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Ranking of the Causes of Delay for Private Sector Industrial Construction Projects in Indian Context

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Abstract - *Delays occur commonly in construction projects. The problem of project delays is a fact that occurs mostly in Indian construction industry. Indian construction sector has not escaped from the problem of time overrun. Delays in construction can bring about various changes in a task, for examplelate completion,lost efficiency, acceleration, expanded expenses and contract termination. Hence it is fundamental to study and break down reasons for construction delays. Present study lives up to identification andranking of reasons ofdelay in private sector industrial construction projects in Indian context. This paper describes the causes of delays in private sector industrial construction projects ofIndian construction industry. Total 73 causes were identified under 9 major groups. The absolute 77 number of respondents includes of 22 developers, 27 contractors and 28 architects who took part in this field survey. This paper proposes a way to deal with complete ranking of reasons of delay by two distinct techniques: Relative importance index and Importance index based on degree of severity and degree of frequency. Results show that out of top 10 factors total 6 factors were common in ranking by both techniques. They wereShortage of labours,Poor site management and supervision by contractor, Delay in progress payments by owner, Ineffective planning and scheduling of project by contractor, Difficulties in financing project by contractor, Poor judgement in estimating time and resources. Moreover, by both techniques labour related factors ranked first while equipment related factor was considered having least effect on delay as it is ranked last. It is trusted that the discoveries of the paper will help the stakeholders to follow up on discriminating causes and further attempt to lessen delay of their projects.*

Keywords: *- Causes of delay, time overrun, construction industry, India, Relative importance index, Importance index,*

I. INTRODUCTION

The Indian construction sector over the last few years had faced challenges arising from weak investment cycle and delays or uncertainties in policies leading to weak order inflows as well as slowdown in execution. According to ICRA (Investment Information and Credit Rating Agency of India Limited) as of June 30, projects involving investments of Rs 9 lakh crore were stalled due to weak macro-economic environment and prolonged delays in getting clearances and land acquisition.

A report was published in "The financial express" on dated November 12, 2014 about India's infrastructure sector. According to report, the Planning Commission has stated that 83 per cent of over 700 central sector projects have sustained cost overruns of nearly Rs 1,90,000 crore and delays of up to 12 years. According to the plan panel, the projects are delayed due to a variety of reasons including delay in land acquisition, relief and rehabilitation issues, environment and forest norms and adverse law and order situation in some cases.

Construction delays are common problems in civil engineering projects. The completion of projects in a timely manner is often a critical factor and measure of project success. Delay can be defined as time overrun or extension of time to complete the project. In other words, delay is a situation when the actual progress of a construction project is slower than the planned schedule. In construction industry, there is a basic goal of stakeholders to achieve timely completion of projects within stipulated budget and required quality as each day of time overrun in the completion of any project has direct impact on the cost of project. There are various factors responsible for delay which requires serious attention to understand and address in order to achieve successful completion of project on time.

II. OBJECTIVE OF STUDY

The principle goal of this study includes following.

- To identify the major causes of delays for private sector industrial construction projects in the south Gujarat region of India through a survey and give ranking to these causes by scientific techniques.
- To study the difference of perception of various stakeholders (Contractors, Consultant and Developer) regarding delays of project.

III. LITERATURE REVIEW

Various studies have been doneto determine the causes of delay in construction industry.

Abdalla M. Odeh and Hussien T. Battaineh[1] (2002) identified the most important causes of delay in construction projects with traditional type contracts from the viewpoint of construction contractors and consultants. Results of the

survey indicate that contractors and consultants agreed that owner interference, inadequate contractor experience, financing and payments, labour productivity, slow decision making, improper planning, and subcontractors are among the top ten most important factors.

Saleh Al HadiTumi[11] et al. (2009)carried out a questionnaire survey in Libya and targeted a most important causes of delays in construction projects of Benghazi city in Libya. Results conclude: improper planning, lack of effective communication, shortage of supply, design errors, slow decision making, financial issues, shortage of materials are the top most causes of delay.

M. Haseeb[10] et al. (2011) conducted a research on problems of projects and effects of delays in the construction industry of Pakistan. They identified the factors of delay and their effects on the success and completion of project. The most common factor of delay are natural disaster in Pakistan like flood and earthquake and some others like financial and payment problems, improper planning, poor site management, insufficient experience, shortage of materials and equipment etc. In Pakistan mostly delay occur in large construction projects is change of government due to which construction is stopped and new government propose new design for construction as well as bill are not easily passed by new government. They gave recommendations that for reducing delay in project, contractor must have knowledge about his resources strength and obtain up-to-date Machinery, and try to obtain new equipment for construction. Managerial and technical staff should be acquired for site management and supervision. It is necessary to include skilled and experienced workers in staff because of them the performance of work is improved.

Geraldine john kikwasi[3] (2012)carried out a research to assess causes and effects and disruptions in construction projects in Tanzania. Two sampling techniques were used to select respondents namely: purposive and random sampling. Literature review, questionnaires and interviews techniques were used to collect data for the study and findings reveal that the main causes of delay and disruptions are: design changes, delays in payment to contractors, information delays, funding problems, poor project management, compensation issues and disagreement on the valuation of work done. On the other hand, time overrun, cost overrun, negative social impact, idling resources and disputes are the main effects of delays and disruptions.

Ghulam Abbas Niazai and KassimGidado[4] (2012) held comprehensive survey to identify the critical factors that cause construction delays in Afghanistan and their findings show that the main critical factors that cause construction delays are: security, corruption, poor qualification of the contractor's technical staff, payment delays by clients and poor site management and supervision by contractor.

Aftab Hameed Memon[2] (2014)did study for identifying the significant factors causing time overrun in Malaysian construction industry. Investigation through survey was carried out in central and southern parts of Malaysian among the respondents from three categories i.e. client, consultant and contractors. The feedback was received from 75 respondents against 300 companies contacted. The feedback was analysed statistically which revealed that cash flow and financial difficulties faced by contractor, poor site management and supervision, incompetent subcontractor, shortage of workers and financial difficulties of the owner are major contributors of time overrun. He recommends that the problem of time overrun can be controlled through proper planning of work, committed leadership and management, and effective communication system.

Survey conducted by K. L. Ravisankar[6] (2014) outlined 50 factors for delay in Indian construction industry. Delay factors are assembled into seventeen groups. He indicated that the most important causes are: Shortage of unskilled & skilled labour, Design changes by owner or his agent during construction, Fluctuation of prices, High waiting time for availability of work teams; Rework due to errors. These are all the top five delay factors which affect construction project.

IV. RESEARCH METHODOLOGY

The research methodology for present study contains two stages. The first stage included a literature search and interviews. The literature review was conducted through books, conference proceedings, articles, internet and international project management journals. As the outcome of this phase, 73 causes of delays for industrial construction projects were identified. These causes were categorized 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 1.

The second stage includes preparation of two type of questionnaire based on two different approach used for giving ranking to causes of delay of industrial 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 (IMPI) is calculated as a function of frequency and severity indices.

V. Data Collection

The target population included civil engineering and buildings construction firms of South Gujarat region of India. The architects, contractors and developers of Surat and Navsari city of South Gujarat were targeted for survey. The details of various stakeholders and total numbers of them 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)[5]

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

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]suggested 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 following values:

Z = 1.645
P = 0.5
ε = 0.1

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 architect, i.e., N, of 240, the representative sample size of the population required, is determined as shown below:

$$n = \frac{67}{1+\frac{67-1}{240}} \approx \mathbf{52}$$

Sample size of contractor,

$$n = \frac{67}{1+\frac{67-1}{284}} \approx \mathbf{54}$$

Sample size of developer,

$$n = \frac{67}{1+\frac{67-1}{600}} \approx \mathbf{60}$$

Total no of sample size = **166**

The questionnaire was distributed to various stakeholders more than the sample size requirement.Total 150 questionnaires were distributed to different respondents in Surat and Navsari cities of South Gujarat Region. This study received 77 responses. So, the response rate (as compare to sample size=166) is in this research is 51.33%.

VI. Data analysis approaches

The following two types of approach were used for data analysis.

6.1.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 be 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:

$$\text{RII} = \frac{\sum W}{A*N}$$

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.

This type of main questionnaire (Table 1) will be asked for finding relative importance index. Please indicate by ticking (✓) the appropriate column the relative importance of each of the following causes of industrial construction delay. Please tick mark according to your point of view only in one column in each row as shown below.

Table 1 Sample questionnaire for RII

No.	Group	Causes of Delay	Very Important	Important	Somewhat Important	Not Important
1	Project Management	Original contract duration is too short		✓		

6.2 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).

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

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

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.

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

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

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.

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

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

This type of Main questionnaire (Table 2) will be asked for finding Importance index. Please tick (✓) the appropriate column to indicate frequency of occurrence of causes and degree of severity of the causes on industrial construction delay as shown below.

Table 2 Sample questionnaire for IMPI

No.	Group	Causes of delay	Frequency of occurrences				Degree of severity			
			Always	Often	sometimes	Rarely	Extreme	Great	Moderate	little
1	Project management	Original contract duration is too short		✓					✓	

VII. RESULTS AND FINDINGS

The essential information gathered from the first piece of the survey was broken down from the viewpoint of owners, consultants and contractors. The absolute 77 number of respondents includes of 22 developers/Owners, 27 contractors and 28 architects/consultantstook part in this field survey.

7.1 Top 10 causes ranked by Relative Importance Index (RII) Technique (based on all respondent)

The relative importance index, RII, is figured for every reason to distinguish the most critical causes. The reasons for delay are ranked in light of RII values. From the positioning relegated to every reason for delays, it is conceivable to recognize the most critical factors or reasons of delays in industrial construction projects of South Gujarat locale of India.

Based on the ranking, the 10 most important causes of construction delays by RII were:

Table 3 Top 10 causes of delay by RII Technique

Rank	Causes of Delay	RII	Rank	Causes of Delay	RII
1	Shortage of labours	0.844	6	Poor qualification of the contractor's technical staff	0.763
2	Poor site management and supervision by contractor	0.815	7	Difficulties in financing project by contractor	0.753

3	Delay in progress payments by owner	0.812	8	Natural calamities (flood, landslides, …)	0.753
4	Ineffective planning and scheduling of project by contractor	0.795	9	Poor judgement in estimating time and resources	0.747
5	Delay in obtaining permits from municipality	0.773	10	Unclear and inadequate details in drawings	0.747

7.2 Top 10 causes ranked by Importance Index (IMPI) Technique (Based on all respondent)

Based on the ranking, the 10 most important causes of construction delays by IMPI were:

Table 4 Top 10 causes of delay by IMPI Technique

Rank	Causes of Delay	IMPI (%)	Rank	Causes of Delay	IMPI (%)
1	Shortage of labours	55.213	6	Original contract duration is too short	43.404
2	Delay in progress payments by owner	51.885	7	Bureaucracy in Government agencies	42.584
3	Poor site management and supervision by contractor	47.348	8	Delays in producing design documents	42.080
4	Ineffective planning and scheduling of project by contractor	45.977	9	Late in reviewing and approving design documents by consultant	41.701
5	Difficulties in financing project by contractor	45.719	10	Poor judgement in estimating time and resources	41.608

7.3 Comparison of rank of groups of causes of delay between RII and IMPI technique

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

Table 5 Comparison of rank of groups of causes of delay between RII and IMPI technique

Comparison of rank of groups of causes of delay by both techniques					
Sr. No.	**Group**	**RII**	**Rank**	**IMPI (%)**	**Rank**
1	Labour	0.7175	1	39.1252	1
2	Materials	0.7097	2	33.7979	6
3	Owner	0.7032	3	37.3713	2
4	Consultant	0.6921	4	35.2345	4
5	Design	0.6903	5	33.1417	7
6	Contractor	0.6902	6	35.6782	3
7	Project management	0.6800	7	35.2301	5
8	External	0.6605	8	31.8578	8
9	Equipment	0.6578	9	30.3900	9

7.4 Comparison of Rank of groups of causes of delay among various parties (Architect, Contractor, Developer)

Table summarises RII and ranking of the categories of causes of delay as perceived by all respondent. It shows labour related group ranked first by contractor and developer, while consultant related factor ranked first by architect. External, Equipment and Design related group were ranked last respectively by Architect, Contractor and Developer.

Table 6 Comparison between various groups of stakeholders by RII Technique

Comparison between various groups of stakeholders by RII Technique							
Sr. No.	**Group**	**RII Architect**	**Rank**	**RII Contractor**	**Rank**	**RII Developer**	**Rank**
1	Consultant	0.765	1	0.693	6	35.662	6
2	Materials	0.748	2	0.698	4	38.239	3
3	Design	0.744	3	0.676	7	32.122	9
4	Owner	0.739	4	0.725	2	36.950	4

5	Labour	0.712	5	0.743	1	39.418	1
6	Contractor	0.711	6	0.707	3	35.738	5
7	Equipment	0.709	7	0.652	9	38.339	2
8	Project management	0.705	8	0.698	5	33.115	8
9	External	0.659	9	0.674	8	35.571	7

7.5 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 were checked by 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 ofSpearman'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:

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

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 0.61, between architect and developer is 0.56, between contractor and developer is 0.65. This shows that there is very marginal difference in opinion of experts' for weighting of criteria and they all exhibit strongly positive correlation.

I. SUMMARY

The delay inprivate sector industrialconstruction 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. 73causes of delay were identified through research. The identified causes are combined into nine groups. The fieldsurvey included 22 developer, 27 contractors, and 28 consultants. Data collected were analysed by frequency, severityimportance and relative importance. Results based on RII & IMPI techniques pointed out that "Shortage of labours,Poor site management and supervision by contractor, Delay in progress payments by owner, Ineffective planning and scheduling of project by contractor, Difficulties in financing project by contractor, Delay in obtaining permits from municipality, Poor qualification of the contractor's technical staff, Original contract duration is too short, Bureaucracy in Government agencies, Delays in producing design documents, Natural calamities (flood, landslides, …),Poor judgement in estimating time and resources, Unclear and inadequate details in drawings, Late in reviewing and approving design documents by consultant" are the most critical causes for delay in private sector industrial construction projects in South Gujarat region of India. It is hoped that findings of this study will be helpful to Industrial Construction project stakeholders to reduce the delay of their projects.

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APPENDIX I

No.	Group	Causes of Delay
1	Project management	Original contract duration is too short
2		Legal disputes between various parties
3		Type of construction contract (Turnkey, construction only,)
4		Type of project bidding and award (negotiation, lowest bidder,)
5		Inadequate definition of substantial completion
6		Lack of personnel training and management support
7		Poor judgement in estimating time and resources
8		Preparation of scheduling work-delay
9		Delay in Shop drawings
10		Quality assurance and control
11		Old construction methods
12	Owner	Delay in progress payments by owner
13		Change orders by owner during construction
14		Delay to furnish and deliver the site to the contractor by the owner
15		Suspension of work by owner
16		Poor communication and coordination by owner and other parties
17		Late in revising and approving design documents by owner
18		Conflicts between joint-ownership of the project
19		Slowness in decision making process by owner
20		Delay in approving shop drawings and sample materials
21		Unavailability of incentives for contractor
22	Contractor	Poor site management and supervision by contractor
23		Ineffective planning and scheduling of project by contractor
24		Difficulties in financing project by contractor
25		Poor communication and coordination by contractor with other parties
26		Delay in site mobilization
27		Delays in sub-contractors work
28		Rework due to errors during construction
29	Contractor	Conflicts between contractor and other parties (consultant and owner)
30		Conflicts in sub-contractors schedule in execution of project Contractor

31		Contractor handling work on more than one site
32		Poor qualification of the contractor's technical staff
33		Frequent change of sub-contractors because of their inefficient work
34	Consultant	Inadequate experience of consultant
35		Poor communication/coordination between consultant and other parties
36		Delay in performing inspection and testing by consultant
37		Late in reviewing and approving design documents by consultant
38		Inflexibility (rigidity) of consultant
39		Conflicts between consultant and design engineer
40	Design	Complexity of project design
41		Mistakes and discrepancies in design documents
42		Un-use & unaware of advanced engineering design software
43		Inadequate design-team experience
44		Delays in producing design documents
45		Unclear and inadequate details in drawings
46		Misunderstanding of owners requirements by design engineer
47		Insufficient data collection and survey before design
48	Materials	Shortage of construction materials in market
49		Delay in material delivery
50		Late procurement of materials
51		Changes in material types and specifications during construction
52		Delay in manufacturing special building materials
53	Equipment	Low level of equipment-operator's skill
54		Equipment breakdowns
55		Shortage of equipment
56		Low productivity and efficiency of equipment
57		Wrong selection of equipment
58	Labour	Unqualified workforce
59		Low productivity level of labours
60		Shortage of labours
61		Personal conflicts among labours
62	External	Natural calamities (flood, landslides, …)
63		Inclement weather (very cold, very hot, rain …) on construction activities
64		Effect of social and cultural factors
65		Effects of subsurface conditions (e.g., soil, high water table, etc.)
66		Accident during construction
67	External	Unavailability of utilities in site
68		Delay in obtaining permits from municipality
69		Traffic control and restriction at job site
70		Delay in performing final inspection and certification by a third party
71		Bureaucracy in Government agencies
72		Market inflation
73		Mistakes in soil investigation

