International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 03 | June-2015 www.irjet.net p-ISSN: 2395-0072

A METHODOLOGY TO IDENTIFY THE DELAYS AND RANK ITS CAUSATIVE FACTORS IN INDIAN CONSTRUCTION INDUSTRY

Anup Wilfred[1], Muhamad Sharafudeen[2]

[1] *Associate Professor, Civil Engineering Department, MIT, Karnataka, India*
[2] *PG Student, Construction Engineering & Management, MIT, Karnataka, India*

Abstract - *Construction Projects have now turned out to be one of the major driving **forces behind a country's** economic development. But the progress and profitability of the projects are compromised when delays happen in these construction projects. In this study, the major delay causes in Indian Construction Industry is identified through literature review and a questionnaire survey conducted among the Clients, Contractors and Consultants. A total of forty two delay causes were identified which were then categorized under nine major groups. These delay causes were then ranked using two techniques: Relative Importance Index and Importance Index based on degree of severity and frequency of occurrence. A case study is also conducted in the Karnataka region of India to further research the major causes of delay in this region. It is hoped that the results of this study would help in the identification of delay causes in the construction projects of India and let the stakeholders take measures to reduce the occurrence of these delays.*

Key Words: Causes of delay, Indian Construction Industry, ranking of delay causes, Relative Importance Index, Importance Index, Case Study

1. INTRODUCTION

Construction projects act as a major driving force for a country's economic development. The Indian construction sector has acted as an engine of growth for the Indian economy for over the past five decades becoming a basic input for the socio-economic development of the country. It is an indicator of efficiency when a construction project is completed on time, in accordance with specifications, within budget and to stakeholders satisfaction. But delays on Construction projects are a universal phenomenon and are almost always accompanied by cost and time overruns. In the study of Assafand Al-Heiji (2006) construction delay was defined as the 'time overrun either beyond the date that the parties agreed upon for delivery of a project'. It was also defined by Zack(2003) as an 'act or event which extends required time to perform or complete work of the contract manifests itself as additional days of work'.

A delay can be caused by more than one party (Client, Contractor, Consultant); however it can also be caused by none of the parties (such as unusually severe weather conditions). In some cases, a delay may even contribute to the formation of other delays. These delays further contribute to the inaccuracy of initial time and cost estimates and give increase to disturbance of work and loss of productivity, late completion of project, increased time related costs and third party claims and abandonment or termination of contract. Although project management and planning techniques have progressed significantly during the past decade, and use of these techniques is very popular, delays in construction projects in India are very common.

This is undesirable for both the owner and the contractor and reduces the trust that should exist between contractors and owners for future projects. To the owner, delay means loss of revenue through lack of production facilities and rentable space or a dependence on present facilities ,whereas , to the contractor, delay means higher overhead costs because of longer work period, higher material costs through inflation and due to labour cost increases etc. Therefore, delays in construction projects give rise to dissatisfaction to all involved parties and consequently, projects that were deemed profitable often turn into costly and money losing contracts.

Construction projects are composed of many interrelated elements of labor, cost, material, schedule and other resources, making it difficult to discern which factors were the main causes for delay on a given project. Companies would be able to avoid or minimize these delays if major contributing factors were identified and planned for in a timely manner. In this research, these factors are identified and their importance and contribution to the lateness of a typical project is measured. The objective of this research is to identify and rank the relative importance of factors perceived by owners, consultants, managers, engineers and contractors to cause delay in construction projects. The outcomes can help all practitioners to develop wider and deeper perspective of

factors causing delay in construction projects and provide guidance to projects and construction managers for efficient solutions.

2. RESEARCH OBJECTIVE

The following are the objectives of this study:

1. To identify the causes of delay in Construction Projects through Literature review
2. To conduct a Questionnaire Survey among the construction companies in Udupi, Mangalore and Bangalore to identify the delay causes and rank them by RII(Relative importance index) method and by IMPI(Importance Index) method.

3. LITERATURE REVIEW

Hamzah et.al [12] (2011) identifies delay into two types: excusable and non-excusable delay. They developed a theoretical framework with an additional delay type-concurrent delay with this being a non-compensable type of delay mainly caused by third parties and acts of God. Marzouk et.al [6](2012) distributed 33 questionnaires comprising of 43 delay causes and categorized into 7 groups to owners, consultants and contractors organization in Egypt. Frequency Index, Severity Index and Importance Index were calculated and the top ten delay causes were thus determined. Statistical analysis was carried out using analysis of variance ANOVA method to test delay causes, obtained from the survey. Assaf et.al [1](1995) conducted a survey among the contractors, owners and Architectural/ Engineering firms (A/E) in Saudi Arabia which showed that the contractors and A/Es substantially agree on the ranking of the groups of delay factors, whereas contractors and owners, and A/Es and owners do not agree. It was also shown that the financing group of delay factors was ranked the highest by all three parties and that the environment group was ranked the lowest. The most important delay factors according to contractors were preparation and approval of shop drawings, delays in contractors progress, payment by owners and design changes by owners. The most important problems during construction according to A/Es were cash problems, the relationships between different subcontractors schedules in the execution of the project and the slowness of the owners decision making process. The most important delay factors according to owners were design errors, excessive bureaucracy in project owner organization, labor shortages and inadequate labor skills. Samarghandi et.al. [13](2014) developed a multinomial probability model to estimate the amount of contribution of each delay factor in a delayed construction project. He also performed regression analysis to provide more insight for owners, contractors and consultants about the differences between initial and final estimates of a typical construction project in terms of both cost and length. He noted that in Iran, a significant amount of delay stems from regulations, outdated standard contract terms, and lack of planning by government authorities.

Abd El-Razak et.al[3](2008) in his study in Egypt analysed the delays from a project size perspective. The results showed that Design changes by Owner during construction was the top cause of delay for Size of Projects less than 5,000,000 Egyptian Pounds (EGP); Financing by contractors was the top cause for size of projects more than 5,000,000 EGP and less than 24,000,000 EGP and Partial payments during construction was the top cause for size of projects more than 24,000,000 EGP. He also categorised by project sector so as to analyse the data from a project type point of view. Financing by contractor was ranked top in the Housing, Tourism and Educational project sector while slowness of the owner decision making process was the top cause for Industrial projects. Aibinu and Odeyinka [5](2006) made a study on 'Construction Delays and their causative factors in Nigeria'. They found out that in Nigeria, there was no national agency responsible for coordinating the activities of the bodies and associations and hence there appeared to be a lack of synergy. Also since there was only a low entry barrier into the industry, many unwieldy repetitive registers were existent, which were inconsistent in content and standard and open to abuse. 44 delay factors were identified from 9 factor categories and a questionnaire was prepared to sample the opinion of construction managers on the extent to which each of the factors contributed to overall delays. Based on the overall ranking of the 44 factors, the top 5 factors were contractors financial difficulties, clients cash flow problems, architects incomplete drawing, subcontractors slow mobilizations and equipment breakdown and maintenance problems. The Pareto analysis also revealed that about 88% of the delay factors was responsible for about 90% of the overall delays on building projects surveyed. It was also noted that financial problems ranked higher in the client, contractor and subcontractors categories. It was suggested by them to establish a construction bank to help source long term loans for construction project development that could alleviate the problem of finance.

Lo et.al [4](2006) conducted a study on 'Construction delays in Hong Kong Civil Engineering Projects'. The first stage of their study was to prepare a questionnaire that contained 30 identified causes of delay for which the respondents (a client group, consultant group, contractor group) were asked to indicate their perceived magnitude of significance and the effectiveness of the corresponding mitigation measures suggested by the Construction Industry Review Committee (CIRC) with reference to a corresponding 1-5 scale. All three groups of respondents thought that inadequate contractor resources or a lack of capital are key factors in delays. But they differed in their viewpoints toward the significance of the various causes of delay and the effectiveness of the respective mitigation measures. The greatest difference of viewpoint existed between the consultant group and the contractor group

regarding the significance of delay causes and the effectiveness of corresponding mitigation measures. The second phase of the project was to have a case study on the actual causes of Construction delay for Six Projects. It was noted that inclement weather, unforeseen ground conditions, inaccurate bills of quantities and delays in providing design information were the most common causes of delay. Aziz [2](2013) discussed a paper on 'Ranking of delay factors in construction projects after Egyptian Revolution'. The Research methodology involved a questionnaire survey prepared after incorporating 99 delay factors into 9 categories. This was filled out by 2500 highly experienced Construction professionals. This collected data was then analysed through Relative Importance Index (RII) method and ranked. The respondents ranked 'Delay in progress payments' as the prime cause of delay in construction projects in Egypt. Also the prime factors were identified for each categories related to Consultant, Contractor, Design, Equipment, External, Labor, Material, Owner and Project. A prediction model for actual project duration was created and a case study was later done on a residential building in Alexandria. It was found out from studying and analysing the previous project, that the actual duration increased from planned project duration by 43.75% and predicted actual project duration by 45.28%. Reasons of such increase, found from analysing the forms in questionnaire were the same. A number of recommendations were suggested by the author and the first 5 recommendations were that the Owner must pay progress payments in time; it is forbidden to pay any kind of bribes for any beneficiary; Inexperienced Contractors should not be given major works; the Contractors should pay more attention to effective planning and scheduling and that Site management and supervision should be made in a proper manner.

Arditi [7]et.al(2005) says that time impact analysis is the most credible delay analysis method among the four methods – (1) as planned vs. as-built schedule analysis method (2) the impact as-planned schedule analysis method (3) the collapsed as-built schedule analysis method and (4) the time impact analysis method. The time impact analysis method relies on the assumption that delay impacts to a project can be assessed by running a series of analyses on schedule updates. It uses CPM principles. It assesses delays effects on the project schedule by analysing the schedule periodically, generally on a day-by-day basis. Window analysis, a variation of time impact analyses, uses weekly or monthly updates to perform the analysis. Delay events are inserted into the schedule and delay impacts are accumulated every time the schedule is recalculated.

4. RESEARCH METHODOLOGY

The research methodology for this study contains three stages. The first stage involves Literature search and review. The literature review was conducted through International Project Management Journals, books, conference proceedings and Internet. As the outcome of this review, 42 causes of delay were identified suitable to the present study. These causes were then grouped under nine different categories namely Project Related, Owner related, Contractor related, Consultant related, Design related, Material related, Equipment related, labour related and External factors depending on their nature and mode of occurrence.

The second stage was analytical which first involved the preparation of a questionnaire based on two different approaches used for giving ranking to causes of delay of Residential construction projects. This study suggests two different techniques: Relative Importance Index (RII) and Importance Index (II). In the first technique, Relative importance of each cause of delay can be calculated while in the second technique, Importance index is calculated as a function of frequency and severity indices.

The third stage was a case study where the progress of a particular project was tracked for delays and its causative reasons. After weighing up the pros and cons of different Delay analysis methods, Time based analysis was selected for tracking the Project progress.

5. DATA COLLECTION

The target population for this study included Civil Engineering and building construction firms of Mangalore, Udupi and Bangalore region of Karnataka. The Clients, Contractors and Consultants of this region were targeted for the survey. The details of various firms and their contacts were obtained through internet and personal references. Since the population size was unknown, Google Z Score test was used to calculate the sample size.

$$\text{Sample Size} = \frac{(z\text{-score})^2 \times (\text{std.deviation}) \times (1-\text{std.deviation})}{(\text{Margin of error})^2} \quad (1)$$

Where z-score is the statistic value for the confidence interval used, i.e., 2.575, 1.96 and 1.645 for 99% , 95% and 90% confidence levels respectively.

Taking confidence interval as 90%, i.e., 10% significance level, standard deviation as 20% & margin of error as 10%, the sample size of the population is calculated as follows:

$$\text{Sample size} = \frac{(1.65)^2 \times (0.2) \times (1-0.2)}{(0.1)^2}$$

= 45 samples

This 45 samples of responses were to be collected from Clients, Contractors and Consultants equally. As the response rate is very low, the questionnaire was distributed to the various parties more than the sample size requirement. A total of 60 questionnaires were distributed to different respondents in Mangalore, Udupi and Bangalore. The response rate was slow and timely reminders were also required. This study has so far received 48 response, 15 each from the Consultants and Clients and 18 responses from the Contractors side. This was more than the required sample size.

6. DATA ANALYSIS

6.1 Relative Importance Index Technique

Kometa[14] et al. had used the Relative Importance Index method to determine the relative importance of the various causes and effects of delays and the same method is adopted for the present study among various parties (i.e., Clients, Contractors and Consultants). The four – point Likert scale was adopted and it ranged from 1 (less important) to 4 (extremely important). This was transformed to Relative Importance Indices (RII) for each factor as follows:

$$RII = \frac{\sum W}{A * N} \quad (2)$$

Where, W is the weighting given to each factor by the respondents (ranging from 1 to 4), A is the highest weight (i.e, 4 in this case), and N is the total number of respondents. The RII value had a range from 0 to 4 (0 not inclusive) and higher the value of RII, more important was the cause of delays. The RII rankings made it possible to cross compare the relative importance of the factors as perceived by the three groups of respondents (i.e., Clients, Contractors and Consultants). Each individual cause's RII perceived by all respondents should be used to assess the general and overall rankings in order to give an overall picture of the causes of construction delays in Indian construction Industry.

6.2 Importance Index Technique

In this technique, for each cause of delay the Importance Index is calculated as a function of frequency and severity indices. Here, both frequency of occurrence and severity were categorized on a four-point scale with the values 4 to 1. Frequency of occurrence is categorized as always, often, sometimes and rarely (on 4 to 1 point scale). Similarly, degree of severity was categorized as extreme, great, moderate and little (on 4 to 1 point scale).

1) Frequency index: To rank the causes of delay based on frequency of occurrence as identified by the participants, the following formula is used:

$$\text{Frequency Index (F.I) (\%)} = \sum a\,(n/N) \times 100/4 \quad (3)$$

Where, a is the constant expressing weighting given to each response (ranges from 1 for rarely upto 4 for always), n is the frequency of the responses, and N is total number of responses.

2) Severity Index: A formula is used to rank causes of delay based on severity as indicated by the participants.

$$\text{Severity Index (S.I) (\%)} = \sum a\,(n/N) * 100/4 \quad (4)$$

Where, a is the constant expressing weighting given to each response (ranges from 1 for little up to 4 for severe), n is the frequency of the responses, and N is the total number of responses.

3) Importance Index: The importance index of each cause is calculated as a function of both frequency and severity indices as follows:

$$\text{Importance Index (IMP.I) (\%)} = [\text{F.I. (\%)} * \text{S.I. (\%)}]/100 \quad (5)$$

6.3 Case Study

A live project's progress will be tracked for delays and its causative factors. Window analysis, a variation of time impact analysis is adopted for this case study. The time impact method, the most credible delay analysis method relies on the assumption that delay impacts to a project can be assessed by running a series of analyses on schedule updates. It assesses delays effects on the project schedule by analysing the schedule periodically, generally on a day by day basis; in the case of Window analysis, weekly or monthly updates. Delay events are inserted into the schedule and delay impacts are accumulated every time the schedule is recalculated.

REFERENCES

[1] N. Hamzah, M. Khoiry, I. Arshad, N. Tawil and A. Che Ani, 'Cause of construction delay - Theoretical Framework', in *The 2nd International Building Control Conference*, 2011, pp. 490-495.

[2] M. Marzouk and T. El-Rasas, 'Analyzing delay causes in Egyptian construction projects', *Journal of Advanced Research*, vol. 5, no. 1, pp. 49-55, 2014.

[3] S. Assaf, M. Al-Khalil and M. Al-Hazmi, 'Causes of delay in large building construction projects', *J. Manage. Eng.*, vol. 11, no. 2, pp. 45-50, 1995.

[4] H. Samarghandi, S. Tabatabaei, P. Taabayan and A. MirHashemi, 'Studying the reasons for delay and cost escalation in construction projects : The case of Iran', in *Industrial and Systems Engineering Research Conference*, 2014.

[5] M. Abd El-Razek, H. Bassioni and A. Mobarak, 'Causes of delay in building construction projects in Egypt', *Journal of Construction Engineering and Management*, vol. 134, no. 11, pp. 831-841, 2008.

[6] A. Aibinu and H. Odeyinka, 'Construction delays and their causative factors in Nigeria', *Journal of Construction Engineering and Management*, vol. 132, no. 7, pp. 667-677, 2006.

[7] T. Lo, I. Fung and K. Tung, 'Construction delays in Hong Kong civil engineering projects', *Journal of Construction Engineering and Management*, vol. 132, no. 6, pp. 636-649, 2006.

[8] M. Abd El-Razek, H. Bassioni and A. Mobarak, 'Causes of delay in building construction projects in Egypt', *Journal of Construction Engineering and Management*, vol. 134, no. 11, pp. 831-841, 2008.

[9] D. Arditi and T. Pattanakitchamroon, 'Selecting a delay analysis method in resolving construction claims', *International Journal of Project Management*, vol. 24, no. 2, pp. 145-155, 2006.
[10] S. Kometa, P. Olomolaiye and F. Harris, 'Attributes of UK construction clients influencing project consultants' performance', *Construction Management and Economics*, vol. 12, no. 5, pp. 433-443, 1994.
[11] R. Aziz, 'Ranking of dely factors in construction projects after Egyptian revolution', *Alexandria Engineering Journal*, vol. 52, no. 3, pp. 387-406, 2013.
[12] C. Kao and J. Yang, 'Comparison of windows-based delay analysis methods', *International Journal of Project Management*, vol. 27, no. 4, pp. 408-418, 2009.
[13] J. Yang and C. Kao, 'Critical path effect based delay analysis method for construction projects', *International Journal of Project Management*, vol. 30, no. 3, pp. 385-397, 2012.
[14] N. Braimah and I. Ndekugri, 'Factors influencing the selection of delay analysis methodologies', *International Journal of Project Management*, vol. 26, no. 8, pp. 789-799, 2008.
[15] H. Kim, L. Soibelman and F. Grobler, 'Factor selection for delay analysis using Knowledge Discovery in Databases', *Automation in Construction,* vol. 17, no. 5, pp. 550-560, 2008.

BIOGRAPHIES

Anup Wilfred, Associate Professor, Civil Engineering Department, Manipal Institute of Technology, Karnataka, India

Muhamad Sharafudeen, PG Student, Construction Engineering &Management, Manipal Institute of Technology, Karnataka, India

