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Practical Factors Affecting Delay in High Rise Construction – A Case Study in a Construction Organization

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***Abstract*— A construction project is successful only if the target(s) is/are achieved as per schedule and following the baseline to the core. Any variations from these can be called a delay. Thus, delay in construction project is a situation in which the project cannot be completed within a planned time. Any delay is an expense to all the parties involved in the completion of a particular project. As a result, these may often end up in clashes between parties, arbitration or litigation and in certain cases can lead to the total abandonment of project. This is a common issue faced all over the world. There are several factors attributed to delay. The scenario grabs more attention in the case of high-rise buildings. Due to the rapid boom in construction industry, confinement of land and more stringent rules on floor space index and parking provisions, builders/developers are forced to go for basements as an alternative for parking and other services.**

This paper tries to identify the various factors attributed to delay of high rise building construction and effects of these. The research methodology includes literature review and questionnaire survey. The data was analyzed using relativity index method and multiple regression analysis. Based on the analysis of the data obtained from the survey, it was concluded that the most agreeable practical factors affecting the delay of high rise construction and the corrective measures required for reducing the delay. Same methodology is also adopted for identifying the effects of delay, time and cost over-run being the most common and methods to reduce these. The project progress of a project in nearby locations is also tracked using MS-Project to identify the impact of delay on timeline. An analysis of these delay are then carried out.

***Keywords*— Construction delay, Cost over-run, Effects of delay, High rises, Time over-run**

I. INTRODUCTION

Construction industry is one of the most popular and labour intensive industries. Unlike others, this happens in a more real time and dynamic environment. And as a result is more prone to effects of the forces of earth, human factors, and like wise. The construction industry in India is an important indicator of the development of the country as it creates investment and employment opportunities across varied sectors.

Unplanned delays in a construction industry are a common occurrence. This does not mean that all the projects in construction sector are delayed. But a major share is affected. Construction delay can be defined as execute later than intended planned, or particular period, or letter than specific time that all the concerned parties agreed for construction project. Delay in project is counted as a common problem in construction projects. In the study of Assaf & Al-Hejji (2006), delay could be defined as the time over run either beyond completion date specified in a contract or beyond the date that the parties agrees upon for delivery of a project. It is a project slipping over its planned schedule and is considered as common problem in construction projects. Bassioni & El-Razek (2008) identified that delay in construction project is considered one of the most common problems causing a negative effect on the project and its participating parties.

In India, a study conducted by the Infrastructure and Project Monitoring Division of the Ministry of Statistics and Programme Implementation in 2004 reported that out of 646 central sector projects costing about $50 trillion, approximately 40% are behind schedule, with delays ranging from 1 to 252 months (Lyer and Jha, 2006). In the United Arab Emirates (UAE), where construction contributes 14% to the gross domestic product (GDP), a study by Faridi and El-Sayegh (2006) revealed that 50% of construction projects encounter delays. To recover the damage caused by delays, both the delays and the parties responsible for them should be identified. However, delay situations are complex in nature because multiple delays can occur concurrently and because they can be caused by more than one party, or by none of the principal parties. One delay may contribute to the formation of other delays (Arditi and Pattanakitchamroon, 2006). The analysis of these delays involves not only the calculation of the delay time but also the identification of the root causes and the responsibility for delays.

Due to the rise in the number of buildings sprouting in every corner of the country, there are more stringent building rules developed by every Municipality/Corporation. Limiting of Floor area ratio (FAR) with respect to plot area, norms laid out by pollution control boards in each localities etc, builders and developers are forced to look in to alternatives to increase their profits, by able to project more saleable

area keeping into account all the statutory obligations are met. The solution was to go for high rise constructions. These would help in achieving the needs without compromising in the area for usability. However, these were not achieved easily as construction of high rises meant going deeper than those needed for typical and conventional foundations. Construction of basement is difficult for it must be carried out below deep ground in adverse condition such as existence of ground water, muddiness or limited working space. The case became more serious in areas of soil with high water table and clayey soil. Therefore the objective of the study is to identify the factors causing delay of high rise buildings and its impact on the project.

II. LITEATURE REVIEW

Delays happen in most construction projects, whether simple or complex. In construction, delay could be defined as the time overrun either beyond the contract date or beyond the date that the parties agreed upon for delivery of project, Assaf and Al-Hejji (2006). A project consists of a collection of activities. Delays can occur in any or all of these activities, and these delays can concurrently cause delays in the completion of the project. A project delay is the accumulated effect of the delays in the individual activities. Delay analysis is used to determine the cause(s) of the delay in order to ascertain whether an extension of time should be awarded. An extension of time relieves the contractor from the liability for damages (Lowsley and Linnett, 2006). The analysis of delays in construction projects is difficult and complicated because of the large number of individual activities that have to be dealt with, even for a relatively simple project. A medium-sized project may consist of hundreds of activities, many of which may take place at different times and with different durations than originally planned (Shi et al., 2001). Some activities may be delayed or accelerated, and such changes may partially or fully, or may not, affect the project completion date. In the study of Alaghbari, et al. (2007), delay is generally acknowledged as the most common, costly, complex and risky problem encountered in construction projects. Majid (2006) stated that delays can be minimized when their causes are identified. Identification of the factors that contributed to the causes of delays has been studied by numerous researchers in several countries. Delay is a situation when the contractor, consultant, and client jointly or severally contributed to the non-completion of the project within the original or the stipulated or agreed contract period. Because of the overriding importance of time for both the Owner (in terms of performance) and the Contractor (in terms of money), it is the source of frequent disputes and claims leading to lawsuits.

Delays caused by the client such as late submission of drawings and specifications, frequent change orders, and incorrect site information generates claims from both the main contractors and sub-contractors which many times entail lengthy court battles with huge financial repercussions. Delays caused by contractors can generally be attributed to poor managerial skills. Lack of planning and a poor understanding of accounting and financial principles have led to many a contractor's downfall.

Under some circumstances, a contractor may be entitled to claim delay damages if he finishes later than an owner-accepted early completion schedule but is still ahead of the official contract completion date. This may occur if the contractor establishes a direct cause-and-effect relationship between owner's breach of a contractual obligation and the delay. In addition, the contractor has the burden of establishing its increased costs as a result of the delay.

III. RESEARCH METHODOLOGY

This research methodology will described and explained based on the objectives and the aims of the study. The literature review of various papers on delay analysis was compiled to arrive at the various factors contributing to delay in the construction sector. A questionnaire was prepared showing the various factors contributing to delay by classifying them into 6 groups. The major factors were identified with the help of filled questionnaire and the same were compared with the actual factors that contributed to a real-time case study. Concisely, the literature review provided the platform for developing specific themes for the questionnaire survey conducted.

A. RESEARCH FLOWCHART:

This research consists of six phases:

i. The first one is the proposal for identifying and defining the problems and establishment of the objectives of the study and development of research plan.
ii. The second phase of the research includes literature review. Literatures of the practical factors contributing to delay in the construction sector were reviewed.
iii. The third phase of the research focused on the modification of the questionnaire design, through distributing the questionnaire to the experienced people in the organization. The purpose of the pilot study was to prove that the questionnaire questions are clear to be answered in a way that help to achieve the objectives of the study and based on its results the questionnaire was modified.
iv. The fourth phase of the research was questionnaire distribution. The questionnaire was used to collect the required data in order to achieve the research objective.
v. The fifth phase of research focused on data analysis and discussion. The Statistical Package for the Social Sciences (SPSS 20) was used to perform the required analysis and multiple regression models were prepared.
vi. The final phase of the research included the conclusions and recommendations.
vii. The sixth phase of the research focused on data analysis and discussion. The Statistical Package for the Social Sciences (SPSS 20)

was used to perform the required analysis and multiple regression models are prepared.

B. PILOT STUDY:

A pilot study provides a trial run for the questionnaire, which involves testing the wording of question, identifying ambiguous questions, testing the techniques that used to collect data, and measuring the effectiveness of standard invitation to respondents (Naoum,1998q). All questionnaires should initially be piloted; completed by small sample of respondents (Fellows and Liu, 1997).

After modifying the questionnaire according to the notes of the supervisor and before collecting the final data from the whole sample, a pilot study is accomplished and five copies of the questionnaire are distributed to five employees in ARTECH to fill them. The purpose of this step is to discover if the questions are well understandable or not, also to find out any problem that may raise in filling the questionnaire. From the pilot study it appears that questions are generally clear. However, it seems some respondents find difficulties in understanding some questions. Therefore, the questions were modified to be clearer.

The following items are summary of the main results obtained from pilot study:

1. Questionnaire should be started with a cover page
2. The first part of questionnaire should be general information about the organization.
3. Some factors and sentences should be modified or represented with more details.
4. Some factors were repeated more than one time with the same meaning. So, it should be to eliminate these repeated factors.
5. Some factors and sentences should be modified in order to give more clear meaning and understanding.
6. Some local factors should be added as recommended by external guide which affect the delay in the organisation.
9. There are some parts of questionnaire required to be regulated well.
10. Some factors should be rearranged in order to give more suitable and consistent meaning.

Cronbach's alpha technique was used to validate the obtained data from the questionnaire.

The Cronbach's coefficient alpha was calculated for each field of the questionnaire. For the groups, values of Cronbach's Alpha were in the range from 0.919 to 0.922. This range is considered high; the result ensures the reliability of each group of the questionnaire. Cronbach's Alpha equals 0.920 for the entire questionnaire which indicates an excellent reliability of the entire questionnaire.

C. RESEARCH POPULATION AND SAMPLE SIZE:

The target groups in this study are owners, contractors and consultants. There were 12 ongoing high rise projects under the firm which had about 8 consultants and 23 contractors. Kish (1965) showed that the sample size can be calculated as following equation for 94% confidence level (Assaf et al 2001, Israel 2003, Moore et al, 2003):

$$n = n'/ [1 + (n'/N)]$$

Where:

- N = total number of population
- n= sample size from finite population
- n' = sample size from infinite population = S^2/V^2; where S^2 is the variance of the population elements and V is a standard error of sampling population. (Usually S= 0.5 and V = 0.06)

So, for 12 projects:

- n= n'/ [1+(n'/N)]
- n'= $S^2/V^2 = (0.5)^2/(0.06)^2 = 69.44$
- N = 12
- n= 69.44/ [1+(69.44 / 12)] = 10

This means that the questionnaire should be distributed to 10 client parties in order to achieve 94% confidence level

And, for 8 consultants:

- n= n'/ [1+(n'/N)]
- n'= $S^2/V^2 = (0.5)^2/(0.06)^2 = 69.44$
- N = 12
- n= 69.44/ [1+(69.44 / 8)] = 7

This means that the questionnaire should be distributed to 7 consultant parties in order to achieve 94% confidence level

And, for 23 contractors:

- n= n'/ [1+(n'/N)]
- n'= $S^2/V^2 = (0.5)^2/(0.06)^2 = 69.44$
- N = 12
- n= 69.44/ [1+(69.44 / 23)] = 17

This means that the questionnaire should be distributed to 17 client parties in order to achieve 94% confidence level.

According to previous results of sample sizes, 40 questionnaires were distributed as follows: 12 to owners, 8 to consultants and 20 to contractors. 30 questionnaires were received as follows: 8 (66.67%) from owners, 8(100%) from consultants and 14 (70%) from contractors as respondents with a total response rate of 75%.

Moser and Kalton (1971) showed that a response rate of less than 30% is likely to produce results subject to non-response bias. Based on this, obtained response rates of 77.5% is reasonable and will reflect good results and outputs.

D. DATA COLLECTION

The questionnaire was chosen to be the method of collecting data in this research, since the questionnaire is probably the most widely used data collection technique for conducting surveys. Questionnaires have been widely used for descriptive and analytical surveys in order to find out the facts, opinions and views (Naoum, 1998 & C.P.Kotari).

The questionnaire is mailed to respondents who are expected to read and understand the questions and write down the reply in the space meant for the purpose in the questionnaire itself.

It enhances confidentiality, supports internal and external validity, facilitates analysis, and saves resources.

Data are collected in a standardized form from samples of population. The standardized form allows the researcher to carry out statistical inferences on the data, often with the help of computers.

A questionnaire survey was designed based on the objectives of the study, which are causes of construction delays and effects of construction. A questionnaire survey was developed to get the opinion and understanding from the experienced respondents regarding to the construction delays problem (*Annexure – I*). The questionnaires are all classified into three sections:

a) Part-I: Respondent Background
b) Part-II: Causes of Construction Delays
c) Part-III: Effects of Construction Delays

The data obtained from the questionnaire was analysed and results for the major impacts were identified.

E. DATA PROCESSING AND ANALYSIS:

The questionnaire quantitative data analysis was done by using the Statistical Package for the Social Sciences (SPSS 20). The research utilises two separate methods to analyse the respondent‘s data to identify the critical attributes among all seven categories, client, consultants, contractor, labor, project specific, external and effect of delay.

$$\text{Relative Importance Index} = \frac{\sum W}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

The first is a descriptive approach with direct interpretation of the survey results to identify the most critical‘based on the relative important index (RII) (Doloi, 2008). The second method, using Statistical Package for Social Sciences (SPSS), intends to explore and detect underlying relationships among the attributes by using the multiple regression method.

1. Descriptive analysis based on relative importance index

2. Multiple regression analysis by using IBM SPSS (statistical package for social scientists) software

1. Relative Importance Index: The relative index technique has been widely used in construction research for measuring attitudes with respect to surveyed variables. Several researches such as Odusami and Onukwube (2008), Elhag etal (2005), Madi (2003), and Akintoye (2000) used the relative importance index in their analysis of factors affecting the accuracy of cost estimate. Likert scaling was used for ranking questions that have an agreement levels. The respondents were required to rate the importance of each factor on a 5-point Likert scale using 1 for strongly disagree, 2 for of disagree, 3 for no opinion, 4 for agree and 5 for strongly agree. Then, the relative importance index was computed using the following equation:

Where W is the weighting given to each factor by the respondent, ranging from 1 to 5, (n1 = number of respondents for strongly disagree, n2 = number of respondents for disagree, n3 = number of respondents for no opinion, n4 = number of respondents for agree, n5 = number of respondents for strongly agree). "A" is the highest weight (i.e. 5 in the study) and N is the total number of samples. The relative importance index ranges from 0 to 1 (Tam and Le, 2006).

2. Multiple Regression Analysis: Multiple regression is a statistical technique that allows us to predict someone‘s score on one variable on the basis of their scores on several other variables. When there are two or more than two independent variables, the analysis concerning relationship is known as multiple correlation and the equation describing such relationship as the multiple regression equation. When using multiple regression in psychology, many researchers use the term – independent variables to identify those variables that they think will influence some other - dependent variable. The term used in the paper is - predictor variables for those variables that may be useful in predicting the scores on another variable that we call the–criterion variable.

The stronger the correlation, the closer the scores will fall to the regression line and therefore the more accurate the prediction. Multiple regression is simply an extension of this principle, where we predict one variable on the basis of several other variables. We here explain multiple correlation and regression taking only two independent variables and one dependent variable (Convenient computer programs exist for dealing with a great number of variables). In this situation the results are interpreted as shown below: Multiple regression equation assumes the form

$$Y = a + b_1X_1 + b_2X_2$$

Where X_1 and X_2 are two independent variables and Y being the dependent variable, and the constants a, b_1 and b_2 can be solved by solving the following three normal equations:

$$\sum Y_i = na + b_1 \sum X_{1i} + b_2 \sum X_{2i}$$
$$\sum X_{1i}Y_i = a\sum X_{1i} + b_1 \sum X_{1i}^2 + b_2 \sum X_{1i}X_{2i}$$

F. DELAY ANALYSIS using – MS-Project

A high rise residential project with 15 floors is considered for the schedule analysis using impacted as-planned analysis. The type of soil is clayey sand with water table at a depth of -2.0m. With continuous de-watering all around the site, it was able to bring down the water table to a certain level. In spite of all the required precautions, excavation still proved to be difficult, due to slushy nature of soil and giving away of micro-piles. The major constraints faced at site were the presence of residential buildings very close to site boundary and a busy highway on the other side. The various factors which caused a delay in completion on time are discussed in the coming pages.

The schedule for the construction works of basements were made in MS-Project. The baseline was set and the activities were tracked on a regular basis (*Annexure – II*). The delay in each activity was carefully studied and the causes for delay were analysed. These factors were given more preference in comparing with the results obtained in a general view of the questionnaire obtained. The important factors contributing to delay were derived by finding out the impact on number of delays delayed by each.
It was found that keeping with the schedule seemed to be a very rigorous procedure, especially due to the site conditions also. Thus the number of delays caused by various factors could be kept in check.

IV. RESULTS AND DISCUSSION

The responses to the questionnaire survey were analysed. The main findings suggest that the total 16 factors are the critical factors of delay in the organisation. Mainly at the time of evaluation of received questionnaires, factors related to contractor are repeatedly found in text boxes provided for factors which are strongly causing delay in Artech Realtors. The most significant factors affecting the delay are improper follow of schedule, improper work methodology, Lack of qualified personnel, Shortage of labours, Type of equipment & Machinery used.

The three most critical factors of the contractor-related factors affecting the delay in Artech Realtors are: - Improper follow of schedule, Improper work methodology and Lack of qualified personnel. The two most critical factors related to client group Changes in design, late payment of bills. The critical factors attributing to consultant are Delay in supply of drawings and Information & update of work status. Shortage of labours and skill of available labours were ranked as most important among the labour related factors while weather condition and Force majeure were the critical factors among external factors that contributed to delay. The critical factors specific to the project (high rise construction) includes Depth of water table and Method of Lifting.

The factors Improper follow of schedule and Improper work methodology have been found highly correlating (correlation coefficient = 0.789) to each other. Other factors that have a very good correlation are change in design and communication with contractors and consultants having a correlation coefficient of .638 and Depth of water table to Depth of foundation with a correlation coefficient of 0.643.

Time over run and cost overrun were found to be most critical effects of delay followed by dispute and arbitration. Total abandonment of project can only found to be in rare cases. Nevertheless, data analysis conducted in the chapter shows that the relativity index and multiple regression method are suitable.

V. CONCLUSION AND RECOMMENDATION

This chapter includes the conclusions and practical recommendations to eliminate delay of construction in the organization Artech Realtors and additional studies in this subject are proposed. This research aimed to find the practical factors affecting the delay in construction of high rise structures by exploring the affecting factors of high rise construction.

This research had four primary objectives, which were achieved through the literature review and data collection using survey techniques and the detail analysis of the survey results. The first objective was to identify the various factors causing delay and the effect of such delays in construction of high rises in Artech Realtors Pvt Ltd. The second objective was To study the perspective of seven areas namely contractor related factors, client related factors, consultant related factors, labour related factors, external factors and project specific factors that contribute to delay and the effect of such delays in construction of high rises in Artech Realtors Pvt Ltd. The third objective was To identify the most critical factors in each group by rank using the relative importance index The last objective was to identify the underlying relationships among the critical factors by using multiple regression method with the help of IBM SPSS software.

These objectives were achieved through two interdependent phases. The first phase included an intensive literature review. This phase was necessary to identify potential factors that affect the delay in construction. The literature review and pilot interviews helped in identifying 43 potential factors which are grouped into six groups. These groups are factors attributed to client, contractor, consultant, labour, external and project specific.

The second phase included the necessary steps in collecting all required information.

A questionnaire was sent to 40 questionnaires were distributed as follows: 12 to owners, 8 to consultants and 20 to contractors. 30 questionnaires were received as follows: 8 from owners, 8 from consultants and 14 from contractors.

Based on the results obtained from this research, the following conclusions of the research are drawn:

An exploration of factors affecting delay of construction was conducted in order to find the degree of importance for each factor. The result of analysis of 43 factors considered in the questionnaire filled by representative sample of employees in Artech Realtors and those from contractors and consultants related to the organisation concluded that the 16 most important critical factors which are require corrective measures and are delaying the projects in Artech Realtors:

These findings show how these factors can greatly affect the delay.

1. The five least important factors as agreed by the respondents are Volume of the project; Number of floors; Location of Site; Migration of Labour and Unclear perception of demand. The results show that these factors have a little affecting on the delay in Artech Realtors. However, it is preferable to be considered by the People in Artech during preparing schedule.
2. The construction delay occurs mostly during the construction phrase. The right methodology of construction is to be adopted. Proper co-ordination with all the contractors involved in work is a must. In addition to this, the contractors should be aware that delays are mostly caused by the poor labor's skill, supervisor not able to coordinate the project very well and also low quality of material used in the construction projects. Therefore, contractor needs to give awareness on these three factors stated above in order to minimize the construction delays' problems.
3. Low technical and managerial skills of contractors are the problems that faced by contractors which might cause construction delays. Therefore, contractors should organize some training programs for their workers in order to update their knowledge and improve their management skill. Due to the dynamic nature of project environments, it is inevitable that conflicts among the project team will arise. All project participants should recognize that conflict are inevitable and actually can be beneficial if resolved in an appropriate manner.

4. The three most critical factors of the contractor-related factors affecting the delay in Artech Realtors are: - Improper follow of schedule, Improper work methodology and Lack of qualified personnel.
5. The two most critical factors related to client group Changes in design, Late payment of bills.
6. The critical factors attributing to consultant are Delay in supply of drawings and Information & update of work status.
7. Shortage of labours and skill of available labours were ranked as most important among the labour related factors while weather condition and Force majeure were the critical factors among external factors that contributed to delay.
8. The critical factors specific to the project (high rise construction) includes Depth of water table and Method of Lifting.
9. The factors Improper follow of schedule and Improper work methodology have been found highly correlating (correlation coefficient = 0.789) to each other. Other factors that have a very good correlation are change in design and communication with contractors and consultants having a correlation coefficient of .638 and Depth of water table to Depth of foundation with a correlation coefficient of 0.643.
10. Time over run and cost overrun were found to be most critical effects of delay followed by dispute and arbitration. Total abandonment of project can only found to be in rare cases.
11. Five out of the 16 top factors being related to the contractor and labour groups. These findings indicated that delay of construction in a client's organization was more affected by factors related to contractor and Labour groups than by others.

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