International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue-01
January 2018

Assessment of Critical Construction Delay Factors: Maharashtra Region

Ashwini Arun Salunkhe

[1] Department of Civil Engineering, DIT Pimpri, Pune, India

[1]1st rsalunkhee@gmail.com

Abstract:

Delays are most frequent phenomena in construction sector and one of the biggest challenges for delivering quality projects. The problem occurrence is very repetitive and some time its complexity leads to disputes & litigation which holds the total project work. The main objective of this paper is to statistically explore the severity of critical construction delay factors. Subsequently, a questionnaire survey was performed with experts from field in government as well as private sector, assessing the rank of delay factor so that importance index and score of delay factors could be scrutinized. One hundred and sixteen delay factors were identified during the research. SPSS®, VERSION 16 was used to evaluate statistical parameters for large database within short period. Non parametric test was conducted for the evaluation of relationship between the participants on their agreement about critical construction delay factors. The critical construction delay factors were determined with the help of statistical methods: relative importance index and mean score.

Keywords

Construction delay, Correlation, Rank, Statistical Analysis

1. Introduction

The massive volume and complexity of projects in Indian construction sector pretense a grand challenge, which provides a fortune of opportunities to several companies in construction industry. The industry is so smitten with various large as well as small scale companies. This results in a demand of large workforce including indirect employment.

Normally, when projects are delayed, they causes time overrun and therefore, incur cost overrun. Delays are always measured as expensive to all parties concerned in projects and very often it will result in clash, claims, total desertion and much difficult for feasibility and also it slows the growth of construction sector (Salunkhe et al 2014). Construction is a risky industry with uncertainties due to many external and internal factors that influence the construction process.

Delays are most frequent phenomena in construction sector and one of the biggest challenges for delivering quality projects. The problem occurrence is very repetitive and some time its complexity leads to disputes & litigation which holds the total project work. Finishing the project with optimum required quality and stipulated time is very vital factor in project life cycle. Also due to huge competition in construction industry it is essential to study the causes and critical factors which control the project success. There are number of performance measuring parameters are cited to call a project successful, such as satisfaction of project participants, technical performance of project and number of disputes at the completion of project (Kumar N.,2011).

However, different analysis methods will provide different results for the same circumstances depending on the time and resources available for the analysis and accessibility of project documentation. This paper analyzes construction delay factors based on the responses received via questionnaire survey. The main purpose of this study is to rank the delay factors and find a most critical delay factor which affects the project performance.

Earlier studies either considered the causes or effects of project delays. This study takes integrated approach of time overrun and cost overrun and attempts to evaluate critical factors from project participant's (Client, Engineer and Contractor) perspective.

The logical question at this point is: Why it is necessary to evaluate critical construction delay factors and how it can help the practitioners to prevent or remedy future delays? In this research we identified delay factors and categorized them as owner related, consultant related, contractor related, material related, labour and equipment related, project related and external related delay factors. Identification of causes of delay factors and ranking the delay factors aloe does not help the project participants to take appropriate steps. The project participants need to understand, for example, what critical delay factor in their work have major impact on project performance and results in time and cost overrun. Once these factors are clear, the participants can take proactive steps to elude such situation.

2. Statistical methods

2.1 Relative Importance Index (RII)

Gunduz et al. (2012) and Sambasivan and Soon (2007) used the relative importance index method to determine the relative importance of various causes of delays.

The same method was adopted in this study within three groups (i.e. clients, engineers and contractors). The four-

point scale ranged from 1 (yes) to 4 (not at all) was adopted and transformed to relative importance indices (RII) for each delay factor as follows:

$$RII = \frac{\sum W}{A \times N}$$

Where W is the weighing 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 1 (0 not inclusive), higher the value of RII, more important was the cause of delays.

2.2 Mean Score (MS)

Tommy et al. (2006) and Wa'el et al. (2007) used the mean score formula to identify the importance of various causes of delays. The same method was adopted in this study within three groups (i.e. clients, engineers and contractors). The four-point scale ranged from 1 (yes) to 4 (not at all) was adopted and transformed to mean score (MS) for each delay factor. The formula is as follows:

$$MS = (4 - \frac{\sum(f \times s)}{N})$$

Where MS is the mean score, f is the frequency of responses to each rating (1-4), s is the score given to each factor by the respondents (ranges from 1 to 4), and N is the total number of responses concerning that factor (113). The MS value had a range from 1 to 4 (0 not inclusive), lower the value of MS, more important was the cause of delays.

2.3 Statistical Package for Social Sciences (SPSS)

SPSS is a Windows based program used for survey authoring and deployment (**SPSS Data Collection**), data mining (**SPSS Modeler**), text analytics, statistical analysis, and collaboration and deployment (batch and automated scoring services) which provides a broad range of capability for the entire analytical process such as to perform data entry, analysis and to create tables and graphs. SPSS is capable of handling large amounts of data and can perform all of the analyses covered in the text and much more. In this study *SPSS® V 16* is used.

All the data from the questionnaire were entered in the software. After data entry in the software the check was performed for the validity as well as reliability of the data with the help of SPSS software.

Further for analysis of the relation between variables (i.e. client, engineer and contractor) the correlation analysis in SPSS software was performed using Spearman Rank order Correlation test.

2.4 Spearman's Rank Correlation

This is a statistical measure to show the strength of a relationship between two variables. Spearman's rank correlation coefficient is used to look at the correlation of data which is ranked or put in order. Spearman rank correlation has been adopted for inferential analysis with the results being tested by a significant level. It is a nonparametric measure of correlation test. In straightforward it is a method of measuring the correlation between two variables. The correlation is measured on a scale from -1 to +1.

The correlation may be:

a. Zero – There is no correlation between both the variables.
b. Between +1 to -1 – There is some correlation.
c. Positive one – Large values of one variable associated with large values of other variables. It is also known as direct relationship.
d. Negative one – Large values of one variable associated with small values of other. It is also known as inverse relationship.

In this study spearman's correlation is referred to alternative b, which in 'non-directional'. Hence while doing the actual statistical test it requires to do 2-tailed test.

The formula is,

$$r_s = 1 - \frac{6\sum d^2}{n^3 - n}$$

r_s = Spearman's Rank Coefficient
d = the difference between the two ranks
d^2 = the difference squared
N = the number of variables

3. Statistical Analysis

3.1 Reliability check

All the collected information from the survey were checked and verified for their correctness with the help of SPSS®, VERSION 16. Table 1 shows the reliability statistics of the collected data and its validity.

Table I: Reliability statistics

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	4	100.0
	Excluded[a]	0	.0
	Total	4	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue-01
January 2018

Case Processing Summary

		N	%
Cases	Valid	4	100.0
	Excluded[a]	0	.0
	Total	4	100.0
.995	117		

Interpretation of the output: As Reliability is 100% further calculations can be carried out.

3.2 Analysis and ranking delay categories by RII

The different delay factors categorized under seven factors (i.e. owner, consultant, contractor, material, labour and equipment, project and external) are analyzed with the help of relative importance index. The delay factors were then ranked on the basis of their importance. These ranking is then used to cross-compare the relative importance of delay factors as perceived by three group of respondents (i.e. clients, engineers and contractors) as shown in Table II.

Table II: Ranking Delay Categories by RII

Delay factors	Client	R	Engineer	R	Contractor	R	Overall	R
Owner related	0.506	4	0.585	2	0.592	1	0.569	1
Consultant related	0.517	2	0.587	1	0.577	3	0.567	2
Contractor related	0.506	4	0.543	6	0.572	4	0.545	3
Material	0.488	5	0.539	7	0.514	6	0.518	5
Labour and equipment related	0.484	6	0.557	5	0.572	4	0.545	3
Project related	0.527	1	0.575	3	0.585	2	0.567	2
External related	0.512	3	0.571	4	0.515	5	0.537	4

**R: Rank*

3.3 Analysis and ranking delay categories by MS

The different delay factors categorized under seven factors (i.e. owner, consultant, contractor, material, labour and equipment, project and external) are analyzed with the help of mean score method. The delay factors were then scored/ranked on the basis of their significance. These ranking is then used to cross-compare the importance of delay factors as perceived by three group of respondents (i.e. clients, engineers and contractors) as shown in Table III.

Table III: Ranking Delay Categories by MS

Delay factors	Client	R	Engineer	R	Contractor	R	Overall	R
Owner related	3.494	4	3.415	2	3.408	1	3.431	1
Consultant related	3.483	2	3.413	1	3.423	3	3.433	2
Contractor related	3.494	4	3.457	6	3.428	4	3.455	3
Material	3.512	5	3.461	7	3.486	6	3.482	5
Labour & equipment related	3.516	6	3.443	5	3.428	4	3.455	3
Project related	3.473	1	3.425	3	3.415	2	3.433	2
External related	3.488	3	3.429	4	3.485	5	3.463	4

**R: Rank*

3.4 Summary of analysis

The different delay factors categorized under seven factors (i.e. owner, consultant, contractor, material, labour and equipment, project and external) are analyzed with the help of relative importance index and mean score method. The delay factors were then ranked on the basis of their significance criteria in respective methods. These ranking is then used to cross-compare the relative importance of delay factors as perceived by three group of respondents (i.e. clients, engineers and contractors) as shown in Table II and Table III. From both the tables it has been observed that the rank given by relative importance index (RII) and mean score (MS) method is same for all seven delay factors for clients, engineers, and contractors.

It was observed from the Table II and Table III that delay factors ranked by client shows that project related delay factors is the most contributory factor for construction delay, which is followed by consultant related factors and then external related delay factors. However contractors ranked owner related delay factors on priority of causing delays in construction industry followed by project related delay factors and then consultant related delay factors. The engineers ranking shows that material related delay factors have less impact on delay, although the consultant, owner and project related delay factors have high influence on causing delays.

3.5 Spearman's rank correlation test

Further analysis was performed to test the degree of agreement on the relative importance of the critical construction delay factors and to rank them in each category between three groups of respondents, a correlation analysis using Spearman's rank correlation

coefficient test was done shown in Table IV. This correlation process is carried out using the Statistical Package for Social Science (SPSS®, Version 16). This test is a nonparametric test and showed the relationship between clients, engineers and contractors on their agreement about the critical construction delay factors.

Table IV, demonstrates software output for the degree of agreement between the respondents. However it can be concluded that all the respondents (clients, engineers and contractors) shows a positive correlation in their agreement on the critical construction delay factors. High correlation indicates that there is a high degree of agreement between the respondents. Though the value of the correlation coefficient is 0.775 between the engineers and contractors which indicate much stronger positive correlation rather than the coefficient of 0.649 between clients and engineers and 0.445 between clients and contractors. Spearman's rank correlation test showed that there are no variations in the viewpoints between three respondents group of the survey. Due to good agreements between client engineers and contractors in ranking the critical construction delay factors, all the data could be used as a whole for further result analysis.

Table IV: Spearman's rank correlation test

Correlations

			ClieRank	EnggRank	ContrRank
Spearman's rho	ClieRank	Correlation Coefficient	1.000	.649	.445
		Sig. (2-tailed)	.	.115	.317
		N	7	7	7
	EnggRank	Correlation Coefficient	.649	1.000	.775*
		Sig. (2-tailed)	.115	.	.041
		N	7	7	7
	ContrRank	Correlation Coefficient	.445	.775*	1.000
		Sig. (2-tailed)	.317	.041	.
		N	7	7	7

*. Correlation is significant at the 0.05 level (2-tailed).

4. Results and discussion

The results obtained from ranking delay analysis the seven most important critical delay factors (based on all respondents) were: (1) Misunderstandings in technical dealing with vendors & contractors (RII:0.619); (2) Improper implementation of construction methods by consultant (RII: 0.655); (3) Compatibility of contractor with new software's (RII: 0.611); (4) Site receiving inspection system (RII: 0588); (5) unavailability of skilled labor (RII: 0.639); (6) Disputes in soil investigation (RII: 0.668); (7) Inaccurate cost estimates (RII: 0.566)

Among all the categories delay factors related to project category received high rank i.e. disputes in soil investigation RII 0.668. Improper implementation of construction methods by consultant under consultant related delay factors has the second highest RII of 0.655. In this overall analysis material related delay factors has least importance index, because almost material in particular cement, steel and aggregates is locally supplied with slight variation in quality.

4.1 Owner related delay factors

The owner related category is mainly crucial to contractors and engineers. The main reasons behind that are owner's interference in planning, approving relevant documents as well as the financial concern. The delay factor conflict in joint ownership is more important to engineers than the contractors. Because the contractors major part consists of execution which comprises issues related to labors, equipment availability or failure. On the other side engineers/architects planning, drawings and design work is mainly dependent on owner.

4.2 Consultant related delay factors

Contrary to the expectation almost delay factors in this category are ranked high by engineers as compare to contractors. This contains the factors like less authority given to consultant to take decision, financial difficulties faced by the consultant etc. This indicates that the high ranking of owners interference. Contractor's highest rank goes to improper implementation of construction methods by consultant. Among this client has ranked highest to the conflicts of consultant with design engineer.

4.3 Contractor related delay factors

According to contractors ranking, regular updation in execution plan including team RACI (Responsible, accountable, consulting and informed) charts is the most responsible contractor related delay factor. However both clients and engineers have ranked high to poor understanding of accounting and finance project in contractors related delay factors. Also clients have ranked, updation of scheduled activities with latest vendor info construction plan, there further historical precedence to support updates for causing delay in construction. Though

clients as well as engineers ranked compability of contractor with new software and technology contributes the delay. It has been seen from engineers response risk analysis and management by contractors also causes delay.

4.4 Material related delay factors

This group of delay factors have almost received high ranking through engineers as compare to contractors. Material damage in store has got higher rank through engineers although both clients and contractors concerns on site receiving inspection system of material is highly responsible for delay. As the material management is a part of contractor supervision, responses shows that shortage of material received higher rank as compare to changes in quality of material. It is because of the variation in availability of materials as well as the material rates. Slow process of material selection and frequently unexpected modification in specification of material during construction are also affecting delay factors according to engineers and contractors compare to clients.

4.5 Labor and equipment related delay factors

This group of delay factors was highly ranked by contractors and engineers. As predicted, this group of delay factor is more important to contractors followed by engineers and clients. According to contractors responses labor strikes delay factor is more important as compare to skilled labors unavailability. Although engineers and clients responses gave higher ranking to skilled labors unavailability. It is worth noting that contractors are mainly concerned with technical delay factors such as staffing problem and technical performance of labor while clients have ranked the delay factors like disputes in labor and seasoned operators in causing delays in construction industry.

4.6 Project related delay factors

Among project related delay factors, disputes in soil investigation delay factor have been ranked highest by clients, engineers as well as contractors. The responses received from contractors for important delay factors also include traffic control at site. Although engineers responses shows that changes in site topography after design, problems due to existing structures causes more delays in construction. Engineers have also ranked the delay factor of accidents on site.

4.7 External related delay factors

In this group of delay factors, inaccurate cost estimates receives high ranking from contractors while engineers have ranked, changes in government laws and regulation is the most important delay factor among this category. However, clients responses shows that restriction due to site location and inclement weather effects are the most important delay factors for causing delay.

5. Remedial measures to reduce delays

We divide remedial measures to develop into six categories (1) remedial measures on owner (2) remedial measures on consultant (3) remedial measures on contractor (4) remedial measures on material (5) remedial measures on labour (6) remedial measures on construction equipment.

5.1 Remedial measures on owner

Changes and alterations in planning execution should be discussed and pre-informed so that it will not lead delay. Payments should be done on time so that project performance will not get affected.

5.2 Remedial measures on consultant

Communication as well as document system should be developed so that drawings and their mistakes (if any) can be corrected as soon as possible. This will not only avoid delay but rework of construction also gets cured. Implementation of practical knowledge for junior consultant's proper training course should be developed. The role of this training programme should include better inspection practices, leadership skill development, co-ordination system improvement.

5.3 Remedial measures on contractor

Decision and steps taken during project life cycle would be beneficial for project performance. Use of MSP, Primavera or any other planning & scheduling software must be compulsory. As the construction projects include huge number of participants, team approach should be developed. Contractor should employ different teams like, technical team; finance team; research team etc and each team will have their specific goal or purpose. Technical staff should be assigned to project according to their area of expertise or capability. This will be helpful to reduce the rework as well as overcome the problem of inadequate handling of project progress. Meeting between all teams should be arranged to build up effective management between project teams.

5.4 Remedial measures on material

For the implementation of material management and quality assurance a dedicated team should be deployed. The role of this team should be material procurement, vendor selection, inspection. Thus it will be helpful in stores management as well as overcome the factor of untimely delivery. In project cost estimation this team will be helpful for alerting the factor of price escalation.

5.5 Remedial measures on labour

To improve labour productivity and skill, training programme should be developed and implemented. To avoid accidents on construction site, safety tools, safety training programme as well as safety plan should be prepared. In order to generate safety awareness of different safety gadgets to workers and employees, Construction Company should plan for safety budget.

5.6 Remedial measures on construction equipment

During selection of construction equipment by contractor due consideration should be given to its owning cost, its operating cost, operating fuel cost and maintenance cost. To assist equipment selection process optimization model, graphics model, artful intelligence based model must be used depending upon project. To avoid unavailability and shortage of construction equipment a proper equipment vendor database should be maintained by contractor.

6. Conclusion

The data collection was achieved through industry-wide questionnaire survey in construction organizations/firms. Further it quantifies relative importance indices and mean scores of the construction delay factors.

The delay analysis methodology presented in this study reveals the comparison of Relative Importance Index (RII) and Mean Score (MS) methods which are used in construction sector for computing impact of delay. The study reveals that both of delay analysis methods: relative importance index and mean score, gives same result at the end of analysis. SPSS® V16 helps to evaluate statistical parameters for large database within short period with accuracy.

We identified main critical delay factors and ten most important factors were: (1) Late revising & approving relevant documents by owner; (2) delays in payments by owner; (3) Conflicts of consultant with design engineer; (4) Rework in construction faced by contractor; (5) Problems in financing project progress by contractor; (6) Is contractor compatible with new technology; (7) Poor Material management; (8) unavailability of skilled labours; (9) Unavailability of equipment; (10) Disputes in soil investigation.

The results of study will be the guideline for the stakeholders to maximize profit. Also the study suggests several factors to avoid or minimize the delays of project from economic point of view. As India is developing country, this study is essential to develop future infrastructure under economical basis. So that it will contribute to the improvement of growth rate potential and also to increase the competitiveness of the economy.

Realizing the importance of subject, construction delay not only results in time overrun but also in cost overrun. There are various causes due to which project suffers from these delays. As the project is running on many number of factors & participant, these all are having individual causes. But the important participants like owner, contractor, and consultant have more influence on project performance. Hence the causes of these participants are discussed which will helpful to improve the project delivery in terms of time as well as cost effectiveness.

7. References

[1] Abd. Majid, M. Z., and McCraffer, R. (1998). “Factors of non-excusable delays that influence contractor’s performance”. J. Mange. Eng., 14(3), 42-49, DOI: 10.1061 /(ASCE)0742-597X(1998)14:3(42).

[2] Alwi, S., and Hampson, K. (2003). “Identifying the important causes of delays in building construction projects”. The 9th East Asia-Pacific conference on structural eng. and constr., Bali, Indonesia.

[3] Assaf, S. A., and Al-hejji S. (2006). “Causes of delay in large construction projects”. International Journal of Project Managementt., Science Direct, 24, 349-357, DOI: 10.1016.

[4] Assaf, S. A., Al-Khalif, M., and Al-Hazmi, M. (1995). “Causes of delay in large building construction projects”. J. Mgmt. Eng., 11(2), 45-50, DOI: 10.1061/(ASCE)0742-597X(1995)11:2(45).

[5] Gunduz, M., Nielsen, Y., and Ozdemir, M. (2012). “Quantification of delay factors by using relative importance index (RII) method for construction projects in Turkey”. J. Mgmt. Eng., ASCE , DOI: 10.1061/(ASCE)ME.1943-5479.0000129.

[6] Haseeb, M., Xinhai-Lu, Bibi, A., Dyian, M., and Rabbani, W., (2011). “Problems of projects and effects of delays in the construction industry of Pakistan”. Australian Journal of Business and Mgmt. Research, 1(5), 41-50.

[7] Kumar Neeraj Jha, 2011. “Construction Project Management.” Pearson Education India, ISBN: 8131732495, 9788131732496.

[8] Salunkhe A. A. and Patil R., 2014. “Effect Of Construction Delays On Project Time Overrun: Indian Scenario”, International Journal of Research in Engineering and Technology, 3 (1), ISSN: 2319-1163.

[9] Salunkhe A. A. and Patil R., 2014. “Identification of Critical Construction Delay Factors”, International Journal of Latest Trends in Engineering and Technology (IJLTET), 3 (4), 256-261, ISSN: 2278-621X.

[10] Tommy, Y., Fung, W. H., and Tung, C. F. (2006). “Construction delays in Hong Kong civil engineering projects”. J. Constr. Eng. and Mgmt., ASCE, 132(6), 636-649, DOI: 10.1061/(ASCE)0733-9364(2006)132:6(636).

[11] Wa’el, Alaghbari Mohd., Kadir, R. A., Salim, A. and Ernawati (2007). “The significant factors causing delay of building construction projects in Malaysia.” Engineering, Construction and Architectural Management, 14(2),192-206, DOI:10.1108/09699980710731308.

[12] Yee Cheong Yong, Nur Emma Mustaffa, (2012) "Analysis of factors critical to construction project success in Malaysia", Engineering, Construction and Architectural Management, Vol. 19 Issue: 5, pp.543-556, https://doi.org/10.1108/09699981211259612Yee C. Y. and Nur E. M.