	Contractor's excessive workload	Improper progress monitoring and cost control
10	Lack of relationship between labor and management	Very poor consultancy fee	Lack of skilled workers

Table 4-38 shows comparison of the ranks of most important causes of delay by contractors with other groups. It is noticed that contractor's view is moderately different than owner. For example, they found interference in owners decision for financing the project is the first cause of delay but owner marked it as 53rd. The engineers also supported this issue and by recognizing as the17th important factor. Since it is the issue directly related with the owner, and only for the multiple ownership projects, the owner found it less important. Other important causes by contractor, beyond owner and consultant groups, are contractor's cash flow problem during construction, lack of

modern equipment in national market, contractor's excessive workload, unskilled operator or technical person, and delay in contractor progress payment by owner. Liquid money shortage by contractor is a common problem if owner selects lowest bidders without proper qualification, in most of the cases a contractor selected in this way will suspend work or reduces the labor and/or equipment, subsequently reducing the speed of the work progress. Since, consultant complained about the lack of modern equipment of contractor; they argued that this is the national problem because the equipments are rare in the national market and costly to procure from international market. Contractor's excessive workload is a common problem, also supported by owner and consultant and they ranked this cause as 20th and 28th. This problem can be solved by an experienced construction manager, a factor which was identified as the 2nd important cause by all the groups. But this problem (excessive works) is solely created by the contractor and, therefore, can also be resolved by them. Probably, they don't have a proper understanding of the volume of work they can successfully run, or in aspiring to increase their earnings; they take in more and more work but are careless about management. Unskilled operator sometime creates accident, or reduces the work rate which leads to schedule delay. Besides, delay in progress payment by owner is another important issue to delay the schedule which is usually influenced by fund shortage of owner.

In brief, all parties agreed that lack of proper management, lack of experience construction manager, and lowest bidder selection are the most important causes of delays. Owners and engineers views coincided in matters pertaining to safety rules. In addition, improper progress monitoring and cost control was identified as important causes of delay but the contractors have reservation. On the other hand, contractors and

engineers discovered very poor consultancy fee as one of the most key causes of delay, but owners disagreed with this perspective. Besides, owners and contractors thought that fund shortage by owner was highly important factor of delay but engineer did not share this opinion.

TABLE 4-38 Rank differences of top 10 important causes by contractor with other groups

Factor of delay	**Rank**		
	Owner	**Contractor**	**Engineer**
Interference in owner's decisions	53	1	17
Lack of experience construction manager	2	2	1
Lowest bidder selection	3	3	2
Funding shortage by owner	7	4	3
Contractor's cash flow problem during construction	28	5	37
Lack of modern equipment in national market	33	6	32
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	16	7	13
Lack of proper management	8	8	5
Contractor's excessive workload	20	9	18
Very poor consultancy fee	43	10	6

Similar study have been done by Assaf and Hejji (2006) in Saudi Arabia and they also found lowest bidder selection; and improper planning and scheduling were important causes of delay by owners' experience. Mahamid (2013) conducted another study in Saudi Arabia to find important causes of delay from owners' perspective. He found awarding lowest bidder; and improper planning and scheduling are currently the most important factors of delay. Furthermore, he identified improper progress monitoring as an important cause of delay similar to Bangladesh. Moreover, Assaf and Hejji (2006) have discovered that according to the contractors in Saudi Arabia, equivalent to the judgments

of Bangladeshi contractors, interference in owners' decision and fund shortage by owner are two very high important causes of delay. They also asked engineers to select most important causes. Like the Bangladeshi engineers, Saudi Arabian engineers also recommended that lack of proper management and lack of skilled workers are very important causes of delay.

Parallel studies have been conducted in Egypt, India, and Malaysia by Mazouk and El-Rasas (2014), Doloi et al. (2012) and Memon et al. (2010). Improper planning and scheduling, and lack of skilled worker have been identified as very high important causes of delay in India and Egypt which matched with the findings of this study. Besides, similar to Bangladesh, lack of proper management and escalation of resources price were also found to be important factors of delay in India. Some other important factors of delay in Bangladesh construction industry, for example, fund shortage by owner, site constraints, contractor's cash flow problem etc., had also been selected as important causes in Egypt. On the other hand, in Malaysia, lowest bidder selection and poor site management by contractor were identified as very important causes. Thus, the finding of this study shows that many factors of schedule delays in construction industry are common regardless of the country or region.

For group factors, different parties have different comments. For instance, the rules and regulation group was considered as top most important causes by owners, where engineers' found contractor related causes are the most important factors. Contractors recommended financing is the main problem causing delay. However, all parties have more or less similar experience about the managerial issues and they agreed on lack of proper management services in different phases of the project are very important factors

of delay. A recent study in Pakistan (Choudhry et al., 2014) has identified financial issue as the number one factor of delay which supports contractors' view of Bangladesh.

4.7.2 Frequent Causes of Delay

Another objective of the study was to find frequent causes of delay encountered in Bangladeshi construction projects. It was found that the owners and consultants views coincided with respect to the most frequent causes of delay. For example, owners identified lack of experience construction manager, building permits and approval process, safety issues, lowest bidder selection, improper planning and schedule, contractor's excessive workload, lack of proper management, lack of skilled workers, lack of modern equipment, poor site management by contractor etc. as most frequent factors of delay. Engineers also agreed upon all of these factors as frequent causes of delay with little variation in order. However, the scenario differed greatly with the contractors. The lists of most common factors of delays by contractors are given in the table 4.39 and compared with the responses of other two parties. Few causes are found by all the parties as most frequent, for instance, lack of experience construction manager, lowest bidder selection, project site constraints, contractor's excessive workload, improper planning and scheduling by contractor etc. For some cases, for instance, inference in owner's decision for financing, very poor consultancy fee paid by contractor etc., the engineers closely agreed with contractors, but the owners' opinions was found to be far away from them.

TABLE 4-39 Comparison of top 15 most frequent causes by contractor with other groups

Individual factors	Rank		
	Contractor	**Engineer**	**Owner**
Lack of experience construction manager	1	1	1
Interference in owner's decisions for financing	2	17	60
Lowest bidder selection	3	2	5
Lack of proper management	4	8	12
Contractor's cash flow problem during construction	5	36	23
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	6	13	6
Very poor consultancy fee	7	4	38
Lack of modern equipment in national market	8	29	22
Contractor's excessive workload	9	14	10
Obtaining permits from municipality	10	37	21
Delays in contractor's progress payment by Owner	11	47	68
Escalation of resources price	12	23	9
Lack of appropriate and modern techniques in construction	13	15	25
Improper planning and scheduling	14	11	7
Frequent change order by owner during construction	15	38	34

Analogous factors like lack of experience construction manager, site constraints, and fluctuation in material prices have been found most frequent in causing delays within Vietnam (Long et al., 2008). Besides, building permits and approval process was found frequent cause of delay in Taiwan (Yau and Yang, 2006). In Saudi Arabia, improper planning and scheduling; contractors' cash flow problem during construction; and lack of skilled worker were identified as always frequent cause of delay by owner, contractor, and engineer, respectively (Assaf and Hejji, 2006).

4.7.3 Severe Causes of Delay

This research also identified the severity of the causes of delay based on the judgment of different respondent groups. Table 4.40 shows comparison of 15 most severe causes of

delay by contractors with other groups. The most severe causes of delay found by owners point of view are inaccurate cost estimation, fund shortage by owner, transportation problem, lowest bidder selection, obsolete construction methods and technologies to site investigation, lack of experience contractor, lack of constructability analysis, lack of experience manager, escalation of resources price, improper planning and scheduling etc. Almost two third of the cases chosen by the engineer coincided with that of the owner. But some causes such as very poor consultancy fee, mistake in competent consultant selection, poor contract management, project site constraints, interference in owner's decision etc., are most significant causes by engineer (within top 15) but not by owner. Both the owner and engineers had different opinion to that of the contractors. For instance, although contractors found lack of modern equipment in national market, contractor cash flow problem, contract related claim/dispute as most significant causes, the engineers found these issues as moderate causes. In addition, contractor identified interference in owners' decisions; contractor excessive workload, site constraints, unskilled operator/technical person etc., as extremely severe factors but the owner, on the other hand, disapproved. Nonetheless, it is important to note that both the owners and engineers found all the fifteen causes as significant but not extreme.

TABLE 4-40 Comparison of top 15 most severe causes by contractor with other groups

Individual	Rank		
	Contractor	**Engineer**	**Owner**
Fund shortage by owner	1	1	2
Interference in owner's decisions	2	15	52
Lack of experience construction manager	3	2	8
Lack of modern equipment in national market	4	39	49
Improper feasibility study	5	9	18
Lowest bidder selection	6	3	4
Contractor's cash flow problem during construction	7	33	35
Contract related disputes/claim	8	43	42
Contractor's excessive workload	9	24	47
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	10	13	43
Lack of skilled workers	11	4	24
Escalation of resources price	12	20	9
Adverse weather conditions	13	19	14
Unskilled operator/technical personal	14	21	33
Lack of proper management	15	5	12

Long et al. (2008) discovered that fund shortage by owner, lack of experience construction manager, contractors' excessive workload, site constraints, and contract related claim/dispute were severe causes of delay in Vietnam which were also found to be severe in Bangladesh. Besides, fund shortage of owner and lack of experience construction manager were identified as significant causes of delay by owners in Malaysia (Alaghbari et al, 2007). Furthermore, the same study reported that Malaysian contractors' have very likely experience to discover extremely severe causes of delay like Bangladeshi, for instance, lack of experience construction manager, fund shortage by owner, and interference in owners' decision. In addition, owners' thought experience contractor; improper planning and schedule have been identified as most severe causes.

On the other hand, A/Es commented lack of skilled worker, and poor site management by contractor are the severe causes of delay in Saudi Arabia (Assaf and Hejji, 2006).

In case of group causes in severity point of view, contractors gave different opinion to some extent than engineer and owner. They identified financing, managerial, and owner categories of causes are the most significant factors of delay. However, both engineer and owner discovered causes created by contractor are the most significant for delay instead of owner. Besides, owner's added rules and regulation group as another severe group of delay. But all the parties' points of view coincided on the point of managerial and financial issues of causing serious delay of construction projects in Bangladesh. However, Marzouk and El-Rasas (2014), who conducted their study in Egypt, found owner related causes to be enormously significant for schedule overrun followed by contractor issues.

4.7.4 Correlation and Difference among the Respondents Groups

Correlations between the respondent groups are justified to get answer about the level of relationship of their judgment. For this purpose Spearman's rank correlation method was applied between the pair of respondents groups. Spearman's correlation showed that contractors and engineers had a strong positive relation (coefficient 0.96), engineers and owners had a moderate positive relation (coefficient 0.73), and owner and contractor had a poor (coefficient 0.54) but positive relation. In addition, a hypothesis test where the null hypothesis signified no significant difference in the opinion of what constituted construction delay among the three parties (H_0) and an alternate hypothesis that represented the existence of a significant difference (H_a) was performed with the aid of Kruskall-Wallis test. For most of the causes, null hypothesis accepted which means no

significance difference exists. But the level of confidence to conclude about the relationship was very poor for most of causes. Very few causes like fluctuation in material price, modern equipment in national market, lack of feasibility study, lack of experience construction manager, project site clearance, unskilled operator/technical person, equipment failure etc. have found approximately same mean by all the parties and confidence level found above 95%.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF THE STUDY

The objectives of the study were straight forward to find existing causes of delay; specify the frequent, severe, and important causes of delay; establish the correlation and check variance among the respondent groups; and recommend for control the schedule overrun of construction projects in Bangladesh.

To achieve the objectives, relevant literatures were reviewed to know the causes of delay encountered in different countries worldwide and to find the methods of research in this arena. The collected information of delay causes then summarized on questionnaire form. By this way, 109 factors were identified and grouped under 9 major categories, and distributed to the Bangladeshi construction experts for pilot survey. Some of the factors merged with others and some of them are deleted, as a result 79 factors were listed in the questionnaire form to ask the respondents. Respondents were three parties such as contractor, engineer, and owner. Total 70 persons were interviewed, i.e. 30 contractors, 20 engineers, and 20 owners. All data were then analyzed to find frequency, severity, and importance indices. Based on the indices the factors were raked and classified into different categories to reach in conclusion. Moreover, correlations between the parties were checked by Spearman's rank coefficient for pair of groups, and variance analysis among three parties was done by Kruskal-Wallis test. However, from 79 questions, 7 are

not taken into analysis because of the shortage of respondents. The respondents were not understood or unresponsive to answer those questions. Thus, 72 questions finally analyzed to seek the objectives. Based on the findings of the study, conclusions and recommendations are written below.

5.2 CONCLUSION

The study result has been divided into five major parts such as frequency of the causes, severity of the causes, importance of the causes, correlation, and variance among the parties. Thus, this research has been concluded on the following heading based the analyses and result discussed in chapter 4:

Causes of delay

After completing the study about the factors affecting construction delay in Bangladesh, 72 causes are identified by the experts. Among these, there are different categories of delay factors found. Some are always frequent, extremely severe, and most important to make schedule delay by suspending or terminating the project. Other factors are claimed to cause delay in different level. Most important causes of delays are lack of experience construction manager, lowest bidder selection, and fund shortage by owner, lack of proper management by both owner and contractor, improper planning and scheduling, lack of skilled workers, site constraints, contractor's cash flow problem during construction, escalation of resources price, contractor's excessive workload etc. in order.

Frequency of the causes

In individual causes of delay, lack of experience construction manager, lowest bidder selection, project site constraints, improper planning and scheduling by contractor, contractor's excessive workload, lack of proper management, escalation of resources price, poor site management by contractor, fund shortage by owner, contractor's cash flow problem etc. identified as always knocking causes of delay in construction project. Besides, these causes are mostly related with managerial and financial issues.

As group, on average they fall into often frequent category except environmental group. Furthermore, rules and regulation, contractor, owner, financing, and managerial group causes have very similar index value and discovered most frequent factors to delay the schedule of the construction projects.

Severity of the causes

This study found fund that shortage by owner, lack of experience construction manager, and lowest bidder selection are extremely severe causes of delay. In addition, some great severe causes of delays are lack of skilled workers, improper feasibility study, lack of proper management, improper planning and scheduling, contractor's cash flow problem during construction period, escalation of resources price, lack of experience contractor, adverse weather condition, inaccurate cost estimation, improper progress monitoring and cost control etc.

As group, financing is the most significant factor of delay followed by managerial, owner, and contractor.

Importance of the causes

Top ten most important causes of delay arranged in order are lack of experience construction manager, lowest bidder selection, funding shortage by owner, lack of proper management, improper planning and scheduling, lack of skilled workers, site constraints, contractor's cash flow problem during construction, escalation of resource prices, and contractor's excessive.

In case of group causes, financing, owner, managerial, rules and regulation and contractor are the most important factors of schedule overrun in Bangladeshi construction project.

Correlation among the Group of respondents

Spearman's rank correlation shows that owner and contractor groups have poor but positive relationship exist to rank the causes of delay. However, very strong positive correlation has been found between contractors and engineers, and moderately positive relationship found between engineers and owners.

Variance among the Group of Respondents

In frequency point of view, significance difference found among the project owners, engineers and contractors on their perception because almost one third causes of delays were rejected. On the other hand, respondent groups have very good understanding to select severe causes of delay, since very few causes were rejected by hypothesis test. But, the confidence level to define level of understanding among the parties about the specific factor of delay was very low. Very few causes were achieved 95% confidence level in this regard.

5.3 RECOMMENDATION

Based on the findings discussed above, the followings are recommended to control the delay problem in large building construction projects in Bangladesh:

In general:

1. Since managerial problem is discovered as the major causes of delay, administrative persons of construction industry need to special attention to solve the problem.
2. A/E firms as well as contracting companies can arrange training program for their engineers to gain proper managerial knowledge from experienced professionals.
3. Financial issue have to be solved from both owner and contractor sides. It can be done by proper feasibility study by owner at the beginning of the project and constructors must have to do the proper financial analysis about cash flow all over the project period.
4. Government agencies are responsible for the building permits and approval process which is defined in rules and regulation group. Since owners are mostly sufferer due to such problems, the administrative system should be clearer and quick to get responses about this system.

Owner should more responsive about the followings:

1. Ensure proper feasibility study and sources of fund before starting the project.

2. Lowest bidder selection should be prohibited or before final award, it is required to collect enough information about the contractor's past experience, records and existing workload.
3. Select competent consultant and provide them enough consultancy fees to do the work properly by investing enough time and merits.

Contractors should be attentive about following:

1. Since accuracy of cost estimation is the key in winning bid and earning profit, thus proper cost estimation is precondition before submitting bid.
2. Planning and scheduling must have to be realistic.
3. Modern equipment is necessary for quick construction in large building projects. Therefore, they should invest money for buying modern equipments and producing a team of skilled operators and technical persons.

Engineer should take special care about the following:

1. Before contracting any work, adequate knowledge and prior experience should be justified by themselves.
2. Shop drawing should prepare in due time with highest accuracy.
3. Try to avoid design error and conflicts between drawing and specification
4. Ensure enough constructability analysis.

5.4 RECOMMENDATION FOR FUTURE STUDY

The followings are some guidelines for future study:

1. Similar study can be done in other cities of Bangladesh to draw general scenario of schedule overrun.
2. Specific research on schedule delay of government project can be done.
3. Delay in large project like as road, bridge, power plant construction project etc. are the important sectors of research.
4. Quantifying the delay for specific causes and developing model for schedule loss by simulation process would be very necessary and efficient study.
5. "Effects of causes of delay in terms of cost" is another valuable area of study.
6. Comparative analysis of causes of delay in Bangladesh with other parts of the world can be done to know about the country's construction condition in global perspective.

APPENDIX A

RESEARCH QUESTIONNARE

Table A1 Questionnaire for pilot survey and engineers' responses

Group	Delay causes from Expert Interview (pilot survey)	Interview outcome
Financing	Contractor's cash flow problem during construction	
	Delays in contractor's progress payment by Owner	
	Partial payments during construction	
	Interference in owner's decisions	
	Fluctuation in material prices	
	Unreasonable constraints to owner	deleted
	Funding shortage by owner	
	High interest rate/Economic rescission/Inflation	
Owner	Frequent change order by owner during construction	
	Improper feasibility study	
	Lack of proper management	
	Ambiguous bidding process	deleted
	Delay in decision making	
	Confusing requirements	deleted
	Delay in site hand over to contractor	deleted
	Inappropriate type of contract used	deleted
	Lowest bidder selection	
	Date of notice to proceed	deleted
	Delay to deliver owner furnished properties	deleted
	Owner's poor contract management	
	Delay to approve shop drawing	
	Delay in approval of sample material	deleted
	Unclear responsibility	deleted
	Bureaucracy	deleted
	No involvement of consultant in design/construction phase	
	Very poor consultancy fee	Newly added
	Mistake in competent consultant selection	Newly added
Contractor	Improper planning and scheduling	
	Lack of planning and schedule	
	Improper progress monitoring and cost control	

	Poor site management	
	Inadequate site inspection	
	Lack of relationship between labor and management	
	Inaccurate cost estimation	
	Incompetent project team	
	Lack of database for estimating activity duration and resources	
	Lack of experience	
	Lack of modern equipment	
	Lack of appropriate and modern techniques in construction	
	Poor contract management	
	Excessive overtime	
	Rework due to improper quality control	deleted
	Conflicts in work schedule of subcontractors	
	Multiple sub-contractors	
	Lack of competent sub-contractor	
Consultant	Lack of experience	
	Error in design	
	Delay in preparation of shop drawing	
	Lack of shop drawing	
	Conflict of the drawing and specification	
	Delay in response	
	Long period for materials approval at site	deleted
	Delay in work inspection and approval	
	Lack of responsibility	
	Inadequate constructability analysis (Impractical design)	
	Inadequate project management assistance	deleted
	Lack of involvement though project life	
Manpower and Resource	Lack of skilled workers	
	Nationality of labor	deleted
	Poor productivity of worker	
	Material shortage	
	Poor productivity of equipment	
	Delay in material procurement	
	Improper material selection	deleted
	Delay in importing materials and equipment	deleted

	Slow delivery of material and equipment	deleted
	Shortage of equipment	
	Material changes in types and specification during construction	
	Lack of modern equipment in national market	
	Unskilled operator/technical personal	
	Equipment failure	
	Transportation problem	
	Escalation of resources price	
Project	Ambiguous project scope	deleted
	Lack of constructability	
	Inaccurate site investigation	
	Obsolete construction methods and technologies	
	Change in site condition	
	Site constraints	
	Delay in site clearance	
Managerial	Conflicts between the parties in the site	
	Unreasonable risk allocation	deleted
	Mistakes and discrepancies in contract documents	deleted
	Poor contract management	
	Insufficient communication between the owner and designer in design phase	
	Contract related disputes	
	Contractor's excessive workload	
	Manger-worker relations	
	Poor coordination among parties	
	Poor material management	
	Poor quality control	deleted
	Poor site management	
	Lack of experience construction manager	
Rules and regulation	Obtaining permits from municipality	
	Changes in laws and regulations	deleted
	Building permits approval process	
	Safety rules	
	Building codes used in design	deleted
	Bureaucracy	deleted
Environmental	Adverse weather conditions	
	Unforeseen ground conditions	deleted

	Strike or other problem	
	Force majeure	deleted
	Work accidents	
	National and local politics	deleted
	Socio-cultural factors	deleted
	Abduction/ Terror forces	Newly added

Table A2 Questionnaire for Large Scale Survey

Group	Delay causes from Expert Interview (pilot survey)	Frequency				Severity			
		1	2	3	4	1	2	3	4
Financing	Contractor's cash flow problem during construction								
	Delays in contractor's progress payment by Owner								
	Partial payments during construction								
	Interference in owner's decisions								
	Fluctuation in material prices								
	Unreasonable constraints to owner								
	Funding shortage by owner								
	High interest rate/Economic rescission/Inflation								
Owner	Frequent change order by owner during construction								
	Improper feasibility study								
	Lack of proper management								
	Ambiguous bidding process								
	Delay in decision making								
	Confusing requirements								
	Delay in site hand over to contractor								
	Inappropriate type of contract used								
	Lowest bidder selection								
	Date of notice to proceed								
	Delay to deliver owner furnished properties								
	Owner's poor contract management								
	Delay to approve shop drawing								
	Delay in approval of sample material								
	Unclear responsibility								

	Bureaucracy								
	No involvement of consultant in design/construction phase								
	Very poor consultancy fee								
	Mistake in competent consultant selection								
Contractor	Improper planning and scheduling								
	Lack of planning and schedule								
	Improper progress monitoring and cost control								
	Poor site management								
	Inadequate site inspection								
	Lack of relationship between labor and management								
	Inaccurate cost estimation								
	Incompetent project team								
	Lack of database for estimating activity duration and resources								
	Lack of experience								
	Lack of modern equipment								
	Lack of appropriate and modern techniques in construction								
	Poor contract management								
	Excessive overtime								
	Rework due to improper quality control								
	Conflicts in work schedule of subcontractors								
	Multiple sub-contractors								
	Lack of competent sub-contractor								
Consultant	Lack of experience								
	Error in design								
	Delay in preparation of shop drawing								
	Lack of shop drawing								
	Conflict of the drawing and specification								
	Delay in response								
	Long period for materials approval at site								
	Delay in work inspection and approval								
	Lack of responsibility								
	Inadequate constructability analysis (Impractical design)								
	Inadequate project management assistance								
	Lack of involvement though project life								
Manpower and Resource	Lack of skilled workers								
	Nationality of labor								

	Poor productivity of worker								
	Material shortage								
	Poor productivity of equipment								
	Delay in material procurement								
	Improper material selection								
	Material damage								
	Delay in importing materials and equipment								
	Slow delivery of material and equipment								
	Shortage of equipment								
	Material changes in types and specification during construction								
	Lack of modern equipment in national market								
	Unskilled operator/technical personal								
	Equipment failure								
	Transportation problem								
	Escalation of resources price								
Project	Ambiguous project scope								
	Lack of constructability								
	Inaccurate site investigation								
	Obsolete construction methods and technologies								
	Change in site condition								
	Site constraints								
	Delay in site clearance								
Managerial	Conflicts between the parties in the site								
	Unreasonable risk allocation								
	Mistakes and discrepancies in contract documents								
	Poor contract management								
	Insufficient communication between the owner and designer in design phase								
	Contract related disputes								
	Contractor’s excessive workload								
	Manger-worker relations								
	Poor coordination among parties								
	Poor material management								
	Poor quality control								
	Poor site management								
	Lack of experience construction manager								
Rules and regulation	Obtaining permits from municipality								
	Changes in laws and regulations								

	Building permits approval process								
	Safety rules								
	Building codes used in design								
	Bureaucracy								
Environmental	Adverse weather conditions								
	Unforeseen ground conditions								
	Strike or other problem								
	Force majeure								
	Work accidents								
	National and local politics								
	Socio-cultural factors								
	Abduction								

Frequency: Always=4; often=3; sometimes=2; and rare=1

Severity: Extreme=4; great=3; moderate=2 and little=1

Name of the Respondent…….

Age……, Experience……..Contact No……

Email (if any)……

APPENDIX B

TABLE 1 Frequency Analysis of the Causes of Delay by Owners

Factor	**Group**	**FI**	**Rank**	**category**
Lack of experience construction manager	Managerial	77.50	1	Always
Building permits approval process	Rules and Reg.	77.50	2	Always
Safety rules	Rules and Reg.	77.50	3	Always
Inaccurate cost estimation	Contractor	75.00	4	Often
Lowest bidder selection	Owner	72.50	5	Often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	71.05	6	Often
Improper planning and scheduling	Contractor	70.00	7	Often
Lack of database for estimating activity duration and resources	Contractor	69.44	8	Often
Escalation of resources price	Man. & Res.	69.12	9	Often
Contractor's excessive workload	Managerial	68.75	10	Often
Improper progress monitoring and cost control	Contractor	68.06	11	Often
Lack of proper management-owner	Owner	67.50	12	Often
Lack of skilled workers	Man. & Res.	66.25	13	Often
Fluctuation in material prices	Financing	66.18	14	Often
Lack of modern equipment	Contractor	65.00	15	Often
Poor site management by contractor	Contractor	65.00	16	Often
Lack of relationship between labor and management	Contractor	64.58	17	Often
Unskilled operator/technical personal	Man. & Res.	64.06	18	Often
Conflicts between the parties in the site	Managerial	63.89	19	Often
Funding shortage by owner	Financing	63.75	20	Often
Obtaining permits from municipality	Rules and Reg.	63.24	21	Often
Lack of modern equipment in national market	Man. & Res.	62.50	22	Often
Contractor's cash flow problem during construction	Financing	62.50	23	Often
Adverse weather conditions	Environmental	62.50	24	Often
Lack of appropriate and modern techniques in construction	Contractor	61.76	25	Often
Improper feasibility study	Owner	61.25	26	Often
High interest rate/Economic rescission/Inflation	Financing	61.25	27	Often
Incompetent project team	Contractor	60.00	28	Often
Poor site management by manager	Managerial	59.62	29	Often
Material shortage	Man. & Res.	59.38	30	Often

Lack of skilled/experienced sub-contractor	Contractor	59.21	31	Often
Inadequate site inspection	Contractor	57.89	32	Often
Mistake in competent consultant selection	Owner	55.00	33	Often
Frequent change order by owner during construction	Owner	55.00	34	Often
Poor contract management	Managerial	55.00	35	Often
Lack of responsibility	Consultant	55.00	36	Often
Owner's poor contract management	Owner	54.55	37	Often
Very poor consultancy fee	Owner	52.94	38	Often
Lack of experience	Contractor	52.78	39	Often
Lack of constructability	Project	52.78	40	Often
Lack of experience	Consultant	52.50	41	Often
Obsolete (old) construction methods and technologies to site investigation	Project	52.27	42	Often
No involvement of consultant in design/construction phase	Owner	50.00	43	Sometime
Delay in work inspection and approval	Consultant	50.00	44	Sometime
Delay in decision making	Owner	48.68	45	Sometime
Contract related disputes/claim	Managerial	48.61	46	Sometime
Error in design	Consultant	48.61	47	Sometime
Delay in response	Consultant	48.53	48	Sometime
Poor coordination among parties	Managerial	48.21	49	Sometime
Poor material management at site/procuring	Managerial	48.21	50	Sometime
Delay to approve shop (detail) drawing	Owner	48.08	51	Sometime
Delay in site clearance	Project	47.73	52	Sometime
Delay in material procurement	Man. & Res.	47.50	53	Sometime
Multiple sub-contractors	Contractor	47.22	54	Sometime
Strike or other problem	Environmental	46.25	55	Sometime
Insufficient communication between the owner and designer in design phase	Managerial	45.59	56	Sometime
Shortage of equipment	Man. & Res.	45.45	57	Sometime
Inaccurate site investigation	Project	45.00	58	Sometime
Delay in preparation of shop drawing	Consultant	44.44	59	Sometime
Interference in owner's decisions	Financing	44.12	60	Sometime
Transportation problem	Man. & Res.	43.75	61	Sometime
Equipment failure	Man. & Res.	42.65	62	Sometime
Material damage	Man. & Res.	42.50	63	Sometime

Inadequate constructability analysis (Impractical design)	Consultant	42.31	64	Sometime
Slow delivery of material and equipment	Man. & Res.	41.67	65	Sometime
Abduction/terror force	Environmental	41.25	66	Sometime
Material changes in types and specification during construction	Man. & Res.	40.91	67	Sometime
Delays in contractor's progress payment by Owner	Financing	40.00	68	Sometime
Conflict of the drawing and specification	Consultant	39.29	69	Sometime
Change in site condition (i.e, soil report is found different when starting work)	Project	38.89	70	Sometime
Delay in importing materials and equipment	Man. & Res.	37.50	71	Sometime
Work accidents	Environmental	33.75	72	Sometime

TABLE 2 Frequency Analysis of the Causes of Delay by Engineers

Factors	**Group**	**FI**	**Rank**	**Category**
Lack of experience construction manager	Managerial	81.25	1	Always
Lowest bidder selection	Owner	81.25	2	Always
Poor site management by contractor	Contractor	81.25	3	Always
Very poor consultancy fee	Owner	80.00	4	Always
Lack of modern equipment	Contractor	77.50	5	Always
Building permits approval process	Rules and Reg.	77.50	6	Always
Safety rules	Rules and Reg.	77.50	7	Always
Lack of proper management	Owner	76.25	8	Always
Improper progress monitoring and cost control	Contractor	76.25	9	Always
Lack of skilled workers	Man. & Res.	75.00	10	Often
Improper planning and scheduling	Contractor	73.75	11	Often
Poor site management by manager	Managerial	73.75	12	Often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	72.50	13	Often
Contractor's excessive workload	Managerial	72.50	14	Often
Lack of appropriate and modern techniques in construction	Contractor	72.50	15	Often
Improper feasibility study	Owner	71.25	16	Often
Interference in owner's decisions	Financing	70.96	17	Often
Fluctuation in material prices	Financing	70.00	18	Often
Mistake in competent consultant selection	Owner	68.75	19	Often

Funding shortage by owner	Financing	68.75	20	Often
Inaccurate cost estimation	Contractor	68.75	21	Often
Lack of relationship between labor and management	Contractor	68.75	22	Often
Escalation of resources price	Man. & Res.	67.50	23	Often
Unskilled operator/technical personal	Man. & Res.	67.50	24	Often
Poor coordination among parties	Managerial	67.50	25	Often
Inadequate site inspection	Contractor	67.50	26	Often
Owner's poor contract management	Owner	66.25	27	Often
Conflicts between the parties in the site	Managerial	66.25	28	Often
Lack of modern equipment in national market	Man. & Res.	65.00	29	Often
Lack of skilled/experienced sub-contractor	Contractor	65.00	30	Often
Incompetent project team	Contractor	63.75	31	Often
Lack of experience	Contractor	63.75	32	Often
Poor contract management	Owner	63.75	33	Often
Poor material management at site/procuring	Managerial	62.50	34	Often
Lack of experience	Consultant	62.50	35	Often
Contractor's cash flow problem during construction	Financing	61.25	36	Often
Obtaining permits from municipality	Rules and Reg.	61.25	37	Often
Frequent change order by owner during construction	Owner	61.25	38	Often
No involvement of consultant in design/construction phase	Owner	61.25	39	Often
Delay in preparation of shop drawing	Consultant	61.25	40	Often
Strike or other problem	Environmental	61.25	41	Often
Adverse weather conditions	Environmental	60.00	42	Often
Delay in decision making	Owner	60.00	43	Often
Material shortage	Man. & Res.	58.75	44	Often
Material changes in types and specification during construction	Man. & Res.	57.50	45	Often
Insufficient communication between the owner and designer in design phase	Managerial	57.50	46	Often
Delays in contractor's progress payment by Owner	Financing	56.25	47	Often
Obsolete (old) construction methods and technologies to site investigation	Project	56.25	48	Often
Conflict of the drawing and specification	Consultant	56.25	49	Often
Delay in response	Consultant	56.25	50	Often
Lack of responsibility	Consultant	56.25	51	Often
Inaccurate site investigation	Project	55.00	52	Often
Lack of constructability	Project	55.00	53	Often
Contract related disputes/claim	Managerial	55.00	54	Often
Equipment failure	Man. & Res.	55.00	55	Often
Inadequate constructability analysis (Impractical design)	Consultant	53.75	56	Often
High interest rate/Economic rescission/Inflation	Financing	53.75	57	Often

Delay in material procurement	Man. & Res.	53.75	58	Often
Delay to approve shop (detail) drawing	Owner	53.75	59	Often
Transportation problem	Man. & Res.	52.50	60	Often
Work accidents	Environmental	52.50	61	Often
Delay in site clearance	Project	52.50	62	Often
Delay in work inspection and approval	Consultant	52.50	63	Often
Multiple sub-contractors	Contractor	51.25	64	Often
Change in site condition (i.e, soil report is found different when starting work)	Project	48.75	65	Sometime
Abduction/terror force	Environmental	48.75	66	Sometime
Material damage	Man. & Res.	47.50	67	Sometime
Shortage of equipment	Man. & Res.	46.25	68	Sometime
Delay in importing materials and equipment	Man. & Res.	46.25	69	Sometime
Slow delivery of material and equipment	Man. & Res.	40.00	70	Sometime
Error in design	Consultant	32.50	71	Sometime

TABLE 3 Frequency Analysis of the Causes of Delay by Contractors

Individual factors	**Group**	**FI**	**Rank**	**category**
Lack of experience construction manager	Managerial	75.83	1	Always
Interference in owner's decisions	Financing	74.07	2	often
Lowest bidder selection	Owner	72.50	3	often
Lack of proper management	Owner	67.86	4	often
Contractor's cash flow problem during construction	Financing	67.50	5	often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	65.83	6	often
Very poor consultancy fee	Owner	65.83	7	often
Lack of modern equipment in national market	Man. & Res.	65.83	8	often
Contractor's excessive workload	Managerial	63.33	9	often
Obtaining permits from municipality	Rules and Reg.	63.33	10	often
Delays in contractor's progress payment by Owner	Financing	62.50	11	often
Escalation of resources price	Man. & Res.	62.50	12	often
Lack of appropriate and modern techniques in construction	Contractor	62.04	13	often
Improper planning and scheduling	Contractor	61.67	14	often
Frequent change order by owner during construction	Owner	61.67	15	often
Unskilled operator/technical personal	Man. & Res.	60.00	16	often
Incompetent project team	Contractor	60.00	17	often
Fluctuation in material prices	Financing	59.17	18	often
Lack of skilled workers	Man. & Res.	59.17	19	often

Inaccurate site investigation	Project	58.33	20	often
Lack of modern equipment	Contractor	58.33	21	often
Lack of skilled/experienced sub-contractor	Contractor	58.33	22	often
Improper progress monitoring and cost control	Contractor	57.50	23	often
Mistake in competent consultant selection	Owner	57.50	24	often
Owner's poor contract management	Owner	57.41	25	often
Obsolete (old) construction methods and technologies to site investigation	Project	56.03	26	often
Improper feasibility study	Owner	55.83	27	often
Building permits approval process	Rules and Reg.	55.83	28	often
Safety rules	Rules and Reg.	55.83	29	often
Funding shortage by owner	Financing	55.83	30	often
Adverse weather conditions	Environmental	55.83	31	often
Material shortage	Man. & Res.	55.83	32	often
Lack of experience	Contractor	55.83	33	often
Material changes in types and specification during construction	Man. & Res.	55.83	34	often
No involvement of consultant in design/construction phase	Owner	55.00	35	often
Conflicts between the parties in the site	Managerial	54.17	36	often
Inaccurate cost estimation	Contractor	54.17	37	often
Delay in preparation of shop drawing	consultant	54.17	38	often
Insufficient communication between the owner and designer in design phase	Managerial	54.17	39	often
Conflict of the drawing and specification	consultant	54.17	40	often
Poor site management by manager	Managerial	53.33	41	often
Poor contract management	Managerial	53.33	42	often
Poor material management at site/procuring	Managerial	53.33	43	often
Material damage	Man. & Res.	52.78	44	often
Delay in decision making	Owner	52.50	45	often
Inadequate constructability analysis (Impractical design)	consultant	52.50	46	often
Strike or other problem	Environmental	51.67	47	often
Lack of constructability	Project	51.67	48	often
Contract related disputes/claim	Managerial	50.83	49	often
Poor coordination among parties	Managerial	50.00	50	sometime
Slow delivery of material and equipment	Man. & Res.	50.00	51	sometime
Poor site management by contractor	Contractor	49.17	52	sometime
Lack of experience	consultant	48.33	53	sometime
High interest rate/Economic rescission/Inflation	Financing	48.33	54	sometime
Delay in response	consultant	48.33	55	sometime
Delay in material procurement	Man. & Res.	47.50	56	sometime
Multiple sub-contractors	Contractor	47.22	57	sometime
Delay to approve shop (detail) drawing	Owner	46.43	58	sometime

Transportation problem	Man. & Res.	45.83	59	sometime
Lack of responsibility	consultant	45.69	60	sometime
Change in site condition (i.e, soil report is found different when starting work)	Project	45.69	61	sometime
Shortage of equipment	Contractor	45.54	62	sometime
Inadequate site inspection	Contractor	44.17	63	sometime
Lack of relationship between labor and management	Contractor	43.52	64	sometime
Work accidents	Environmental	43.33	65	sometime
Equipment failure	Man. & Res.	42.50	66	sometime
Delay in importing materials and equipment	Man. & Res.	42.50	67	sometime
Delay in site clearance	Project	42.31	68	sometime
Delay in work inspection and approval	consultant	42.24	69	sometime
Abduction/terror force	Environmental	40.83	70	sometime
Error in design	consultant	36.67	71	sometime

TABLE 4 Frequency Analysis of the Causes of Delay by All Respondents

Individual factors	**Group**	**FI**	**Rank**	**Category**
Lack of experience construction manager	Managerial	77.86	1	Always
Lowest bidder selection	Owner	75.00	2	Often
Lack of database for estimating activity duration and resources	Contractor	75.00	3	Often
Lack of proper management	Managerial	70.22	4	Often
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	Project	69.20	5	Often
Building permits approval process	Rules and Reg.	68.21	6	Often
Safety rules	Rules and Reg.	68.21	7	Often
Fluctuation in material prices	Financing	68.02	8	Often
Improper planning and scheduling	Contractor	67.50	9	Often
Contractor's excessive workload	Managerial	67.50	10	Often
Very poor consultancy fee	Owner	66.79	11	Often
Contractor's cash flow problem during construction	Financing	66.09	12	Often
Improper progress monitoring and cost control	Contractor	65.81	13	Often
Lack of modern equipment	Contractor	65.71	14	Often
Lack of skilled workers	Man. & Res.	65.71	15	Often
Escalation of resources price	Man. & Res.	65.67	16	Often
Lack of appropriate and modern techniques in construction	Contractor	65.23	17	Often
Lack of modern equipment in national market	Man. & Res.	64.84	18	Often
Unskilled operator/technical personal	Man. & Res.	63.26	19	Often

Poor site management by contractor	Contractor	62.86	20	Often
Obtaining permits from municipality	Rules and Reg.	62.69	21	Often
Inaccurate cost estimation	Contractor	62.50	22	Often
Improper feasibility study	Owner	61.79	23	Often
Funding shortage by owner	Financing	61.79	24	Often
Poor site management by manager	Managerial	61.11	25	Often
Lack of skilled/experienced sub-contractor	Contractor	60.51	26	Often
Mistake in competent consultant selection	Owner	60.38	27	Often
Conflicts between the parties in the site	Managerial	60.29	28	Often
Owner's poor contract management	Owner	59.91	29	Often
Frequent change order by owner during construction	Owner	59.64	30	Often
Adverse weather conditions	Environmental	58.93	31	Often
Material shortage	Man. & Res.	57.58	32	Often
Lack of experience contractor	Contractor	57.14	33	Often
Poor contract management	Owner	57.08	34	Often
Incompetent project team	Contractor	56.43	35	Often
Lack of relationship between labor and management	Contractor	56.36	36	Often
Delays in contractor's progress payment by Owner	Financing	55.70	37	Often
No involvement of consultant in design/construction phase	Owner	55.43	38	Often
Obsolete (old) construction methods and technologies to site investigation	Project	55.42	39	Often
Poor coordination among parties	Managerial	55.08	40	Often
Poor material management at site/procuring	Managerial	55.08	41	Often
Inadequate site inspection	Contractor	54.71	42	Often
Inaccurate site investigation	Project	54.23	43	Often
Material changes in types and specification during construction	Man. & Res.	53.69	44	Often
Lack of experience consultant	consultant	53.68	45	Often
Delay in preparation of shop drawing	consultant	53.68	46	Often
Delay in decision making	Owner	53.62	47	Often
High interest rate/Economic rescission/Inflation	Financing	53.57	48	Often
Insufficient communication between the owner and designer in design phase	Managerial	52.99	49	Often
Lack of constructability	Project	52.97	50	Often
Interference in owner's decisions	Financing	52.93	51	Often
Strike or other problem	Environmental	52.86	52	Often
Conflict of the drawing and specification	consultant	51.56	53	Often
Contract related disputes/claim	Managerial	51.47	54	Often
Multiple sub-contractors	Contractor	51.10	55	Often
Lack of responsibility	consultant	50.85	56	Often
Inadequate constructability analysis (Impractical design)	consultant	50.79	57	Often

Delay in response	consultant	50.75	58	Often
Error in design	consultant	49.63	59	sometime
Delay in material procurement	Man. & Res.	49.29	60	sometime
Delay to approve shop (detail) drawing	Owner	49.18	61	sometime
Material damage	Man. & Res.	49.12	62	sometime
Transportation problem	Man. & Res.	47.84	63	sometime
Delay in work inspection and approval	consultant	47.22	64	sometime
Delay in site clearance	Project	46.93	65	sometime
Equipment failure	Man. & Res.	46.27	66	sometime
Shortage of equipment	Man. & Res.	45.76	67	sometime
Change in site condition (i.e, soil report is found different when starting work)	Project	45.69	68	sometime
Slow delivery of material and equipment	Man. & Res.	44.91	69	sometime
Work accidents	Environmental	43.21	70	sometime
Abduction/terror force	Environmental	43.21	71	sometime
Delay in importing materials and equipment	Man. & Res.	42.14	72	sometime

TABLE 5 Severity Analysis of the Causes of Delay by Owners

Factors	**FI**	**Rank**	**Group**	**Category**
Inaccurate cost estimation	82.50	1	Managerial	Extreme
Funding shortage by owner	81.25	2	Financing	Extreme
Transportation problem	81.25	3	Man. & Res.	Extreme
Lowest bidder selection	80.00	4	Owner	Extreme
Obsolete (old) construction methods and technologies to site investigation	79.55	5	Project	Extreme
Lack of experience	79.17	6	Contractor	Extreme
Lack of constructability	77.78	7	Project	Extreme
Lack of experience construction manager	77.50	8	Managerial	Extreme
Escalation of resources price	76.47	9	Man. & Res.	Extreme
Improper planning and scheduling	75.00	10	Contractor	Great
High interest rate/Economic rescission/Inflation	73.75	11	Financing	Great
Lack of proper management	73.68	12	Owner	Great
Poor site management by manager	73.08	13	Managerial	Great
Adverse weather conditions	71.25	14	Environmental	Great
Improper progress monitoring and cost control	70.83	15	Contractor	Great
Lack of relationship between labor and management	70.83	16	Contractor	Great
Lack of modern equipment	70.00	17	Contractor	Great
Improper feasibility study	70.00	18	Owner	Great

Lack of responsibility	70.00	19	consultant	Great
Lack of database for estimating activity duration and resources	69.44	20	Contractor	Great
Inadequate constructability analysis (Impractical design)	69.23	21	consultant	Great
Building permits approval process	68.75	22	Rules and regulation	Great
Safety rules	68.75	23	Rules and regulation	Great
Lack of skilled workers	68.75	24	Man. & Res.	Great
Poor site management by contractor	68.75	25	Contractor	Great
Incompetent project team	68.75	26	Contractor	Great
Lack of experience	68.75	27	consultant	Great
Poor material management at site/procuring	67.86	28	Managerial	Great
Lack of appropriate and modern techniques in construction	67.65	29	Man. & Res.	Great
Poor contract management	67.50	30	Managerial	Great
Poor coordination among parties	66.07	31	Managerial	Great
Owner's poor contract management	65.91	32	Owner	Great
Unskilled operator/technical personal	65.63	33	Man. & Res.	Great
Material shortage	65.63	34	Man. & Res.	Great
Contractor's cash flow problem during construction	65.00	35	Financing	Great
Mistake in competent consultant selection	65.00	36	Owner	Great
Obtaining permits from municipality	64.71	37	Rules and regulation	Great
Change in site condition (i.e, soil report is found different when starting work)	63.89	38	Project	Great
Frequent change order by owner during construction	63.75	39	Owner	Great
Material changes in types and specification during construction	63.64	40	Man. & Res.	Great
Delay to approve shop (detail) drawing	63.46	41	Owner	Great
Contract related disputes/claim	62.50	42	Managerial	Great
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	61.84	43	Project	Great
Very poor consultancy fee	61.76	44	Owner	Great
Insufficient communication between the owner and designer in design phase	61.76	45	Managerial	Great
Shortage of equipment	61.36	46	Man. & Res.	Great
Contractor's excessive workload	61.25	47	Managerial	Great
Slow delivery of material and equipment	61.11	48	Man. & Res.	Great
Lack of modern equipment in national market	60.71	49	Managerial	Great
Lack of skilled/experienced sub-contractor	60.53	50	Contractor	Great
Fluctuation in material prices	60.29	51	Financing	Great
Interference in owner's decisions	60.29	52	Financing	Great

Conflicts between the parties in the site	59.72	53	Managerial	Great
Inadequate site inspection	59.21	54	Contractor	Great
Delay in response	58.82	55	consultant	Great
No involvement of consultant in design/construction phase	57.89	56	Owner	Great
Material damage	57.50	57	Man. & Res.	Great
Delays in contractor's progress payment by Owner	57.50	58	Financing	Great
Delay in work inspection and approval	57.14	59	consultant	Great
Inaccurate site investigation	55.00	60	Project	Great
Work accidents	55.00	61	Environmental	Great
Equipment failure	54.41	62	Man. & Res.	Great
Delay in preparation of shop drawing	52.78	63	consultant	Great
Delay in decision making	52.63	64	Owner	Great
Delay in material procurement	52.50	65	Man. & Res.	Great
Strike or other problem	52.50	66	Environmental	Great
Abduction/terror force	52.50	67	Environmental	Great
Delay in importing materials and equipment	52.50	68	Man. & Res.	Great
Conflict of the drawing and specification	51.79	69	consultant	Great
Delay in site clearance	50.00	70	Project	Moderate
Multiple sub-contractors	48.61	71	Contractor	Moderate
Error in design	38.89	72	consultant	Moderate

TABLE 6 Severity Analysis of the Causes of Delay by Engineers

Factor	**FI**	**Rank**	**Group**	**Category**
Funding shortage by owner	86.25	1	Financing	Extreme
Lack of experience construction manager	78.75	2	Managerial	Extreme
Lowest bidder selection	78.75	3	Owner	Extreme
Lack of skilled workers	77.50	4	Man. & Res.	Extreme
Lack of proper management	75.00	5	Owner	Great
Improper planning and scheduling	75.00	6	Contractor	Great
Improper progress monitoring and cost control	72.50	7	Contractor	Great
Very poor consultancy fee	70.00	8	Owner	Great
Improper feasibility study	70.00	9	Owner	Great
Poor site management by contractor	68.75	10	Contractor	Great
Mistake in competent consultant selection	68.75	11	Owner	Great
Poor contract management	68.75	12	Managerial	Great
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	67.50	13	Project	Great

Lack of experience	67.50	14	Contractor	Great
Interference in owner's decisions	66.32	15	Financing	Great
Poor site management by contractor	66.25	16	Contractor	Great
Lack of modern equipment	66.25	17	Contractor	Great
Lack of appropriate and modern techniques in construction	66.25	18	Contractor	Great
Adverse weather conditions	66.25	19	Environmental	Great
Escalation of resources price	65.00	20	Man. & Res.	Great
Unskilled operator/technical personal	65.00	21	Man. & Res.	Great
Conflicts between the parties in the site	65.00	22	Managerial	Great
Incompetent project team	65.00	23	Contractor	Great
Contractor's excessive workload	63.75	24	Managerial	Great
Inaccurate cost estimation	63.75	25	Contractor	Great
Owner's poor contract management	63.75	26	Owner	Great
Lack of skilled/experienced sub-contractor	63.75	27	Contractor	Great
Lack of experience	63.75	28	consultant	Great
Poor material management at site/procuring	63.75	29	Managerial	Great
Obtaining permits from municipality	63.75	30	Rules and Reg.	Great
No involvement of consultant in design/construction phase	63.75	31	Owner	Great
Inadequate site inspection	62.50	32	Contractor	Great
Contractor's cash flow problem during construction	62.50	33	Financing	Great
Inaccurate site investigation	62.50	34	Project	Great
Delay in material procurement	62.50	35	Man. & Res.	Great
Building permits approval process	61.25	36	Rules and Reg.	Great
Safety rules	61.25	37	Rules and Reg.	Great
Lack of relationship between labor and management	61.25	38	Contractor	Great
Lack of modern equipment in national market	61.25	39	Man. & Res.	Great
Frequent change order by owner during construction	61.25	40	Owner	Great
Delay in decision making	60.00	41	Owner	Great
Delays in contractor's progress payment by Owner	60.00	42	Financing	Great
Contract related disputes/claim	60.00	43	Managerial	Great
Lack of constructability	58.75	44	Project	Great
Fluctuation in material prices	57.50	45	Financing	Great
Poor coordination among parties	57.50	46	Managerial	Great
Material changes in types and specification during construction	57.50	47	Man. & Res.	Great
Obsolete (old) construction methods and technologies to site investigation	57.50	48	Project	Great
Change in site condition (i.e, soil report is found different when starting work)	57.50	49	Project	Great
Delay in preparation of shop drawing	56.25	50	consultant	Great

Insufficient communication between the owner and designer in design phase	56.25	51	Managerial	Great
Delay to approve shop (detail) drawing	55.00	52	Owner	Great
Transportation problem	55.00	53	Man. & Res.	Great
Material shortage	53.75	54	Man. & Res.	Great
Delay in response	53.75	55	consultant	Great
Equipment failure	53.75	56	Man. & Res.	Great
High interest rate/Economic rescission/Inflation	53.75	57	Financing	Great
Multiple sub-contractors	53.75	58	Contractor	Great
Conflict of the drawing and specification	52.50	59	consultant	Great
Lack of responsibility	51.25	60	consultant	Great
Work accidents	51.25	61	Environmental	Great
Error in design	51.25	62	consultant	Great
Strike or other problem	50.00	63	Environmental	Moderate
Inadequate constructability analysis (Impractical design)	50.00	64	consultant	Moderate
Delay in site clearance	50.00	65	Project	Moderate
Abduction/terror force	50.00	66	Environmental	Moderate
Delay in work inspection and approval	48.75	67	consultant	Moderate
Shortage of equipment	48.75	68	Man. & Res.	Moderate
Material damage	47.50	69	Man. & Res.	Moderate
Delay in importing materials and equipment	46.25	70	Man. & Res.	Moderate
Slow delivery of material and equipment	42.50	71	Man. & Res.	Moderate

TABLE 7 Severity Analysis of the Causes of Delay by Contractors

Individual	**SI**	**Rank**	**Group**	**Category**
Funding shortage by owner	86.67	1	Financing	Extreme
Interference in owner's decisions	84.80	2	Financing	Extreme
Lack of experience construction manager	78.33	3	Managerial	Extreme
Lack of modern equipment in national market	70.83	4	Man. & Res.	Great
Improper feasibility study	70.83	5	Owner	Great
Lowest bidder selection	70.00	6	Owner	Great
Contractor's cash flow problem during construction	70.00	7	Financing	Great
Contract related disputes/claim	69.17	8	Managerial	Great
Contractor's excessive workload	68.33	9	Managerial	Great
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	67.50	10	Project	Great
Lack of skilled workers	67.50	11	Man. & Res.	Great
Escalation of resources price	65.83	12	Man. & Res.	Great
Adverse weather conditions	65.83	13	Environmental	Great

Unskilled operator/technical personal	65.00	14	Man. & Res.	Great
Lack of proper management	64.29	15	Owner	Great
Improper planning and scheduling	63.33	16	Contractor	Great
Poor contract management	63.33	17	Managerial	Great
Lack of modern equipment	62.50	18	Contractor	Great
Conflicts between the parties in the site	62.50	19	Managerial	Great
Inaccurate cost estimation	62.50	20	Contractor	Great
Very poor consultancy fee	61.67	21	Owner	Great
Lack of experience	61.67	22	Contractor	Great
Lack of appropriate and modern techniques in construction	61.11	23	Contractor	Great
Lack of experience	60.83	24	consultant	Great
Frequent change order by owner during construction	60.83	25	Owner	Great
Delay in preparation of shop drawing	60.83	26	consultant	Great
Delays in contractor's progress payment by Owner	60.83	27	Financing	Great
Obsolete (old) construction methods and technologies to site investigation	60.34	28	Project	Great
Poor site management by manager	60.00	29	Managerial	Great
Inadequate constructability analysis (Impractical design)	60.00	30	consultant	Great
Owner's poor contract management	59.26	31	Owner	Great
Improper progress monitoring and cost control	59.17	32	Contractor	Great
Lack of skilled/experienced sub-contractor	59.17	33	Contractor	Great
No involvement of consultant in design/construction phase	59.17	34	Owner	Great
Obtaining permits from municipality	58.33	35	Rules and regulation	Great
Fluctuation in material prices	58.33	36	Financing	Great
Building permits approval process	58.33	37	Rules and regulation	Great
Safety rules	58.33	38	Rules and regulation	Great
Material changes in types and specification during construction	58.33	39	Man. & Res.	Great
Insufficient communication between the owner and designer in design phase	58.33	40	Managerial	Great
Conflict of the drawing and specification	58.33	41	consultant	Great
Lack of constructability	57.50	42	Project	Great
Poor site management by contractor	57.50	43	Contractor	Great
Change in site condition (i.e, soil report is found different when starting work)	56.90	44	Project	Great
Material shortage	56.67	45	Man. & Res.	Great
Inaccurate site investigation	55.83	46	Project	Great
Equipment failure	55.83	47	Man. & Res.	Great
Poor coordination among parties	55.00	48	Managerial	Great

Poor material management at site/procuring	55.00	49	Managerial	Great
Delay in decision making	55.00	50	Owner	Great
Mistake in competent consultant selection	54.17	51	Owner	Great
High interest rate/Economic rescission/Inflation	54.17	52	Financing	Great
Delay in material procurement	54.17	53	Man. & Res.	Great
Incompetent project team	53.33	54	Contractor	Great
Material damage	52.78	55	Man. & Res.	Great
Strike or other problem	52.50	56	Environmental	Great
Transportation problem	52.50	57	Man. & Res.	Great
Lack of relationship between labor and management	51.85	58	Contractor	Great
Shortage of equipment	51.79	59	Man. & Res.	Great
Inadequate site inspection	50.83	60	Contractor	Great
Delay in response	50.00	61	consultant	Moderate
Slow delivery of material and equipment	50.00	62	Man. & Res.	Moderate
Delay to approve shop (detail) drawing	50.00	63	Owner	Moderate
Work accidents	50.00	64	Environmental	Moderate
Delay in site clearance	50.00	65	Project	Moderate
Lack of responsibility	47.41	66	consultant	Moderate
Delay in importing materials and equipment	46.67	67	Man. & Res.	Moderate
Multiple sub-contractors	45.83	68	Contractor	Moderate
Delay in work inspection and approval	45.69	69	consultant	Moderate
Abduction/terror force	44.17	70	Environmental	Moderate
Error in design	40.00	71	consultant	Moderate

TABLE 8 Severity Analysis of the Causes of Delay by All Respondents

Factor	**SI**	**Rank**	**Group**	**category**
Funding shortage by owner	85.00	1	Financing	Extreme
Lack of experience construction manager	78.21	2	Managerial	Extreme
Lowest bidder selection	75.36	3	Owner	Extreme
Lack of skilled workers	70.71	4	Man. & Res.	Great
Improper feasibility study	70.36	5	Owner	Great
Lack of proper management	70.15	6	Owner	Great
Improper planning and scheduling	70.00	7	Contractor	Great
Contractor’s cash flow problem during construction	68.29	8	Financing	Great
Escalation of resources price	68.28	9	Man. & Res.	Great
Lack of experience	67.65	10	Contractor	Great
Adverse weather conditions	67.50	11	Environmental	Great
Inaccurate cost estimation	66.25	12	Contractor	Great

Improper progress monitoring and cost control	66.18	13	Contractor	Great
Poor site management	66.07	14	Contractor	Great
Site constraints (i.e. Road side, neighbor buildings, R/A or Commercial Area etc.)	65.94	15	Project	Great
Poor contract management	65.83	16	Managerial	Great
Lack of modern equipment	65.71	17	Contractor	Great
Lack of modern equipment in national market	65.63	18	Man. & Res.	Great
Poor site management	65.48	19	Managerial	Great
Unskilled operator/technical personal	65.15	20	Man. & Res.	Great
Contractor's excessive workload	65.00	21	Managerial	Great
Contract related disputes/claim	64.71	22	Managerial	Great
Lack of appropriate and modern techniques in construction	64.45	23	Contractor	Great
Lack of experience	64.29	24	consultant	Great
Very poor consultancy fee	64.18	25	Owner	Great
Obsolete (old) construction methods and technologies to site investigation	62.92	26	Project	Great
Conflicts between the parties in the site	62.50	27	Managerial	Great
Safety rules	62.14	28	Rules and Reg.	Great
Owner's poor contract management	62.07	29	Owner	Great
Fluctuation in material prices	61.92	30	Man. & Res.	Great
Frequent change order by owner during construction	61.79	31	Owner	Great
Obtaining permits from municipality	61.57	32	Rules and Reg.	Great
Delays in contractor's progress payment by Owner	61.26	33	Financing	Great
Mistake in competent consultant selection	61.15	34	Owner	Great
Incompetent project team	61.07	35	Contractor	Great
Lack of constructability	61.02	36	Project	Great
Lack of skilled/experienced sub-contractor	60.87	37	Contractor	Great
Poor material management at site/procuring	60.55	38	Managerial	Great
No involvement of consultant in design/construction phase	60.14	39	Owner	Great
High interest rate/Economic rescission/Inflation	59.64	40	Financing	Great
Building permits approval process	59.48	41	Rules and Reg.	Great
Material changes in types and specification during construction	59.02	42	Man. & Res.	Great
Lack of relationship between labor and management	58.90	43	Contractor	Great
Inadequate constructability analysis (Impractical design)	58.73	44	consultant	Great
Interference in owner's decisions	58.65	45	Financing	Great
Insufficient communication between the owner and designer in design phase	58.58	46	Managerial	Great
Error in design	58.46	47	consultant	Great

Lack of database for estimating activity duration and resources	58.33	48	Contractor	Great
Poor coordination among parties	58.20	49	Managerial	Great
Change in site condition (i.e, soil report is found different when starting work)	58.19	50	Project	Great
Material shortage	57.95	51	Man. & Res.	Great
Inaccurate site investigation	57.69	52	Project	Great
Delay in preparation of shop drawing	57.35	53	consultant	Great
Transportation problem	57.33	54	Man. & Res.	Great
Inadequate site inspection	56.52	55	Contractor	Great
Delay in material procurement	56.07	56	Man. & Res.	Great
Delay in decision making	55.80	57	Owner	Great
Conflict of the drawing and specification	55.08	58	consultant	Great
Equipment failure	54.85	59	Man. & Res.	Great
Delay to approve shop (detail) drawing	54.51	60	Owner	Great
Delay in response	53.36	61	consultant	Great
Lack of responsibility	52.54	62	consultant	Great
Shortage of equipment	52.54	63	Man. & Res.	Great
Multiple sub-contractors	51.84	64	Contractor	Great
Work accidents	51.79	65	Environmental	Great
Strike or other problem	51.79	66	Environmental	Great
Material damage	51.75	67	Man. & Res.	Great
Delay in work inspection and approval	49.21	68	consultant	Moderate
Delay in site clearance	49.12	69	Project	Moderate
Slow delivery of material and equipment	49.07	70	Man. & Res.	Moderate
Delay in importing materials and equipment	48.21	71	Man. & Res.	Moderate
Abduction/terror force	48.21	72	Environmental	Moderate

TABLE 9 Kruskal-Wallis Test for Frequency Analysis among Respondent Groups

Factor of delay	**Group**	**N**	**Mean Rank**	**Chi-square**	**Level of severity**	**Accept H_0 if α>0.05**
financing_contr_cash_prb	Contr	30	37.88			
	Engr	20	32.33			
	Owner	20	35.10			
	Total	70		1.027	0.598	accepted
financing_delay_prog_pay	Contr	30	42.25			
	Engr	20	37.78			
	Owner	20	23.10			
	Total	70		12.302	0.002	rejected
financing_Inter_owner_decision	Contr	30	31.38			

	Engr	20	41.90			
	Owner	17	29.32			
	Total	67		5.332	0.070	accepted
financing_fluct_material_price	Contr	30	30.23			
	Engr	20	38.40			
	Owner	17	35.47			
	Total	67		2.466	0.291	accepted
financing_fund_short_owner	Contr	30	31.26			
	Engr	20	40.52			
	Owner	20	36.82			
	Total	70		2.802	0.246	accepted
financing_hig_Inter_rate_Inflation	Contr	30	31.40			
	Engr	20	36.07			
	Owner	20	41.07			
	Total	70		2.997	0.223	accepted
owner_change_order	Contr	30	37.36			
	Engr	20	36.67			
	Owner	20	31.52			
	Total	70		1.173	0.556	accepted
owner_Imp_feasibility_study	Contr	30	31.33			
	Engr	20	42.15			
	Owner	20	35.10			
	Total	70		3.637	0.162	accepted
owner_lack_proper_mang	Contr	28	33.16			
	Engr	20	38.45			
	Owner	20	32.42			
	Total	68		1.257	0.533	accepted
owner_delay_decision_making	Contr	30	33.96			
	Engr	20	40.70			
	Owner	19	30.63			
	Total	69		2.843	0.241	accepted
owner_lowest_bidder_selection	Contr	30	33.15			
	Engr	20	40.32			
	Owner	20	34.20			
	Total	70		1.815	0.403	accepted
owner_poor_contract_mang	Contr	27	27.48			
	Engr	20	33.80			
	Owner	11	26.63			
	Total	58		2.223	0.329	accepted
owner_delay_appr_shop_drawing	Contr	28	29.32			
	Engr	20	35.10			
	Owner	13	28.31			
	Total	61		1.857	0.395	accepted
owner_no_consultant_in_const	Contr	30	35.12			
	Engr	20	39.17			
	Owner	19	30.42			
	Total	69		2.010	0.366	accepted
owner_poor_consultancy_fee	Contr	30	33.00			
	Engr	20	42.95			
	Owner	17	25.23			
	Total	67		8.307	0.016	rejected
owner_mistake_consultant_selection	Contr	30	30.90			
	Engr	20	39.00			

	Owner	15	29.20			
	Total	65		3.219	0.200	accepted
contr_improper_planning_sched	Contr	30	31.80			
	Engr	20	38.92			
	Owner	20	37.62			
	Total	70		1.916	0.384	accepted
contr_improper_prog_monitoring	Contr	30	28.96			
	Engr	20	41.37			
	Owner	18	36.08			
	Total	68		5.321	0.070	accepted
contr_poor_site_manag	Contr	30	26.46			
	Engr	20	47.55			
	Owner	20	37.00			
	Total	70		13.989	0.001	rejected
contr_inad_siteinspection	Contr	30	27.40			
	Engr	20	44.72			
	Owner	19	36.76			
	Total	69		10.053	0.007	rejected
contr_lack_relat_labor_mangt	Contr	27	21.05			
	Engr	20	38.92			
	Owner	12	35.25			
	Total	59		15.199	0.001	rejected
contr_inaccrt_cost_estimation	Contr	30	24.51			
	Engr	20	35.72			
	Owner	10	38.00			
	Total	60		7.941	0.019	rejected
contr_incop_project_team	Contr	30	29.13			
	Engr	20	41.75			
	Owner	20	38.80			
	Total	70		5.954	0.051	rejected
contr_lack_experience	Contr	30	29.73			
	Engr	20	42.00			
	Owner	18	34.11			
	Total	68		5.056	0.080	accepted
contr_lack_modern_equipment	Contr	30	29.80			
	Engr	20	44.35			
	Owner	20	35.20			
	Total	70		6.582	0.037	rejected
contr_lack_appr_modern_tech_construction	Contr	27	29.98			
	Engr	20	37.82			
	Owner	17	30.23			
	Total	64		2.621	0.270	accepted
contr_multi_sub_contractor	Contr	30	33.15			
	Engr	20	39.27			
	Owner	18	31.44			
	Total	68		1.974	0.373	accepted
contr_lack_skilled_sub_contr	Contr	30	33.10			
	Engr	20	38.52			
	Owner	19	34.28			
	Total	69		1.005	0.605	accepted
consl_lack_experience	Contr	30	34.45			
	Engr	20	41.12			
	Owner	20	31.45			

	Total	70		2.704	0.259	accepted
consl_error_design	Contr	30	32.03			
	Engr	20	40.02			
	Owner	18	32.47			
	Total	68		2.520	0.284	accepted
consl_delay_preparation_shop_draw	Contr	30	34.88			
	Engr	20	40.62			
	Owner	18	27.05			
	Total	68		4.878	0.087	accepted
consl_conflict_draw_specf	Contr	30	34.40			
	Engr	20	36.95			
	Owner	14	22.07			
	Total	64		6.531	0.038	rejected
consl_delay_response	Contr	30	31.68			
	Engr	20	39.60			
	Owner	17	31.50			
	Total	67		2.677	0.262	accepted
consl_delay_work_insp_appr	Contr	29	27.55			
	Engr	20	36.25			
	Owner	14	35.14			
	Total	63		3.795	0.150	accepted
consl_lack_responsibility	Contr	29	26.32			
	Engr	20	33.70			
	Owner	10	33.25			
	Total	59		3.432	0.180	rejected
consl_inad_constuct_analysis	Contr	30	32.86			
	Engr	20	35.27			
	Owner	13	24.96			
	Total	63		3.009	0.222	accepted
ManRes_lack_skilled_workers	Contr	30	29.98			
	Engr	20	42.75			
	Owner	20	36.52			
	Total	70		5.425	0.066	accepted
ManRes_poor_productivity_worker	Contr	30	31.20			
	Engr	20	35.15			
	Owner	16	35.75			
	Total	66		0.991	0.609	accepted
ManRes_malterial_short	Contr	30	34.33			
	Engr	20	39.15			
	Owner	20	33.60			
	Total	70		1.055	0.590	accepted
ManRes_poor_productivity_Equipment	Contr	27	31.53			
	Engr	20	28.10			
	Owner	10	23.95			
	Total	57		1.846	0.397	accepted
ManRes_malterial_damage	Contr	30	36.11			
	Engr	20	38.62			
	Owner	20	31.45			
	Total	70		1.551	0.461	accepted
ManRes_delay_import_matl_equp	Contr	25	31.66			
	Engr	20	23.77			
	Owner	9	24.22			
	Total	54		3.995	0.136	accepted

ManRes_slow_delivary_matl_equp	Contr	28	29.92			
	Engr	20	31.12			
	Owner	11	28.13			
	Total	59		0.265	0.876	accepted
ManRes_shortage_equp	Contr	30	35.06			
	Engr	20	35.60			
	Owner	14	22.57			
	Total	64		5.774	0.056	accepted
ManRes_malt_chang_type_spc_dur_cons	Contr	30	32.80			
	Engr	20	34.42			
	Owner	11	19.86			
	Total	61		6.141	0.046	rejected
ManRes_lack_modern_equp_national_markt	Contr	30	32.90			
	Engr	20	32.90			
	Owner	14	31.07			
	Total	64		0.115	**0.944**	accepted
ManRes_unskld_operator	Contr	30	30.06			
	Engr	20	38.35			
	Owner	16	33.87			
	Total	66		2.625	0.269	accepted
ManRes_equpmt_failure	Contr	30	30.85			
	Engr	20	42.60			
	Owner	17	29.44			
	Total	67		6.629	0.036	rejected
ManRes_transportation_problem	Contr	30	28.08			
	Engr	20	33.45			
	Owner	8	24.93			
	Total	58		2.288	0.319	rejected
ManRes_Resource_price_escalation	Contr	30	30.93			
	Engr	20	35.72			
	Owner	17	37.38			
	Total	67		1.652	0.438	accepted
Project_lack_constructibilty	Contr	30	29.31			
	Engr	20	31.70			
	Owner	9	28.50			
	Total	59		0.393	0.821	accepted
Project_inccr_site_invest	Contr	30	36.61			
	Engr	20	33.85			
	Owner	15	24.63			
	Total	65		4.664	0.097	accepted
Project_obslt_cons_methd_tech	Contr	29	30.50			
	Engr	20	32.02			
	Owner	11	27.72			
	Total	60		0.465	0.792	accepted
Project_change_site_condn	Contr	29	29.17			
	Engr	20	32.25			
	Owner	9	24.44			
	Total	58		1.575	0.455	accepted
Project_site_constraints	Contr	30	31.38			
	Engr	20	37.80			
	Owner	19	37.76			
	Total	69		1.575	0.373	accepted
Project_delay_site_clearance	Contr	26	25.63			

	Engr	20	33.15			
	Owner	11	29.40			
	Total	57		2.646	0.266	accepted
Mang_conflict_bet_parties	Contr	30	29.98			
	Engr	20	38.87			
	Owner	18	37.16			
	Total	68		3.081	0.214	accepted
Mang_poor_contrc_management	Contr	30	28.01			
	Engr	20	35.20			
	Owner	10	28.55			
	Total	60		2.463	0.292	accepted
Mang_insuff_comm_bet_own_designer	Contr	30	35.18			
	Engr	20	37.32			
	Owner	17	28.00			
	Total	67		2.547	0.280	accepted
Mang_contract_dispute	Contr	30	34.13			
	Engr	20	37.70			
	Owner	18	31.55			
	Total	68		1.054	0.590	accepted
Mang_contractor_excess_workload	Contr	30	32.36			
	Engr	20	39.47			
	Owner	20	36.22			
	Total	70		1.629	0.443	accepted
Mang_poor_coordination_among_parties	Contr	30	28.96			
	Engr	20	42.02			
	Owner	14	26.46			
	Total	64		8.659	0.013	rejected
Mang_poor_malt_manag	Contr	30	31.13			
	Engr	20	38.40			
	Owner	14	27.00			
	Total	64		3.803	0.149	accepted
Mang_poor_site_management	Contr	30	25.88			
	Engr	20	41.90			
	Owner	13	30.88			
	Total	63		10.166	0.006	rejected
Mang_lack_experience_const_managr	Contr	30	34.81			
	Engr	20	36.02			
	Owner	20	36.00			
	Total	70		0.068	**0.966**	accepted
Rul_obtn_permit_municipl	Contr	30	34.30			
	Engr	20	33.07			
	Owner	17	34.55			
	Total	67		0.071	**0.965**	accepted
Rul_buld_permit_appr_process	Contr	28	26.89			
	Engr	20	31.82			
	Owner	10	32.15			
	Total	58		1.431	0.489	accepted
Rul_safety_rules	Contr	30	26.71			
	Engr	20	42.05			
	Owner	20	42.12			
	Total	70		10.547	0.005	rejected
Envr_advrs_weather_condtns	Contr	30	33.13			
	Engr	20	35.90			

	Owner	20	38.65			
	Total	70		1.098	0.577	accepted
Envr_strike_otherpolitical_problem	Contr	30	34.66			
	Engr	20	43.00			
	Owner	20	29.25			
	Total	70		5.244	0.073	accepted
Envr_work_accidents	Contr	30	36.01			
	Engr	20	44.10			
	Owner	20	26.12			
	Total	70		9.223	0.010	rejected
Envr_abduction_terror_force	Contr	30	33.86			
	Engr	20	42.15			
	Owner	20	31.30			
	Total	70		3.862	0.145	accepted

TABLE 10 Kruskal-Wallis Test for Severity Analysis among Respondent Groups

Factors	Group	N	Mean Rank	Chi-square	Level of severity(α)	Accept H_0 if α>0.05
financing_contr_cash_prb	Contr	30	38.43			
	Engr	20	31.65			
	Owner	20	34.95			
	Total	70		1.47	.479	accepted
financing_delay_prog_pay	Contr	30	36.20			
	Engr	20	36.35			
	Owner	20	33.60			
	Total	70		0.27	.874	accepted
financing_Inter_owner_decision	Contr	30	31.03			
	Engr	20	35.30			
	Owner	17	37.71			
	Total	67		1.52	.468	accepted
financing_fluct_material_price	Contr	30	33.65			
	Engr	20	33.70			
	Owner	17	34.97			
	Total	67		0.061	**.97**	accepted
financing_fund_short_owner	Contr	30	37.10			
	Engr	20	35.60			
	Owner	20	33.00			
	Total	70		0.627	.731	accepted
financing_hig_Inter_rate_Inflation	Contr	30	31.28			
	Engr	20	30.98			
	Owner	20	46.35			
	Total	70		8.59	0.014	rejected
owner_change_order	Contr	30	34.70			
	Engr	20	34.90			
	Owner	20	37.30			
	Total	70		0.249	0.883	accepted
owner_Imp_feasibility_study	Contr	30	35.53			
	Engr	20	35.78			

	Owner	20	35.18			
	Total	70		0.010	**0.995**	accepted
owner_lack_proper_mang	Contr	28	29.39			
	Engr	20	37.88			
	Owner	19	36.71			
	Total	67		3.00	0.222	accepted
owner_delay_decision_making	Contr	30	33.95			
	Engr	20	38.50			
	Owner	19	32.97			
	Total	69		1.014	0.602	accepted
owner_lowest_bidder_selection	Contr	30	32.95			
	Engr	20	38.13			
	Owner	20	36.70			
	Total	70		0.978	0.613	accepted
owner_poor_contract_mang	Contr	27	27.17			
	Engr	20	30.60			
	Owner	11	33.23			
	Total	58		1.344	0.511	accepted
owner_delay_appr_shop_drawing	Contr	28	27.34			
	Engr	20	31.25			
	Owner	13	38.50			
	Total	61		3.967	0.138	accepted
owner_no_consultant_in_const	Contr	30	34.42			
	Engr	20	37.40			
	Owner	19	33.39			
	Total	69		0.468	0.791	accepted
owner_poor_consultancy_fee	Contr	30	32.17			
	Engr	20	38.45			
	Owner	17	32.00			
	Total	67		1.609	0.447	accepted
owner_mistake_consultant_selection	Contr	30	27.28			
	Engr	20	39.03			
	Owner	15	36.40			
	Total	65		5.889	0.053	accepted
contr_improper_planning_sched	Contr	30	30.37			
	Engr	20	40.20			
	Owner	20	38.50			
	Total	70		3.86	0.145	accepted
contr_improper_prog_monitoring	Contr	30	29.63			
	Engr	20	39.10			
	Owner	18	37.50			
	Total	68		3.626	0.163	accepted
contr_poor_site_manag	Contr	30	29.00			
	Engr	20	43.63			
	Owner	20	37.13			
	Total	70		7.418	0.025	rejected
contr_inad_siteinspection	Contr	30	29.80			
	Engr	20	40.35			
	Owner	19	37.58			
	Total	69		4.217	0.121	accepted
contr_lack_relat_labor_mangt	Contr	27	24.76			
	Engr	20	31.65			
	Owner	12	39.04			
	Total	59		7.119	0.028	rejected

contr_inaccrt_cost_estimation	Contr	30	27.53			
	Engr	20	28.75			
	Owner	10	42.90			
	Total	60		6.825	0.033	rejected
contr_incop_project_team	Contr	30	28.10			
	Engr	20	39.85			
	Owner	20	42.25			
	Total	70		8.107	0.017	rejected
contr_lack_experience	Contr	30	30.02			
	Engr	20	33.50			
	Owner	18	43.08			
	Total	68		5.504	0.064	accepted
contr_lack_modern_equipment	Contr	30	32.85			
	Engr	20	36.28			
	Owner	20	38.70			
	Total	70		1.168	0.558	accepted
contr_lack_appr_modern_tech_construction	Contr	27	29.31			
	Engr	20	34.33			
	Owner	17	35.41			
	Total	64		1.543	0.462	accepted
contr_multi_sub_contractor	Contr	30	34.57			
	Engr	20	36.90			
	Owner	18	31.72			
	Total	68		0.774	0.679	accepted
contr_lack_skilled_sub_contr	Contr	30	33.02			
	Engr	20	39.23			
	Owner	19	33.68			
	Total	69		1.516	0.469	accepted
consl_lack_experience	Contr	30	33.07			
	Engr	20	34.05			
	Owner	20	40.60			
	Total	70		2.127	0.345	accepted
consl_error_design	Contr	30	31.85			
	Engr	20	40.48			
	Owner	18	32.28			
	Total	68		2.98	0.225	accepted
consl_delay_preparation_shop_draw	Contr	30	37.53			
	Engr	20	33.15			
	Owner	18	30.94			
	Total	68		1.50	0.472	accepted
consl_conflict_draw_specf	Contr	30	34.68			
	Engr	20	31.50			
	Owner	14	29.25			
	Total	64		1.022	0.60	accepted
consl_delay_response	Contr	30	31.67			
	Engr	20	35.00			
	Owner	17	36.94			
	Total	67		1.001	0.606	accepted
consl_delay_work_insp_appr	Contr	29	28.71			
	Engr	20	32.15			
	Owner	14	38.61			
	Total	63		3.181	0.204	accepted
consl_lack_responsibility	Contr	29	26.52			

	Engr	20	29.13			
	Owner	10	41.85			
	Total	59		7.687	0.021	rejected
consl_inad_constuct_analysis	Contr	30	32.67			
	Engr	20	25.83			
	Owner	13	39.96			
	Total	63		5.293	0.071	accepted
ManRes_lack_skilled_workers	Contr	30	32.80			
	Engr	20	41.40			
	Owner	20	33.65			
	Total	70		2.76	0.252	accepted
ManRes_poor_productivity_worker	Contr	30	32.57			
	Engr	20	29.35			
	Owner	16	40.44			
	Total	66		3.873	0.144	accepted
ManRes_malterial_short	Contr	30	33.83			
	Engr	20	40.43			
	Owner	20	33.08			
	Total	70		1.809	0.405	accepted
ManRes_poor_productivity_Equipment	Contr	27	30.22			
	Engr	20	25.35			
	Owner	10	33.00			
	Total	57		2.298	0.317	accepted
ManRes_malterial_damage	Contr	30	34.25			
	Engr	20	33.55			
	Owner	20	39.33			
	Total	70		1.161	0.56	accepted
ManRes_delay_import_matl_equp	Contr	25	28.60			
	Engr	20	22.45			
	Owner	9	35.67			
	Total	54		5.609	0.061	accepted
ManRes_slow_delivary_matl_equp	Contr	28	28.66			
	Engr	20	27.63			
	Owner	11	37.73			
	Total	59		3.726	0.155	accepted
ManRes_shortage_equp	Contr	30	35.47			
	Engr	20	29.13			
	Owner	14	30.96			
	Total	64		1.658	0.436	accepted
ManRes_malt_chang_type_spc_dur_cons	Contr	30	30.27			
	Engr	20	29.10			
	Owner	11	36.45			
	Total	61		1.68	0.432	accepted
ManRes_lack_modern_equp_national_markt	Contr	30	36.68			
	Engr	20	29.08			
	Owner	14	28.43			
	Total	64		3.147	0.207	
ManRes_unskld_operator	Contr	30	33.30			
	Engr	20	33.25			
	Owner	16	34.19			
	Total	66		0.032	**0.984**	accepted
ManRes_equpmt_failure	Contr	30	34.38			
	Engr	20	33.65			
	Owner	17	33.74			

	Total	67		0.024	**0.988**	accepted
ManRes_transportation_problem	Contr	30	25.97			
	Engr	20	28.90			
	Owner	8	44.25			
	Total	58		8.785	0.012	rejected
ManRes_Resource_price_escalation	Contr	30	31.93			
	Engr	20	31.15			
	Owner	17	41.00			
	Total	67		3.264	0.196	accepted
Project_lack_constructibilty	Contr	30	27.00			
	Engr	20	28.23			
	Owner	9	43.94			
	Total	59		8.345	0.015	rejected
Project_inccr_site_invest	Contr	30	30.92			
	Engr	20	37.40			
	Owner	15	31.30			
	Total	65		1.806	0.405	accepted
Project_obslt_cons_methd_tech	Contr	29	28.43			
	Engr	20	26.38			
	Owner	11	43.45			
	Total	60		8.471	0.014	accepted
Project_change_site_condn	Contr	29	28.84			
	Engr	20	29.20			
	Owner	9	32.28			
	Total	58		0.333	0.846	accepted
Project_site_constraints	Contr	30	36.60			
	Engr	20	36.45			
	Owner	19	30.95			
	Total	69		1.286	0.526	accepted
Project_delay_site_clearance	Contr	25	28.64			
	Engr	20	28.20			
	Owner	11	28.73			
	Total	56		0.012	**0.994**	accepted
Mang_conflict_bet_parties	Contr	30	34.30			
	Engr	20	36.50			
	Owner	18	32.61			
	Total	68		0.407	0.816	accepted
Mang_poor_contrc_management	Contr	30	28.30			
	Engr	20	33.00			
	Owner	10	32.10			
	Total	60		1.138	0.566	accepted
Mang_insuff_comm_bet_own_designer	Contr	30	33.72			
	Engr	20	32.35			
	Owner	17	36.44			
	Total	67		0.491	0.782	accepted
Mang_contract_dispute	Contr	30	38.45			
	Engr	20	30.30			
	Owner	18	32.58			
	Total	68		2.585	0.275	accepted
Mang_contractor_excess_workload	Contr	30	38.63			
	Engr	20	34.40			
	Owner	20	31.90			
	Total	70		1.624	.444	accepted
Mang_poor_coordination_among_parties	Contr	30	29.23			

	Engr	20	31.73			
	Owner	14	40.61			
	Total	64		4.438	0.109	accepted
Mang_poor_malt_manag	Contr	30	28.55			
	Engr	20	35.08			
	Owner	14	37.29			
	Total	64		2.992	0.224	accepted
Mang_poor_site_management	Contr	30	27.55			
	Engr	20	34.73			
	Owner	13	38.08			
	Total	63		4.092	0.129	accepted
Mang_lack_experience_const_managr	Contr	30	36.28			
	Engr	20	35.05			
	Owner	20	34.78			
	Total	70		0.096	**0.953**	accepted
Rul_obtn_permit_municipl	Contr	30	31.22			
	Engr	20	35.48			
	Owner	17	37.18			
	Total	67		1.299	0.522	accepted
Rul_buld_permit_appr_process	Contr	28	26.32			
	Engr	20	31.00			
	Owner	10	35.40			
	Total	58		2.648	0.266	accepted
Rul_safety_rules	Contr	30	32.57			
	Engr	20	34.63			
	Owner	20	40.78			
	Total	70		2.155	0.340	accepted
Envr_advrs_weather_condtns	Contr	30	33.77			
	Engr	20	34.25			
	Owner	20	39.35			
	Total	70		1.127	0.569	accepted
Envr_strike_other political _problem	Contr	30	36.35			
	Engr	20	33.68			
	Owner	20	36.05			
	Total	70		0.260	0.878	accepted
Envr_work_accidents	Contr	30	33.22			
	Engr	20	35.33			
	Owner	20	39.10			
	Total	70		1.166	0.558	accepted
Envr_abduction_terror_force	Contr	30	32.27			
	Engr	20	36.05			
	Owner	20	39.80			
	Total	70		1.916	0.384	accepted

REFFERENCES

[1] Abdul-Rahman, H., Berawi, M., 2006. Delay mitigation in the Malaysian construction industry. J. Constr. Eng. Manag. 132, 125–133.

[2] Ahmed, S., Azhar, S., 2002. Construction delays in Florida: an empirical study. Final Rep. Submitt. to Plan. Consult. State Florida, Dep. Community Aff.

[3] Ahsan, K., Gunawan, I., 2010. Analysis of cost and schedule performance of international development projects. Int. J. Proj. Manag. 28, 68–78.

[4] AIA MBA Joint Committee, 2010: http://www.mbawpa.org/aia-mba/d4-precedence.asp

[5] Odeyinka, H. A., Yusif, A., 1997. The causes and effects of construction delays on completion cost of housing projects in Nigeria. J. Finan. Manag. Prop. Constr. 2, 31-44.

[6] Aibinu, A.A., Jagboro, G., 2002. The effects of construction delays on project delivery in Nigerian construction industry. Int. J. Proj. Manag. 20, 593–599.

[7] Aibinu, A.A., Odeyinka, H.A., 2006. Construction delays and their causative factors in Nigeria. J. Constr. Eng. Manag. 132, 667–677.

[8] Akanni, P.O., Oke, A. E., Akpomiemie, O. A., 2014. Impact of environmental factors on building project performance in Delta State, Nigeria. HBRC J.

[9] Alaghbari, W., Kadir, M.R. A., Salim, A., 2007a. The significant factors causing delay of building construction projects in Malaysia. Eng. Constr. Archit. Manag. 14, 192–206.

[10] Alaghbari, W., Kadir, M.R. A., Salim, A., 2007b. The significant factors causing delay of building construction projects in Malaysia. Eng. Constr. Archit. Manag. 14, 192–206.

[11] Al-Dubaisi, A., 2008. Change orders in construction projects in Saudi Arabia. MS thesis, Dep. Constr. Eng. Manag. King Fahd Univ. Pet. Miner. Saudi Arab.

[12] Al-Khalil, M., Al-Ghafly, M., 1999. Important causes of delay in public utility projects in Saudi Arabia. Constr. Manag. Econ. 17, 647–655.

[13] Al-Momani, A., 2000. Construction delay: a quantitative analysis. Int. J. Proj. Manag. 18, 51–59.

[14] Al-Tabtabai, H.M., 2002. Causes for Delays in construction projects in Kuwait. Eng. J. Univ. Qatar 15, 19–37.

[15] Ameh, O.J., Soyingbe, A.A., Odusami, K.T., 2010. Significant factors causing cost overruns in telecommunication projects in Nigeria. J. Constr. Dev. Ctries. 15, 49–67.

[16] Apolot, R., Alinaitwe, H., Tindiwensi, D., 2011. An investigation into the causes of delay and cost overrun in Uganda ' s public sector construction projects. Second Int. Conf. Adv. Eng. Technol. 305–311.

[17] Apolot, R., Tindiwensi, D., 2013. Investigation into the causes of delays and cost overruns in Uganda ' s public sector construction projects. J. Constr. Dev. Ctries. 18, 33–47.

[18] Asnaashari, E., Knight, A., Hurst, A., Farahani, S.S., 2009. Causes of construction delays in Iran : project management , logistics , technology and environment. 25th Annual ARCOM Conference, 7-9 September 2009, Nottingham, UK. pp. 897–906.

[19] Assaf, S., Al-Khalil, M., Al-Hazmi, M., 1995. Causes of delay in large building construction projects. J. Manag. Eng. 11, 45–50.

[20] Assaf, S.A., Al-Hejji, S., 2006. Causes of delay in large construction projects. Int. J. Proj. Manag. 24, 349–357.

[21] Berawi, M.A., Berawi, A.R., Mohamed, O., Othman, M., Yahya, I.A., 2006. Delay mitigation in the Malaysian construction industry. J. Constr. Eng. Manag. 132, 125–133.

[22] Chan, D.W., Kumaraswamy, M.M., 1997. A comparative study of causes of time overruns in Hong Kong construction projects. Int. J. Proj. Manag. 15, 55–63.

[23] Choudhry, R.M., Aslam, M.A., Hinze, J.W., Arain, F.M., 2014. Cost and schedule risk analysis of bridge construction in Pakistan : establishing risk guidelines. J. Constr. Eng. Manag.

[24] Definition of Shop-drawing: http://www.structuremag.org/article.aspx?articleID=1046

[25] Doloi, H., Sawhney, A., Iyer, K., Rentala, S., 2012. Analysing factors affecting delays in Indian construction projects. Int. J. Proj. Manag. 30, 479–489.

[26] Dosumu, O., Iyagba, R., 2013. An appraisal of factors responsible for errors in Nigerian construction. Ethiop. J. Environ. Stud. Manag. 6, 49–57.

[27] Ejaz, N., Ali, I., Tahir, M. F., 2013. Assessment of delays and cost overruns during construction projects in Pakistan. Digital Library, University of Moratuwa, Sri Lanka.

[28] Elinwa, A., Joshua, M., 2001. Time-overrun factors in Nigerian construction industry. J. Constr. Eng. Manag. 127, 419–425.

[29] El-Razek, M.E.A., Bassioni, H.A., Mobarak, A.M., 2008. Causes of delay in building construction projects in Egypt. J. Constr. Eng. Manag. 134, 831–841.

[30] Enshassi, A., Al-najjar, J., Kumaraswamy, M., 2009. Delays and cost overruns in the construction projects in the Gaza Strip. J. Financ. Manag. Prop. Constr. 14, 126–151.

[31] Enshassi, A., Modough, Z., 2012. Case studies in awarding the lowest bid price in construction projects literature review. IUG J. Nat. Eng. Stud. 20, 113–137.

[32] Faridi, A., El-Sayegh, S., 2006. Significant factors causing delay in the UAE construction industry. Constr. Manag. Econ. 24, 1167–1176.

[33] Frimpong, Y., Oluwoye, J., Crawford, L., 2003. Causes of delay and cost overruns in construction of groundwater projects in a developing countries: Ghana as a case study. Int. J. Proj. Manag. 21, 321–326.

[34] Fugar, F.D.K., Agyakwah-baah, A.B., 2010. Delays in building construction projects in Ghana. Aust. J. Constr. Econ. Build. 10, 103–116.

[35] Ghoddousi, P., Hosseini, M.R., 2012. A survey of the factors affecting the productivity of construction projects in Iran. Technol. Econ. Dev. Econ. 18, 99–116.

[36] Gunduz, M., Ph, D., Asce, A.M., Nielsen, Y., Ozdemir, M., 2013. Fuzzy assessment model to estimate the probability of delay in Turkish construction projects. J. Manag. Eng. 1–14.

[37] Gündüz, M., Ph, D., Asce, A.M., Nielsen, Y., Özdemir, M., 2013. Quantification of delay factors using the relative importance index method for construction projects in Turkey. J. Manag. Eng. 133–139.

[38] Hameed, A., Abdul, I., Yasmin, N., Abd, T., 2013. Social and web-based risk assessment technique for time and cost overrun (WRATTCO) – A framework. International Conference on Innovation, Management and Technology Research, Malaysia, 22-23 September. pp. 1–7.

[39] Hampton, G., Baldwin, A.N., Holt, G., 2012. Project delays and cost: stakeholder perceptions of traditional v. PPP procurement. J. Financ. Manag. Prop. Constr. 17, 73–91.

[40] Hamzah, N., Khoiry, M. a., Arshad, I., Tawil, N.M., Che Ani, a. I., 2011. Cause of construction delay - theoretical framework. Procedia Eng. 20, 490–495.

[41] Haseeb, M., Xinhai-Lu, Bibi, A., M., D., W., R., 2011. Problems of projects and effects of delays in the construction industry of Pakistan. Aust. J. Bus. Manag. Res. 1, 41–50.

[42] Hatem, D., Lenart, P., 2010. RFIs and shop drawings. Struct. Mag. 30–31.

[43] Hwang, B.-G., Yang, S., 2014. Rework and schedule performance: a profile of incidence, impact, causes and solutions. Eng. Constr. Archit. Manag. 21, 190–205.

[44] Hwang, B.-G., Zhao, X., Ng, S.Y., 2013. Identifying the critical factors affecting schedule performance of public housing projects. Habitat Int. 38, 214–221.

[45] Ibrahim, A.R. Bin, Roy, M.H., Ahmed, Z., Imtiaz, G., 2010. An investigation of the status of the Malaysian construction industry. Benchmarking An Int. J. 17, 294–308.

[46] Jarkas, A.M., Ph, D., Eng, P., Mubarak, S.A., Kadri, C.Y., 2013. Critical factors determining bid / no bid decisions of contractors in Qatar. J. Manag. Eng.

[47] Kaliba, C., Muya, M., Mumba, K., 2009. Cost escalation and schedule delays in road construction projects in Zambia. Int. J. Proj. Manag. 27, 522–531.

[48] 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. Constr. Manag. Econ. 15, 83–94.

[49] Kazaz, A., Ulubeyli, S., Nihan, T., 2012. Causes of delays in construction projects in Turkey.

[50] Kikwasi, G., 2013. Causes and effects of delays and disruptions in construction projects in Tanzania. Australas. J. Constr. Econ.

[51] Koushki, P. a., Al□Rashid, K., Kartam, N., 2005. Delays and cost increases in the construction of private residential projects in Kuwait. Constr. Manag. Econ. 23, 285–294.

[52] Lee, C., 2011. The causes and effects of project delays in the coal mining industry in South Africa. Masters Bus. Leadersh. UNISA, South Africa.

[53] Le-Hoai, L., Lee, Y.D., Lee, J.Y., 2008. Delay and cost overruns in Vietnam large construction projects: a comparison with other selected countries. KSCE J. Civ. Eng. 12, 367–377.

[54] Lim, C.., Mohamed, M.Z., 2000. An exploratory study into recurring construction problems. Int. J. Proj. Manag. 18, 267–273.

[55] Lo, T.Y., Fung, I.W.H., Tung, K.C.F., 2006. Construction delays in Hong Kong civil engineering projects. J. Constr. Eng. Manag. 132, 636–649.

[56] Long, N., Ogunlana, S., Quang, T., Lam, K., 2004. Large construction projects in developing countries: a case study from Vietnam. Int. J. Proj. Manag. 22, 553–561.

[57] Mahamid, I., 2011. Risk matrix for factors affecting time delay in road construction projects: owners' perspective. Eng. Constr. Archit. Manag. 18, 609–617.

[58] Mahamid, I., 2013. Contributors to schedule delays in public construction projects in Saudi Arabia : owners ' perspective. J. Constr. Proj. Manag. Innov. 3, 608–619.

[59] Mahamid, I., Bruland, A., Dmaidi, N., 2012. Causes of delay in road construction projects. J. Manag. Eng. 28, 300–310.

[60] Manavazhi, M.R., Adhikari, D.K., 2002. Material and equipment procurement delays in highway projects in Nepal. Int. J. Proj. Manag. 20, 627–632.

[61] Mansfield, N., Ugwu, O., Doran, T., 1994. Causes of delay and cost overruns in Nigerian construction projects. Int. J. Proj. Manag. 12, 254–260.

[62] Marzouk, M.M., El-Rasas, T.I., 2014. Analyzing delay causes in Egyptian construction projects. J. Adv. Res. 5, 49–55.

[63] Mbiti, T.K., Blismas, N., Wakefield, R., Lombardo, R., 2011. System archetypes underlying the problematic behaviour of construction activity in Kenya. Constr. Manag. Econ. 29, 3–13.

[64] Memon, A., Rahman, I., Abdullah, M., Azis, A., 2011. Factors affecting construction cost in Mara large construction project: perspective of project management consultant. Int. J. Sustain. Constr. Eng. Technol. 1.

[65] Meng, X., 2012. The effect of relationship management on project performance in construction. Int. J. Proj. Manag. 30, 188–198.

[66] Methods, M., 2007. Current practices and future potential in modern methods of construction.

[67] Mezher, T.M., Tawil, W., 1998. Causes of delays in the construction industry in Lebanon. Eng. Constr. Archit. Manag. 5, 252–260.

[68] Mohammed, K., Isah, A., 2012. Causes of delay in Nigeria construction industry. Interdiscip. J. Constr. Res. Bus. 4, 785–795.

[69] Mahamid, I,, Bruland, A., Dmaidi, N., 2012. Delay causes in road construction projects. J. Manag. Eng. 28(3), 300-310.

[70] Motaleb, O., 2013. An investigation into the risk of construction projects delays in the UAE. Int.J.Info.Technol.Proj. Manag. 4 (3), 50.

[71] Motaleb, O., Kishk, M., 2013. An investigation into the risk of construction projects delays in the UAE. Int. J. of Info. Technol. Proj. Manag. (IJITPM). 4(3), 50-65. doi:10.4018/jitpm.2013070104

[72] Motaleb, O., Kishk, M., 2010. An investigation into causes and effects of construction delays in UAE, in: Proceeding 26th Annu. ARCOM Conf. 6-8 Sept. 2010, Leeds, UK. pp. 1149–1157.

[73] Nahyan, M.T. Al, Sohal, A.S., Fildes, B.N., Hawas, Y.E., 2012. Transportation infrastructure development in the UAE: stakeholder perspectives on management practice. Constr. Innov. Information, Process. Manag. 12, 492–514.

[74] Nawaz, T., Shareef, N.A., Ikram, A.A., 2013. Cost performance in construction industry of Pakistan. Ind. Eng. Lett. 3, 19–34.

[75] Nega, F., 2008. Causes and effects of cost overrun on public building construction projects in Ethiopia.Doctoral dissertation, Addis Ababa University.

[76] Odeh, A., Battaineh, H., 2002. Causes of construction delay: traditional contracts. Int. J. Proj. Manag. 20, 67–73.

[77] Okpala, D., Aiekwu, A., 1988. Causes of high costs of construction in Nigeria. J. Constr. Eng. Manag. 114, 233–244.

[79] Oladapo, a. a., 2007. A quantitative assessment of the cost and time impact of variation orders on construction projects. J. Eng. Des. Technol. 5, 35–48.

[80] Olawale, Y., Sun, M., 2010. Cost and time control of construction projects: inhibiting factors and mitigating measures in practice. Constr. Manag. Econ. 28, 509–526.

[81] Olawale, Y.A., Sun, M., 2010. Cost and time control of construction projects: inhibiting factors and mitigating measures in practice. Constr. Manag. Econ. 28, 509–526.

[82] Omoregie, A., Radford, D., n.d. Infrastructure delays and cost escalation : causes and effects in Nigeria, in: Proceedings of the 6th International Conference on Postgraduate Research, Netherlands. pp. 79–93.

[83] Othman, A.A., Torrance, J.V., Hamid, M.A., 2006. Factors influencing the construction time of civil engineering projects in Malaysia. Eng. Constr. Archit. Manag. 13, 481–501.

[84] Pal, S., Nagrale, P., 2013. Analysis of delay due to material supply by tower crane at different height of high rise buildings in Mumbai. IOSR J. Eng. 3, 19–26.

[85] Pourrostam, T., Ismail, A., 2012. Causes and effects of delay in Iranian construction projects. Int. J. Eng. Technol. 4, 598–601.

[86] Pourrostam, T., Ismail, A.,2011. Significant factors causing and effects of delay in Iranian construction projects. Australian Journal of Basic & Applied Sciences, 5(7).

[87] Promkuntong, K., Jearkjirm, V., Ogunlana, S.O., 1996. Construction delays in a fast-growing economy: comparing Thailand with other economies. Int. J. Proj. Manag. 14, 37–45.

[88] Rahman, I.A., Memon, A., Karim, A.T., 2013. Significant factors causing cost overruns in large construction projects in Malaysia. J. Appl. Sci. 13, 286–293.

[89] Ramabodu, M.S., and Verster, J.J.P. 2010. Factors contributing to cost overruns ofconstruction projects, in: The proceeding of ASOCSA 5th Built Environment Conference, Durban South Africa.

[90] Ramanathan, C., Narayanan, S., Idrus, A., 2012. Construction delays causing risks on time and cost-a critical review. Aust. J. Constr. Econ. Build. 12, 37–57.

[91] Salam, M.A., Staines, H.J., Blackwood, D.J., Sarkar, S., 2001. Analysis of the relationships between causes of delay in construction projects in Bangladesh, in: 17th Annual ARCOM Conference, 5-7 September. pp. 619–28.

[92] Salunkhe, A.A., Patil, R.S., 2014. effect of construction delays on project time overrun : Indian scenario. Int. J. Res. Eng. Technol. 3, 543–547.

[93] Sambasivan, M., Soon, Y.W., 2007. Causes and effects of delays in Malaysian construction industry. Int. J. Proj. Manag. 25, 517–526.

[94] Semple, B.C., Hartman, F.T., Jergeas, G., 1995. Construction claims and disputes : causes and cost / time overruns 120, 785–795.

[96] Shehu, Z., 2014. Factors contributing to project time and hence cost overrun in the Malaysian construction industry. J.Finan.Manag.Prop. and Constr. 19 (1), 5-5.

[97] Shen, L., Tam, V.W.Y., Tam, L., Ji, Y., 2010. Project feasibility study: the key to successful implementation of sustainable and socially responsible construction management practice. J. Clean. Prod. 18, 254–259.

[98] Sorooshian, S., 2014. Delay-based reliability analysis on construction projects. Life Sci. J. 11, 104–113.

[99] Sullivan, A., Harris, F.C., 1985. Delays on large construction projects. Int. J. Proj. Manag. 6, 25–33.

[100] Sun, M., Meng, X., 2009. Taxonomy for change causes and effects in construction projects. Int. J. Proj. Manag. 27, 560–572.

[101] Sweis, G., Sweis, R., Hammad, A., Shboul, A., 2008. Delays in construction projects : the case of Jordan 26, 665–674.

[102] Telford, I.T., 1991. Inadequate site investigation. Published for the Institute of Civil Engineers, 1 Heron Quay,Telford House, London E144JD.

[103] Toor, S.-U.-R., Ogunlana, S., 2008. Problems causing delays in major construction projects in Thailand. Constr. Manag. Econ. 26, 395–408.

[104] Tumi, H., A, O., Abdul, Pakir, 2009. Causes of delay in construction industry in Libya,in: The International Conference on Economics and Administration, Faculty of Administration and Business, University of Bucharest, Romania, 14-15th November. pp. 265–272.

[105] Wambeke, B.W., Asce, M., Hsiang, S.M., Liu, M., Asce, A.M., 2011. Causes of variation in construction project task starting times and duration. J. Constr. Eng. Manag. 137, 663–677.

[106] Yang, J., Chu, M., Huang, K., 2013. An empirical study of schedule delay causes based on Taiwan's litigation. Proj. Manag. J. 44, 21–31.

[107] Yang, J.-B., Yang, C.-C., Kao, C.-K., 2010. Evaluating schedule delay causes for private participating public construction works under the Build-Operate-Transfer model. Int. J. Proj. Manag. 28, 569–579.

[108] Yau, N., City, J., Yang, J., 2012. Factors causing design schedule delays in Turnkey Projects in Taiwan. Proj. Manag. J. 43, 50–61.

[109] Zakaria, Z., Ismail, S., Yusof, A., 2013. Cause and impact of dispute and delay the closing of final account in Malaysia construction industry. J. Southeast Asian Res. 2012, 1–12.

VITAE

Name : Muhammad Saiful Islam

Nationality : Bangladeshi

Date of Birth : 7th February, 1982

Email : msaifulisalm98@gmail.com

Degrees:

Bachelor of Science in Civil and Environmental Engineering from Shahjalal University of Science & Technology, Sylhet, Bangladesh (July, 2006).

Master of Science in Construction Engineering & Management from King Fahd University of Petroleum and Minerals, Dhahran, K.S.A. (May, 2014)

Research Experience:

- **Islam**, **M.S.,** Ahmed Y., 2013. Risk assessment of construction projects in Bangladesh, in: The proceeding of International Postgraduate Research Conference (IPGRC), 8-10 April, Salford University, UK.

- **Islam,M.S.,** Rahman, H., Ashrafuzzaman, M., 2012. Evaluation and comparison of building construction technologies in two major cities of Bangladesh. Int. J. Struc. Civil Eng. Res. 1(1), 99-109.

- Khaleduzzaman, M., **Islam, M.S.,**Kundu, S.K., Shil, S., 2011. Building construction workers' quality and safety: a case study on Sylhet city, in: The Proceedings of The Conference on Engineering Research, Innovation and Education, 11-13, January, SUST, Sylhet, Bangladesh.

- **Islam**, **M.S.,**Chowdhury, A.I., Iqbal, S.A., Rahman, S.A.B., Hossain, M.K., 2010. Assessment of Healthcare Waste Generation in Sylhet City. Bangladesh J. Env. Sci. 18, 56-61.