Critical Causes of Delay in Residential Construction Projects: Case Study of Central Gujarat Region of India

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***Abstract*— Delays are unique one in every of the largest issues construction companies are facing today. Delays will result in several negative effects like lawsuits between house owners and contractors, exaggerated prices, loss of productivity and revenue, and contract termination. Thus, comprehensive study on delays in construction projects is important. Present study works on identification and ranking of causes of delay in residential construction projects in Indian context. This paper identifies the causes of delays in residential construction projects of Indian construction industry. Total 59 causes were identified under 9 major groups. Total 50 respondents comprises of 20 developers, 17 contractors and 13 architects who participated in this field survey. This paper suggests an approach to carry out ranking of causes of delay by two different techniques: Relative importance index and Importance index based on degree of severity and degree of frequency and also discuss about the ranking of the causes. Results were shows that out of top 10 factors total 5 factors were common in ranking by both methods. They were original contract duration is too short, shortage of labours, delay in material delivery, low productivity level of labours, delay in progress payments by owner. Moreover, by both methods labour related factors ranked first while external factor was considered having least effect on delay as it is ranked last. All three parties agreed on that labour related factor was most important while external factor was least important. It is hoped that the findings of the paper will help the stakeholders to act on critical causes and further try to reduce delay of their projects.**

***Keywords*— Causes of delay, Construction industry, India, Relative importance index, Importance index.**

I. INTRODUCTION

In construction, delay could be defined 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. It is a project slipping over its planned schedule and is considered as common problem in construction projects. To the owner, delay means loss of revenue through lack of production facilities and rentable space or a dependence on present facilities. In some cases, to the contractor, delay means higher overhead costs because of longer work period, higher material costs through inflation, and due to labour cost increases. Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. These sources include the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations. However, it rarely happens that a project is completed within the specified time. The Construction industry is large, volatile, and requires tremendous capital outlays. Typically, the work offers low rates of return in relation to the amount of risk involved.

Delays on construction projects are a universal phenomenon. They are almost always accompanied by cost and time overruns. Construction project delays have an adverse effect on parties (developer, contractor, and consultant) to a contract in terms of a growth in adversarial relationships, distrust, litigation, arbitration, cash-flow problems, and a general feeling of apprehension towards each other. So, it is essential to define the actual causes of delay in order to minimize and avoid the delays in any construction project.

II. OBJECTIVES OF STUDY

The main objectives of this study include the following.

I. To identify the causes of delay for residential construction projects in Indian context.

II. To rank causes of delay by RII(relative importance Index) method and by IMPI(Importance Index) method.

III. LITERATURE REVIEW

A number of studies have been carried out to determine the causes of delay in construction projects.

Alwi and keith (2003)[1] did survey for identifying the important causes of delays in building Construction projects in Indonesia. A questionnaire survey was carried out targeting 89 respondents from large contractors and 23 respondents from small contractors. The respondents were asked to assess the level of effect the 31 potential delay causes on their projects.

The delay factors were grouped into six major groups. The results showed that the large and small contractors generally agree on the importance ranking of the individual delay variables. In relation to the groups of the delay variable, however, the result showed that there is no agreement between the two groups of contractors. The professional management group was ranked the highest and the external groups were ranked the lowest by large contractors. Whereas, small contractors ranked the design and documentation group as the highest and the execution group as the lowest.

A survey on time performance of different types of construction projects in Saudi Arabia was conducted by Assaf and Hejji (2005)[3] to determine the causes of delay and their importance according to each of the project participants, i.e., the developer, consultant and the contractor. The field survey conducted included 23 contractors, 19 consultants, and 15 developers. Seventy-three causes of delay were identified during the research. 76% of the contractors and 56% of the consultants indicated that average of time overrun is between 10% and 30% of the original duration. The most common cause of delay identified by all the three parties is ‘‘change order’’. Surveys concluded that 70% of projects experienced time overrun and found that 45 out of 76 projects considered were delayed.

Frimpong et. al., [5] conducted a survey to identify and evaluate the relative importance of significant factors contributing to delay and cost overruns in Ghana groundwater construction projects. A questionnaire with 26 factors was carefully designed from preliminary investigations conducted in groundwater drilling projects between 1970 and 1999 in Ghana. The questionnaire was directed towards three groups in both public and private organizations: owners of the groundwater projects, consulting offices, and contractors working in the groundwater works. The questionnaire was distributed to a random sample of 55 owners, 40 contractors and 30 consultants. The result of the study revealed the main causes of delay and cost overruns in construction of groundwater projects: monthly payment difficulties from agencies; poor contractor management; material procurement; poor technical performance; and escalation of material prices.

Al-Momani[2] investigated causes of delay in 130 public projects in Jordan. The main causes of delay were related to design, user changes, weather, site conditions, and late deliveries, economic conditions and increase in quantity. The study suggested that special attention to factors will help industry practitioners in minimizing contract disputes. Delays have strong relationship with failure and in effective performance of contractors.

Chan and Kumaraswamy[10] conducted a survey to evaluate the relative importance of 83 potential delay factors in Hong Kong construction projects and found five principal factors: poor risk management and supervision, unforeseen site conditions, slow decision making, client-initiated variations, and work variations. They also found that there was a difference in perceptions as to causes of delays by different groups of participants in building and civil engineering works. They suggested that biases of different industry groups might direct blame for delays to other groups.

Ogunlana *et al*., [11] studied the delays in building projects in Thailand, as an example of developing economies. They concluded that the problems of the construction industry in developing economies could be nested in three layers: (1) problem of shortages or inadequacies in industry infrastructure, mainly supply of resources; (2) problems caused by clients and consultants; and (3) problems caused by incompetence of contractors.

Doloi H. et al.(2012) [4] did research to analyze factors affecting delays in Indian construction projects. They selected set of 45 attributes. Their research first identified the key factors impacting delay in Indian construction industry and then established the relationship between the critical attributes for developing prediction models for assessing the impacts of these factors on delay. A questionnaire and personal interviews have formed the basis of their research. Factor analysis and regression modelling were used to examine the significance of the delay factors. From the factor analysis, most critical factors of construction delay were identified as lack of commitment followed by inefficient site management and poor site coordination ranked third.

IV. Research Methodology

The research methodology for present study contains two phases. The first phase included a literature search and interviews. The literature review was conducted through books, conference proceedings, internet and international project management journals. As the outcome of this phase, 59 causes of delays for residential construction projects were identified. These causes were categorise in nine main groups as: 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. Framework of the causes is given in Appendix I.

The second phase includes preparation of two type of questionnaire based on two different approach used for giving ranking to causes of delay of residential construction projects. Present study suggests two different techniques for ranking of causes of delay. In first technique Relative Importance Index (RII) of each cause of delay can be calculated and in second technique Importance index is calculated as a function of frequency and severity indices.

V. Data Collection

The target population included civil engineering and buildings construction firms of central Gujarat region of India. The architects, contractors and developers of various city of central Gujarat were targeted for survey. The details of various stakeholders and total numbers of were collected

through internet. These details were considered as size of population to decide sample size of study. To obtain a statistically representative sample of the population, the formula shown in Eq. (1) was used (Hogg and Tannis 2009) [6]:

$$n = \frac{m}{1+\frac{m-1}{N}} \quad (1)$$

where n, m, and N = the sample size of the limited, unlimited, and available population, respectively. m is estimated by Eq. (2):

$$m = \frac{z^2 * p * (1-p)}{\varepsilon^2} \quad (2)$$

where z = the statistic value for the confidence level used, i.e., 2.575, 1.96, and 1.645, for 99%, 95%, and 90% confidence levels, respectively; p = the value of the population proportion that is being estimated; and ε = the sampling error of the point estimate. Because the value of p is unknown, Sincich et al. (2002) [12] suggest a conservative value of 0.50 be used so that a sample size that is at least as large as required be obtained. By using a 90% confidence level, i.e., 10% significance level, the unlimited sample size of the population, m, is approximated as follows:

$$m = \frac{1.645^2 * 0.5 * (1-0.5)}{(0.1)^2}$$

$$= 67$$

Accordingly, for the total number of stakeholders as per detail available through internet, i.e., N = 1610, the representative sample size of the population required, is determined as shown below:

$$n = \frac{67}{1+\frac{67-1}{1610}}$$

$$\approx 64$$

As the response rate is always very low, the questionnaire was distributed to various stakeholders more than the sample size requirement. Total 117 questionnaires were distributed to different respondents in Aanand, Ahmedabad, Vadodara, Nadiad. They were sent the reminder for sending their feedback after 10 to 15 days of sending the questionnaire. This study received 50 responses. So, the response rate (as compare to sample size=64) is in this research is 78%, which is considered as very good in this kind of survey research.

VI. Data Analysis Approch

The following two types of approach should be used for data analysis.

A. *Relative Importance Index technique:*

Kometa et al.[8] used the Relative Importance Index method to determine the relative importance of the various causes and effects of delays. The same method is going to adopted in this study within various groups (i.e. clients, consultants or contractors). The four-point scale ranged from 1 (less important) to 4 (extremely important) is adopted and transformed to relative importance indices (RII) for each factor as follows:

$$RII = \frac{\sum W}{A*N} \quad (3)$$

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), higher the value of RII, more important was the cause of delays.

The RII was used to rank (R) the different causes. These rankings made it possible to cross-compare the relative importance of the factors as perceived by the three groups of respondents (i.e. developer, consultants and contractors). 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.

B. *Importance Index technique:*

In this technique, For each cause/factor two questions were asked: What is the frequency of occurrence for this cause? And what is the degree of severity of this cause on project delay? Both frequency of occurrence and severity were categorized on a four-point scale. Frequency of occurrence is categorized as follows: always, often, sometimes and rarely (on 4 to 1 point scale). Similarly, degree of severity was categorized as follows: extreme, great, moderate and little (on 4 to l point scale).

1) Frequency index: A formula is used to rank causes of delay based on frequency of occurrence as identified by the participants.

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

Where, a is the constant expressing weighting given to each response (ranges from 1 for rarely up to 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.

$$\text{Severity Index (S.I.) (\%)} = \sum a\,(n/N) * 100/4 \quad (5)$$

Where a is the constant expressing weighting given to each response (ranges from I for little up to 4 for severe), n is the

frequency of the responses, and N is 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:

Importance Index (IMP.I.)(%) = [F.I.(%)* S.I. (%)]/100 (6)

VII. Results And Findings

The all ranking indices explained earlier were used to rank delay causes from viewpoints of the three parties (Developer, Contractors and Consultants). Total 50 respondents participated in this survey. These respondents included 20 developers, 17 contractors and 13 architects/ consultant.

A. *Top 10 causes ranked by Relative Importance Index (RII) technique(based on all respondent):*

The relative importance index, RII, was computed for each cause to identify the most significant causes. The causes were ranked based on RII values. From the ranking assigned to each cause of delays, It was possible to identify the most important factors or causes of delays in Indian construction industry.

Based on the ranking, the 10 most important causes of construction delays by RII were: (1) Original contract duration is too short.[RII=0.815]; (2) Shortage of labours.[RII=0.81]; (3) Delay in material delivery.[RII=0.8]; (4) Late procurement of materials.[RII=0.775]; (5) Low productivity level of labours.[RII=0.75]; (6) Delay in progress payments by owner.[RII=0.74]; (7) Ineffective planning and scheduling of project by contractor.[RII=0.735]; (8) Difficulties in financing project by contractor.[RII=0.725]; (9) Delays in producing design documents.[RII=0.725]; (10) Poor communication and coordination by contractor with other parties .[RII=0.72]

B. *Top 10 causes ranked by Importance Index (IMPI) technique(Based on all respondent):*

The importance index of each cause is calculated as a product of both frequency and severity indices. Based on the ranking, the 10 most important causes of construction delays by IMPI were: (1) Delay in material delivery[IMPI=49.5%]; (2) Original contract duration is too short[IMPI=48.91%]; (3)Delay in progress payments by owner [IMPI=48.18%] ; (4)Shortage of labours[IMPI=47.85%]; (5) Difficulties in financing project by contractor[IMPI=44.415%]; (6) Poor communication/coordination between consultant and other parties Consultant[IMPI=41.975%]; (7)Poor site management and supervision by contractor[IMPI=41.745%]; (8) Low productivity level of labours[IMPI=41.65%]; (9) Poor communication and coordination by owner and other parties[IMPI=39%]; (10) Changes in material types and specifications during construction [IMPI=38.7%]

C. *Comparison of rank of groups of causes of delay between RII and IMPI techniques ;*

The following table shows difference in rank of nine groups of delay by RII and IMPI technique.

TABLE I
INDEX AND RANK OF CAUSES OF GROUPS OF DELAY FACTORS

Sr. No	Group	RII	Rank	IMPI(%)	Rank
1	Labour	0.704	1	35.24	1
2	Materials	0.698	2	33.82	2
3	Design	0.684	3	29.64	6
4	Equipment	0.664	4	24.14	8
5	Project	0.662	5	32.62	4
6	Contractor	0.653	6	32.26	5
7	Developer	0.644	7	33.64	3
8	Consultant	0.616 8	8	29.6	7
9	External	0.553	9	22.3	9

D. *Comparison of rank of groups of causes of delay among various parties.(developer, contractor, architect):*

Table II summarises RII and ranking of the categories of causes of delay as perceived by all respondent. It shows labour related group ranked first by developer and contractor, while design related factor ranked first by architect. All parties agreed that external factors is least affecting on project delay.

TABLE II
RANK OF GROUP OF CAUSES OF DELAY BY ALL THREE PARTIES

Sr. No	Group	RII Developer	Rank	RII Contractor	Rank	RII Architect	Rank
1	Labour	0.713	1	0.746	1	0.635	8
2	Design	0.698	2	0.605	6	0.766	1
3	Materials	0.688	3	0.713	3	0.696	4
4	Contractor	0.686	4	0.549	8	0.737	2
5	Project	0.654	5	0.623	5	0.724	3
6	Developer	0.644	6	0.629	4	0.662	6
7	Consultant	0.620	7	0.588	7	0.502	7
8	Equipment	0.600	8	0.735	2	0.668	5
9	External	0.581	9	0.485	9	0.598	9

E. *Data accuracy checks:*

It is always essential to check accuracy of collected data by statistical methods. In this research, ranking of criteria by various groups was checked as per Spearman's rank

correlation coefficient. In order to test the relative agreement between the responses from different groups, the ranks of the calculated RII weights corresponding to the causes of delay were analysed using the Spearman's rank correlation method. Rank correlation coefficient is a measure of correlation that exists between the two sets of ranks. It is a measure of association that is based on the ranks of the observations and not on the numerical value of the data. The value of Spearman's rank correlation coefficient will vary between "+1" to "-1". "+1" indicates a perfect positive correlation and "-1" indicates perfect negative correlation between two variables (Kendall and Gibsson [7] , 1990; Kothari [9], 2004) . It was worked out by following equation:

$$r = 1 - \left\{\frac{6\sum d^2}{n^3 - n}\right\} \qquad (7)$$

where, r is spearman's rank correlation coefficient between two parties, d is difference between ranks assigned to variables for each cause, n is number of parameter being rank.

The value of Spearman's rank co-relation coefficient between architect and contractor is 0.84, between architect and developer is 0.46, between contractor and developer is 0.7. This shows that there is very marginal difference in opinion of experts' for weighting of criteria and they all exhibit strongly positive correlation.

VIII. SUMMARY

The delay in construction projects in India is studied through field survey. It studied frequency, severity and importance and relative importance of the causes of delay. The importance index of each cause is calculated as a product of both frequency and severity indices of each cause. 59 causes of delay were identified through research. The identified causes are combined into nine groups. The field survey included 20 developer, 17 contractors, 13 consultants. Data collected were analyzed by frequency, severity importance and relative importance. Results shows that out of top 10 factors total 5 factors were common in ranking by both methods. They were Original contract duration is too short, Shortage of labors, Delay in material delivery, Low productivity level of labors, Delay in progress payments by owner. Moreover, by both methods labour related factors were ranked first while external factors were ranked as last. All three parties agreed on that labour related factor was most important while external factor was least important. It is hoped that the findings of the paper will help the stakeholders to act on critical causes and further try to reduce delay of their projects.

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APPENDIX I

CLASSIFICATION OF CAUSES OF DELAY

Sr. No.	Causes of delay	Group
1	Original contract duration is too short	Project
2	Legal disputes between various parties	
3	Ineffective delay penalties	
		Owner
4	Delay in progress payments by owner	
5	Delay to furnish and deliver the site to the contractor by the owner	
6	Change orders by owner during construction	
7	Late in revising and approving design documents by owner	
8	Delay in approving shop drawings and sample materials	
9	Poor communication and coordination by owner and other parties	
10	Slowness in decision making process by owner	
11	Unavailability of incentives for contractor for finishing ahead of schedule	
12	Suspension of work by owner	
		Contractor
13	Difficulties in financing project by contractor	
14	Rework due to errors during construction	
15	Conflicts b/w contractor and other parties (consultant and owner)	
16	Poor site management and supervision by contractor	
17	Poor communication and coordination by contractor with other parties	
18	Ineffective planning and scheduling of project by contractor	
19	Improper construction methods implemented by contractor	
20	Inadequate contractor's work	
21	Delay in site mobilization	
		Consultant
22	Delay in performing inspection and testing by consultant	
23	Delay in approving major changes in the scope of work by consultant	
24	Inflexibility (rigidity) of consultant	
25	Poor communication/coordination between consultant and other parties Consultant	
26	Late in reviewing and approving design documents by consultant	
27	Conflicts between consultant and design engineer	
28	Inadequate experience of consultant	
		Design
29	Mistakes and discrepancies in design documents	
30	Delays in producing design documents	
31	Unclear and inadequate details in drawings	
32	Complexity of project design	
33	Insufficient data collection and survey before design	
34	Misunderstanding of owner's requirements by design engineer	
		Materials
35	Changes in material types and specifications during construction	
36	Delay in material delivery	
37	Damage of sorted material while they are needed urgently	
38	Delay in manufacturing special building materials	
39	Late procurement of materials	
40	Late in selection of finishing materials due to availability of many types in market	
		Equipment
41	Equipment breakdowns	
42	Shortage of equipment	
43	Low level of equipment-operator's skill	
44	Low productivity and efficiency of equipment	
		Labour
45	Shortage of labours	
46	Unqualified workforce	
47	Low productivity level of labours	
48	Personal conflicts among labours	
49	Effects of subsurface conditions (e.g., soil, high water table, etc.)	

50	Delay in obtaining permits from municipality	External
51	Rain effect on construction activities	
52	Unavailability of utilities in site (such as, water, electricity, telephone, etc.)	
53	Effect of social and cultural factors	
No.	**Causes of delay**	**Group**
54	Traffic control and restriction at job site	External
55	Accident during construction	
56	Differing site (ground) conditions	
57	Changes in government regulations and laws	
58	Delay in providing services from utilities (such as water, electricity)	
59	Delay in performing final inspection and certification by a third party	