



Identifying factors causing cost overrun of the construction projects in India

SWAPNIL P WANJARI* and GAURAV DOBARIYA

Department of Civil Engineering, Visvesvaraya National Institute of Technology, Nagpur 440010, India
e-mail: swapnil_wanjari@yahoo.co.in; er.dobariyagaurav@gmail.com

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Abstract. Delay and cost overrun are common phenomena in projects worldwide. However, these are especially severe in developing countries. In India as per MOSPI report, 235 projects out of 410 were severely affected cost overrun due to certain factors. A short questionnaire was conducted with 15 prominent factors responsible for cost overrun and forwarded to 190 constructional professionals across India. Total 85 responses were received and it was analyzed using various statistical tools such as analysis of variance (ANOVA) and factor analysis tool using SPSS. In this study, top three factors affecting cost overruns were identified such as price escalation of raw material, delay in planned activity and lack of co-ordination between construction parties which could be significantly responsible for cost overrun of construction project in India. Factor analysis method was also carried out to group the factors into three components of overall questionnaire. These components, such as client control component, project management component, and contractor control component, would be useful to the various parties involved in the construction activities. This paper also provides suggestive frameworks which have been framed after discussing with large number of construction professionals or expert.

Keywords. Cost overrun in India; ANOVA; factor analysis; construction projects.

1. Introduction

Cost overrun can be simply defined as “when the final cost of the project exceeds the original estimates” [1]. As per the 342nd Report of the Ministry of Statistics and Programme Implementation in India [2], projects of public sector in India are seriously affected by cost overruns due to various reasons. Four-hundred ten projects were reviewed out of 727 running projects all over India. It was found that 235 projects running were with cost overruns out of 410 projects. It was around 57% projects which has quite large and serious indication towards remedial measures. Delay and cost increase are common phenomena in projects worldwide. However, these are especially severe in developing countries [3]. MOSPI fact finding reports indicating 57% project causes cost overrun, on the other hand has also set an ambitious target of investing US \$1 trillion investments in infrastructure during the 2014–19 [4]. In order to meet requirements of developing in infrastructure in India, annual spending on infrastructure need to be more than double by year 2020 [4]. A very few studies were done in India on cost overrun of construction project; however, studies did not target entire view of India or high valued project cost, etc.

2. Literature review

Many researchers have exercised cost overrun in their country through questionnaire survey or through interviewed with expert industries personal. Large numbers of factors which could be responsible for cost overrun. Some of the factors such as price escalation of raw materials [5–8], high cost of labour is shown in table 1, such as price escalation, dispute in bill settlements, [7, 9, 10], delayed in planned activity [6, 11, 12], etc. Around 25 numbers of factors were identified and summarized in table 1 along with references details. Since 25 numbers of factors are too large and some of factors have same meaning. These 25 numbers of factors were reduced to 15 numbers prominent factors responsible for cost overrun. Some of the factors may seem to be insignificant on one project, they may prove to be significant on some another project, as conditions are not always the same.

Kaming *et al* [7] classified factors influencing construction time and cost overruns in Indonesia and analyzed the correlation between the two. The scope of their particular research was only focuses on the high-rise projects. Dis-sanayaka and Kumaraswamy [13] identified and grouped factors significantly related to time and cost performance and then developed the time and cost overrun models. Recently Aziz *et al* [14] found that cost was one of the

*For correspondence

Table 1. Classification of factors causing cost overrun.

No index entries found	Factor affecting cost overrun	References	Code	Finalised Factors for Questionnaire survey
1	Price escalation of raw materials	Frimpong <i>et al</i> [5], Moura <i>et al</i> [8], Kaliba <i>et al</i> [6], Rahman <i>et al</i> [22], Kaming <i>et al</i> [7]	C01	Price escalation of raw materials
2	High cost of labour	Kaming <i>et al</i> [7], Azhar <i>et al</i> [9, 10]		
3	High cost of transportation	Eshofonie and Patience [23]		
4	Dispute on bill settlement	Ameh <i>et al</i> [24], Sharma and Goyal [25]	C02	Dispute on bill settlement
5	Delay in planned activity	Harisweni [12], Kaliba <i>et al</i> [6], Rahman <i>et al</i> [22]	C03	Delay in planned activity
6	Long period between design and tendering time	Eshofonie and Patience [23]		
7	Ambiguous or incomplete tender document	Omorieg and Radford n.d. [26], Rosenfeld [27], Sharma and Goyal [25]	C04	Ambiguous or incomplete tender document
8	Contract management	Mansfield <i>et al</i> [28], Eshofonie and Patience [23], Doloi [29]		
9	Additional Work	Le-Hoai <i>et al</i> [17], Sharma and Goyal [25]	C05	Additional Work
10	Frequent design changes	Kaming <i>et al</i> . [7], Frimpong <i>et al</i> [5], Omorieg and Radford [26], Harisweni [12], Le-Hoai <i>et al</i> [17], Azhar <i>et al</i> [9, 10], Cheng [30]	C06	Frequent design changes
11	Scope changes	Kaming <i>et al</i> [7], Frimpong <i>et al</i> [5], Moura <i>et al</i> [8], Rahman <i>et al</i> [22], Kaliba <i>et al</i> [6]		
12	Lack of co-ordination between construction parties	Azhar <i>et al</i> [9, 10], Sharma and Goyal [25]	C07	Lack of co-ordination between construction parties
13	Poor site management and supervision	Rahman <i>et al</i> [22]		
14	Fraudulent practices and kick backs	Omorieg and Radford [26], Azhar <i>et al</i> [9, 10], Doloi [29], Sharma and Goyal [25]	C08	Fraudulent practices and kick backs
15	Supplier manipulation	Eshofonie and Patience [23]		
16	Mistake during construction	Eshofonie and Patience [23]	C09	Mistake during construction
17	Force Majeure	Kaliba <i>et al</i> [6], Kaming <i>et al</i> [7], Frimpong <i>et al</i> [5]	C10	Force Majeure
18	High quality expectation from owner	Cheng [30], Shanmugapriya and Subramanian [31]	C11	High quality expectation from owner
19	Contractual claims, such as, extension of time with cost claims	Rahman <i>et al</i> [22]	C12	Shortening of contract period
20	Shortening of contract period	Omorieg and Radford [26], Okpala and Aniekwu[32]		
21	Wastage on site	Shanmugapriya and Subramanian [31]	C13	Wastage on site
22	Relationship between site management and labour	Omorieg and Radford [26], Rahman <i>et al</i> [22], Doloi [29]	C14	Relationship between site management and labour
23	Poor financial control on site	Azhar <i>et al</i> [9, 10], Ameh <i>et al</i> [24], Doloi [29]	C15	Poor financial control on site
24	Cash flow and financial difficulties faced by contractors	Frimpong <i>et al</i> [5], Le-Hoai <i>et al</i> [17], Rahman <i>et al</i> [22], Doloi [29]		
25	Financial difficulties of owner	Koushki <i>et al</i> [16], Rahman <i>et al</i> [22]		

major consideration throughout out the project management life cycle for waste management project in Egypt. It was discovered the factors such as lowest bidding procurement

method, bureaucracy in bidding/tendering method, additional work; wrong method of cost estimation; funding problems were critical for enhancing cost variation.

Rahman *et al* [15] found that the top three significant factors of cost overrun are fluctuation of prices of materials, financial difficulties faced by contractors and poor site management and supervision in Malaysia. Frimpong *et al* [5] identified causes of delay and cost overrun in construction of projects in Ghana. They identified 26 factors related to cost overruns and delays. Out of which, monthly payment difficulties from agencies, poor contract management, poor technical performances, material procurement, and escalation of material prices were the top five factors causing time and cost overruns.

With survey of 450 randomly selected private residential project owners and developers in Kuwait, Koushki *et al* provided model to estimates of cost increases and time delays and their causes [16]. The three main traits of cost overruns were contractor related problem, material related problem and owner's financial constraints. In order to minimize time and cost overruns, they recommended that project owner should allocate sufficient time and money at design phase, availability of sufficient funds, and selection of proficient consultant and trustworthy contractor to carry out the work. A questionnaire survey was conducted in Portugal by Moura *et al* [8] found that design error, direct change in order and different site conditions were the top three factors affecting cost overruns. In Pakistan, Azhar *et al* [9, 10] carried out a questionnaire survey consisting of 42 factors affecting cost overruns with 25 sets of responses. It was concluded that medium size firms were more prone to cost overruns in comparison with large and small firms because they were in transitional phase where they need to take more risk to find more business and establish them. It was found that fluctuation in prices of raw material, high cost of machineries, unstable cost of manufactured materials, lowest bidding procurement method, and poor site management were the top five factors governing cost overruns.

Le-Hoai *et al* [17] studied factors affecting cost overruns and time overruns in Vietnam and found top three factors which governed time and cost overruns were poor site management and supervision, poor project management assistance, and financial difficulties of owner. Kaliba *et al* [6] researched in Zambia and found that delayed payments, financial processes and difficulties on the part of contractors and clients, and contract modification were top three causes. In United Kingdom, Olawale and Sun [18] identified top three causes affecting cost overruns as design changes, risk and uncertainty associated with project and inaccurate evaluation of project's time or duration. Across the world, many researchers have conducted studies on project cost overruns problem found different factors. However, no countries have similar factors responsible for cost overrun which could be due to political, regional variations of nations. India very few studies have been conducted, which have limitation of regional location. So it is necessary to study this cost overrun aspect throughout India, with all

types of organizations such as client oriented, consultant oriented and contractor oriented.

3. Methodology

A questionnaire study was designed with 15 prominent questions related to cost overrun in table 2. It was sent to 190 construction professionals across India (northern region, southern region, western region, eastern region and central regions).

3.1 Questionnaire design

Sets of 25 important factors were shortlisted from the references of various literatures around the world related to cost overrun. As a part of preliminary study, advice was taken from experts for shortlisting important factors causing cost overrun in construction industry. Questionnaire studies were conducted to find various factors affecting cost overrun in Indian scenario. Then this could have helped some technocrat and bureaucrat to take corrective action for future project investment in India.

3.2 Data collection

The questionnaire were distributed to 190 personal across India by mail during October 2014 to April 2015 among professionals working in the construction industry, and subsequently followed up to obtain responses. To get the opinion of the factors affecting cost overruns, four options (1. agree, 2. partially agree, 3. partially disagree and 4. disagree) were given where respondents were asked to mark their level of agreement to each question. The

Table 2. Factors causing cost overrun.

Code	Finalised factors for questionnaire survey
C01	Price escalation of raw material
C02	Dispute on bill settlement
C03	Delay in planned activity
C04	Ambiguous or incomplete tender document
C05	Additional work
C06	Frequent design changes
C07	Lack of co-ordination between construction parties
C08	Fraudulent practices and kick backs
C09	Mistake during construction
C10	Force majeure
C11	High quality expectation from owner
C12	Shortening of contract period
C13	Wastage on site
C14	Relationship between site management and labour
C15	Poor financial control on site

respondents were given an additional option of “no idea” in case if a respondent never came across of such factor.

In this research, a four point Likert scale was adopted in view of its ease and fittingness for assessing the outcome of each factor on the project cost overruns, derived from the respondents' own decision based on working experience throughout their professional career in construction industry. In order to examine the study of the responses, numerical values were allocated to the respondents' opinion as follows:

- Agree - 4
- Partially agree - 3
- Partially disagree - 2
- Disagree - 1
- No idea - Response not considered during analysis

3.3 Respondent's profile

Based on the data collected from the respondents, the factors were investigated for their relative importance among each respondents' category. The questionnaires were distributed randomly among 190 construction personnel working across India in which 64 were clients, 32 were consultants and 94 were contractors. Eighty-five sets of questionnaire were received successfully, from which clients, consultants and contractors were 33, 10 and 44 respectively. The response rate was observed as 52% for

client, 31% for consultants and 44% for contractor, which showed overall response rate of nearly 45%, and it may be acceptable for such study which was shown in table 3.

The data was collected from all over India with the division into five parts namely East, West, Central, North and South. Responses came from different regions of India were shown in table 4. Main purpose of the collection of data from various regions was to ensure that the data should represent overall scenario of Indian construction industry.

The data was also collected for the cost of current project in order to have common idea about the respondents which observed that 23 respondents were involved in projects worth less than Rs. 10 Cr. (<US \$ 2 million), 28 respondents were involved in projects worth between Rs. 10 and 50 Cr. (US \$ 2–10 million), 19 respondents were involved in projects worth between Rs. 50 and 100 Cr (US \$ 10–20 million) and 15 respondents were involved in projects worth more than 100 Cr. (US \$ 20 million) as showed in figure 1.

4. Results and discussions

The statistical analysis was done on the respondents' data using IBM SPSS 22 package. In order to check suitability of the data for further analysis, reliability analysis is to be done initially.

Table 3. Respondents profile based on type of organization.

Description	Number of copied distributed	Number of respondents	Response rate %	Percentage of number of responses
Client	64	33	52	39
Consultant	32	10	31	12
Contractor	94	42	44	49
Total	190	85	45	100

Table 4. Respondents profile based on working zone in India.

Working zone in India	Frequency	Percent
North	7	8.2
South	13	15.3
East	5	5.9
West	47	55.3
Central	13	15.3
Total	85	100



4.1 Reliability analysis

Reliability analysis is a technique to verify the internal consistency of the data having multiple scales. Reliability test could be carried out by obtaining various reliability coefficients in which the most commonly used is Cronbach alpha. Reliability of the data is considered as at low level when Cronbach alpha is less than 0.3 which means the data is not suitable for further analysis whereas reliability of the data is considered as high level when Cronbach alpha is more than 0.7 which implies that data is suitable for further analysis.

To check the reliability of data, Cronbach alpha was computed for factors using the formula given in Eq. (1). In

this study, Cronbach's alpha was computed using software SPSS 22.

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N - 1)\bar{c}}, \quad (1)$$

where α is Cronbach alpha, N is number of items, \bar{c} is average inter-item covariance among the items, and \bar{v} is average variance.

The computed value of Cronbach's alpha for cost overrun factors was 0.721 which is greater than 0.7. Therefore, data obtained from respondents was reliable and could be used for further analysis.

4.2 Ranking of factors

The rankings of factors were carried from the opinion of respondent who were fully agree with that particular factors. All other marks such as partially agreed, partially disagreed and not agreed. Frequency count was done based on types of organization, location/various zones in India, type and size of projects, experiences of the respondents.

4.2a Types of organization: The factors causing cost variation for construction project is tabulated in table 5 using SPSS. Number of respondents who were agreed to cause of cost variation are ranked together. The feedback from client, consultant and contractors, who were marked as "Agree", counted in the "Total" and it is sorted out from largest to smallest value in Excel sheet. Percentage of persons from the samples who agreed on particular factor causing cost variation was calculated out of total count of 85 numbers. From table 5, 67% respondents had fully agreed on price escalation of raw materials caused cost overrun of project in India. Second and third they were

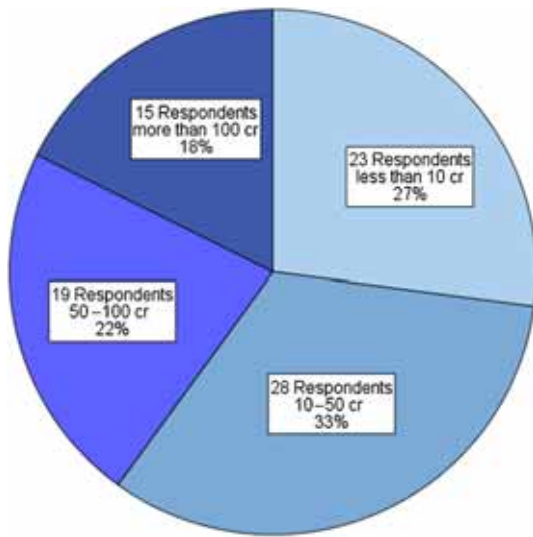


Figure 1. Respondent profile based on cost of current project.

Table 5. Ranking of factors on type of organization.

Factors causing cost overrun		Client Agree (33) Count	Consultant Agree (10) Count	Contractors Agree (42) Count	Total Agree (85) Count	Percentage Agree %	Rank Agree Count
C1	Price escalation of raw material	22	4	31	57	67	R1
C3	Delay in planned activity	13	6	22	41	48	R2
C7	Lack of co-ordination between construction parties	7	8	24	39	46	R3
C5	Additional work/extra items	8	5	25	38	45	R4
C6	Frequent changes in design	8	4	26	38	45	R5
C13	Wastage on site	15	4	14	33	39	R6
C15	Poor financial control on site	11	6	15	32	38	R7
C2	Dispute on bill settlement	8	1	22	31	36	R8
C4	Ambiguous or incomplete tender document	5	5	21	31	36	R9
C12	Shorting of contract period	4	1	25	30	35	R10
C11	High quality expectation from owner	3	2	24	29	34	R11
C8	Fraudulent practices and kick backs	15	5	8	28	33	R12
C9	Mistake during construction	14	3	6	23	27	R13
C14	Relationship between site management and labour	8	3	11	22	26	R14
C10	Force majeure	2	3	3	8	9	R15

agreed on “delay in planned activity” and “lack of co-ordination between construction parties” could be the major three reason of cost overrun. It has also observed that majority of responded from client organization such as public works department, government department were agree on “price escalation of raw materials” caused largely on cost overrun out of 15 identified factor given to them. However consultant did not much agree upon the view of client or contractors, they are more inclined toward “Lack of co-ordination between Construction Parties” and voted eight respondents on fully agree out of 10 respondents. Similar factors were identified by Frimpong as escalation of materials prices and poor site management were two factors out of five significant factors causing cost overrun in Ghana. Poor project management and supervision in Vietnam [17]. However delayed payments, financial processes [6], design changes, risk, inaccurate evaluation of projects time and duration [18] were also identified as prominent factors causing of cost overrun of construction project. Hence the factors causing of cost overrun have varied from country to country.

4.2b Location/various zones in India: Views of respondent from various zones such as North, South, East, West and Central India have reported in table 6. Respondent from North, West and Central zone of India had fully agreed on price escalation of raw material causes cost overrun however south zone responded agreed upon delay in planned activity and poor financial control on site. And East zone respondent agreed on frequent changes in design at

construction site. Hence larger parts of India such as North, West and Central zone have agreed with price escalation of raw materials.

4.2c Value of projects: Most of the responses were received from Rs. 10–50 crore projects and 10 crore projects as shown in table 7. Twenty-two out of 28 respondents agreed on price escalation of raw materials causes cost overrun in 10–50 crore project. Furthermore 17 out of 23 respondents agreed on price escalation of raw material causes cost overrun in less than 10 crores projects. However, 12 respondents out of 15 from more than 100 crore project agreed for delay in planned activities caused the cost overrun of construction project. Azhar also found medium size firms were more prone to cost overrun due to fluctuation in prices of raw materials as compare to large firms [9, 10]. Hence for small project up to 50 crores, respondent believed price escalation of raw materials causes cost overrun whereas big projects costing more than 100 cr, respondent believed on delayed in planned activities causes cost over.

4.2d Experiences of respondents: To review the opinion of respondent, majority of the respondents in the survey were from 5 to 10 years of experiences group and their opinions are valuable as more than 5 years of construction project experience are quite better. As the experience of respondent is higher and higher, weighable of opinion are more and more valuable. In this study 31 respondents out of 42 in the years of 5–10 years of experience have agreed on price escalation of raw materials could cause the cost overrun of the project.

Table 6. Ranking of factors based on working zone in India.

		North Agree (7) Count	South Agree (13) Count	East Agree (5) Count	West Agree (47) Count	Central Agree (13) Count	Total Agree (85) Count	Percentage Agree %	Rank Agree Count
	Factors causing cost overrun								
C1	Price escalation of raw material	6	6	2	33	10	57	67	R1
C3	Delay in planned activity	1	8	2	22	8	41	48	R2
C7	Lack of co-ordination between construction parties	3	7	2	22	5	39	46	R3
C5	Additional work/extra items	3	6	2	20	7	38	45	R4
C6	Frequent changes in design	4	5	3	20	6	38	45	R5
C13	Wastage on site	3	4	2	19	5	33	39	R6
C15	Poor financial control on site	0	8	3	19	2	32	38	R7
C4	Ambiguous or incomplete tender document	3	7	0	17	4	31	36	R8
C2	Dispute on bill settlement	4	4	2	14	7	31	36	R9
C12	Shorting of contract period	2	5	2	18	3	30	35	R10
C11	High quality expectation from owner	3	6	0	16	4	29	34	R11
C8	Fraudulent practices and kick backs	1	3	2	18	4	28	33	R12
C9	Mistake during construction	0	4	0	17	2	23	27	R13
C14	Relationship between site management and labour	0	7	0	15	0	22	26	R14
C10	Force majeure	1	1	0	6	0	8	9	R15

Table 7. Ranking of factors based on value of projects.

		Less than 10 cr Agree (23) Count	10–50 cr Agree (28) Count	50–100 cr Agree (19) Count	More than 100 cr Agree (15) Count	Total Agree (85) Count	Percentage Agree %	Rank Agree Count
Factors causing cost overrun								
C1	Price escalation of raw material	17	22	10	8	57	67	R1
C3	Delay in planned activity	12	11	6	12	41	48	R2
C5	Additional work/extra items	15	11	7	7	40	46	R3
C6	Frequent changes in design	12	11	10	6	39	45	R4
C7	Lack of co-ordination between construction parties	14	12	6	7	39	45	R5
C13	Wastage on site	8	14	6	5	33	39	R6
C15	Poor financial control on site	12	8	4	8	32	38	R7
C2	Dispute on bill settlement	8	10	10	3	31	36	R8
C4	Ambiguous or incomplete tender document	9	10	5	7	31	36	R9
C12	Shorting of contract period	9	11	5	5	30	35	R10
C11	High quality expectation from owner	10	11	6	2	29	34	R11
C8	Fraudulent practices and kick backs	7	14	4	3	28	33	R12
C9	Mistake during construction	7	11	3	2	23	27	R13
C14	Relationship between site management and labour	6	8	6	2	22	26	R14
C10	Force majeure	3	2	0	3	8	9	R15

Similarly in the age group of 10–15 years, 9 out of 13 respondents were agreed on as shown in table 8.

Price escalation of raw material was ranked first by both client and contractor. Possible explanation could be that price escalation in material has to be borne by the client and also affects the contractor as they have to initially pay for it till payment of the running bills, however the consultant plays an advisory role and not involved in the fluctuation in the material price.

4.3 Anova

The one way ANOVA test was used for comparison of means of more than two groups of an independent variable. The aim was to test for the differences in means of the dependent variable broken down by the levels of independent variable. In this analysis, the independent variable was taken as 'working zone in India' which was tested against all the dependent variables i.e. the factors responsible for cost overruns. The exercise was undertaken in order to verify the similarity in opinions among the construction professionals from various regions of the nation.

The null and alternative hypothesis was formed to examine in the difference of opinions among the construction professionals from different regions in India which are as follows:

Null hypothesis (H_0) – There is no significance difference in the opinion for factors affecting cost overruns among construction professionals from different regions of India.

Alternate hypothesis (H_a) – There is significant difference in the opinion for factors affecting cost overruns among construction professionals from different regions of India.

With the significance level of 0.05, the data was tested to check agreement among the construction professionals from different working zones for their opinions about factors responsible for cost overruns and result obtained from software SPSS were as shown in table 9. It was observed from table 9 that the construction professionals across India were agreed upon 14 out of 15 factors responsible for cost overruns at a significance level 0.05. Opinion of construction professionals was significantly different for only one factor 'Mistake during construction'. Thus null hypothesis was not able to reject hence the null hypothesis was accepted for 14 factors. Therefore, there is no significant difference among construction professionals in opinion for cost overrun factors from different regions of India.

4.4 Factor analysis

Factor analysis is a method of data reduction which is used for reducing large number of factors to a small number of component factors. It is a useful method for investigating factors relationship for compound concepts.

4.4a *Co-relation matrix of variable*: The purpose of forming co-relation matrix was to obtain the determinant of the matrix which was useful to identify multi-co-linearity and singularity of data [19]. Value of the determinant obtained from co-relation matrix should be greater than 0.000 01.

Table 8. Ranking of factors based on experiences of respondents.

Code	Factors causing cost overrun	0–5	5–10	10–15	15–20	more than 20	Total	Percentage	Rank
		years Agree (13) Count	years Agree (42) Count	years Agree (13) Count	years Agree (10) Count	years Agree (7) Count	Agree (85) Count	Agree %	Agree Count
C01	Price escalation of raw material	8	31	9	5	4	57	67	R1
C03	Delay in planned activity	7	23	4	3	4	41	48	R2
C05	Additional work/Extra items	6	23	4	4	3	40	46	R3
C07	Lack of co-ordination between construction parties	4	22	6	3	5	40	45	R4
C06	Frequent changes in design	4	21	7	3	3	38	45	R5
C13	Wastage on site	6	15	6	4	2	33	39	R6
C15	Poor financial control on site	5	16	4	3	4	32	38	R7
C02	Dispute on bill settlement	4	13	8	5	1	31	36	R8
C04	Ambiguous or incomplete tender document	7	16	4	1	3	31	36	R9
C12	Shorting of contract period	5	15	6	3	1	30	35	R10
C11	High quality expectation from owner	4	14	6	2	3	29	34	R11
C08	Fraudulent practices and kick backs	5	11	6	2	4	28	33	R12
C09	Mistake during construction	4	12	4	0	3	23	27	R13
C14	Relationship between site management and labour	6	10	3	1	2	22	26	R14
C10	Force majeure	5	3	1	0	0	8	9	R15

Table 9. ANOVA—‘working zone in India’ and ‘factor affecting cost overrun’.

Factors affecting cost overruns	Sum of squares	df	Mean square	F	Sig.
Lack of co-ordination between construction parties	0.546	4	0.136	0.201	0.937
Additional work/extra items	0.738	4	0.184	0.217	0.928
Wastage on site	1.049	4	0.262	0.253	0.907
Frequent changes in design	1.042	4	0.261	0.292	0.882
Dispute on bill settlement	1.212	4	0.303	0.331	0.857
Shorting of contract period	3.059	4	0.765	0.659	0.622
Fraudulent practices and kick backs	3.775	4	0.944	0.837	0.506
Relationship between site management and labour	2.795	4	0.699	1.032	0.396
Ambiguous or incomplete tender document	5.419	4	1.355	1.036	0.394
Force majeure	4.557	4	1.139	1.084	0.370
High quality expectation from owner	5.012	4	1.253	1.204	0.316
Price escalation of raw material	3.153	4	0.788	1.438	0.229
Delay in planned activity	3.670	4	0.918	1.747	0.148
Poor financial control on site	4.673	4	1.168	1.991	0.104
Mistake during construction	7.901	4	1.975	3.219	0.017

Co-relation matrix was also useful to find out Kaiser–Meyer–Olkin (KMO) which is the measure of sampling adequacy. The obtained value of KMO should be greater than 0.5 for data being adequate [20].

The co-relation matrix for variables of cost overruns was obtained from software IBM SPSS package 22 which was shown in table 10. The determinant of correlation matrix was 0.003 which was considered as being adequate (>0.00001), which indicated that neither matrix have multi-collinearity or singularity [19]. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was found to be

0.674 which was greater than 0.50. Additionally, significance level of Bartlett test was observed as 0.001 which was less than 0.05 implied that matrix passed through test of identity matrix. These measures confirmed the suitability of the data for proceeding with factor analysis.

4.4b Extraction of factors: Extraction of factors was carried out using software SPSS which was done using principle component analysis (PCA). The basic concept underlying the PCA is that the extracted components explain most of the variance of the correlated variables.

Table 10. Correlation matrix of variables.

	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	C13	C14	C15
C01	1.00														
C02	0.20	1.00													
C03	0.06	0.22 ^b	1.00												
C04	-0.06	0.16	0.29 ^a	1.00											
C05	0.15	0.21	0.34 ^a	0.47 ^a	1.00										
C06	0.13	0.11	0.20	0.42 ^a	0.53 ^a	1.00									
C07	-0.11	0.19	0.15	0.38 ^a	0.24 ^b	0.43 ^a	1.00								
C08	-0.01	-0.05	-0.02	-0.19	-0.21	-0.04	-0.01	1.00							
C09	0.07	0.03	0.16	0.01	-0.12	-0.09	-0.08	0.42 ^a	1.0						
C10	-0.11	-0.06	0.21	0.18	0.12	0.13	0.05	0.31 ^a	0.21	1.00					
C11	0.32 ^a	0.31 ^a	0.24 ^b	0.42 ^a	0.54 ^a	0.33 ^a	0.27 ^b	-0.27 ^b	0.03	0.05	1.00				
C12	0.15	0.10	0.34 ^a	0.51 ^a	0.43 ^a	0.44 ^a	0.26 ^a	-0.07	-0.01	0.14	0.52 ^a	1.00			
C13	-0.07	0.09	.05	-0.18	-0.22	-0.21	-0.01	0.53 ^a	0.35 ^a	-0.02	-0.15	-0.23 ^b	1.00		
C14	-0.05	0.30 ^a	-0.06	0.19	-0.02	0.03	0.30 ^a	0.29 ^a	0.12	0.15	0.01	0.14	0.22 ^b	1.00	
C15	-0.13	0.11	.22 ^b	0.29 ^a	0.14	0.24 ^b	0.42 ^a	0.24 ^b	0.22 ^b	0.29 ^a	0.04	0.30 ^a	0.10	0.40 ^a	1.00

Determinant of correlation matrix = 0.003 > 0.00001; Kaiser-Meyer-Olkin measure of sampling adequacy = 0.674; and Bartlett test for sphericity = 385.5, Significance = 0.001

^a Correlation is significant at the 0.01 level (2-tailed)^b Correlation is significant at the 0.05 level (2-tailed)

Table 11. Total variance explained.

Component	Initial Eigen values			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.910	39.400	39.400	5.452	36.346	35.346
2	2.521	16.807	56.207	2.849	18.993	54.338
3	1.167	7.780	63.987	1.371	9.140	63.478

Table 12. Factor analysis loading results – unrotated.

Variable of cost overruns	Component		
	CFC1	CFC2	CFC3
Additional work/extra items	0.839		
Frequent changes in design	0.777		
Ambiguous or incomplete tender document	0.757		
Shorting of contract period	0.737		
High quality expectation from owner	0.730		
Lack of co-ordination between construction parties	0.556		
Delay in planned activity	0.491		
Fraudulent practices and kick backs		0.789	
Mistake during construction		0.672	
Wastage on site		0.591	
Relationship between site management and labour		0.549	
Poor financial control on site		0.535	
Force majeure		0.471	
Price escalation of raw material			0.640
Dispute on bill settlement			0.763

Table 11 was prepared in order to show total variance explained by extracted factors which was obtained as 61%. From table 12, all possible number of extracted factors with Eigen values, percentage of variance and cumulative percentage of variance of factors with initial solution and rotated solution. The initial statistics of total variance explain for cost overruns extracts three factors whose Eigen values were more than 1, explained 63.98% of total variance. A component with an Eigen value of less than 1 was considered less important therefore it could be ignored [21].

Factor loadings were obtained in table 12 which basically the correlation coefficient linking an original variable and an extracted component factor. The higher the absolute value of the factor loading, the more the variable contributes to that component factor.

4.4c Rotation of matrix: In order to get factor loadings which would understood easily, a VARIMAX rotation was carried out on the factors to reduce the number of factors on which the determinants have high loading [17]. The factors resulting from grouping of the variables using rotation were showed in table 13 in which CFC stands for ‘component factor for cost overruns’.

Name of each component was proposed as per their inherent characteristics of the variables present in each component. It was observed from table 14 that the

components were named as client control component, project management component, and contractor control component. This would essential, mainly if additional analysis would be conducted on these extracted components.

The factors such as shortening of contract period, high quality expectation from owner, additional work/extra items, poor financial control on site, price escalation of raw material and frequent changes in design was loaded on a single component factor “client control component” as these factors are related to the client. The factors dispute on bill settlement, delay in planned activity, lack of co-ordination between construction parties, ambiguous or incomplete tender document, and relationship between site management and labour get loaded together as a single component CFC 2 as project management component as all the five factors were related to project/site management. Further the factors fraudulent practices and kickbacks, mistake during construction and wastage on site loaded together on a single component contractor control component. Factor loading of the factor force majeure was 0.459 which was less than 0.5 hence it was ignored. The principle components of cost overruns are listed in table 10 using factor analysis with varimax rotation.

Table 13. Factor analysis loading results using VARIMAX rotation.

Variable of cost overruns	Component factor		
	CFC1	CFC2	CFC3
Shorting of contract period	0.799		
High quality expectation from owner	0.746		
Additional work/extra items	0.705		
Poor financial control on site	0.591		
Price escalation of raw material	0.568		
Frequent changes in design	0.564		
Dispute on bill settlement		0.819	
Delay in planned activity		0.767	
Lack of co-ordination between construction parties		0.723	
Ambiguous or incomplete tender document		0.545	
Relationship between site management and labour		0.520	
Fraudulent practices and kick backs			0.846
Mistake during construction			0.757
Wastage on site			0.646
Force majeure			0.459

Table 14. Factor categories using factor analysis.

Component factor	Does cost overrun responsible due to...	Component name
CFC 1	Shorting of contract period High quality expectation from owner Additional work/extra items Poor financial control on site Price escalation of raw material Frequent changes in design	Client control component
CFC 2	Dispute on bill settlement Delay in planned activity Lack of co-ordination between construction parties Ambiguous or incomplete tender document Relationship between site management and labour	Project management component
CFC 3	Fraudulent practices and kick backs Mistake during construction Wastage on site	Contractor control component

5. Suggestive framework for top three factors

In this section, tentative solutions are proposed for top three factors affecting cost overruns with framework/model in order to improve efficiency and effectiveness of a project. Top three factors affecting in Indian construction industry were observed as price escalation of raw material, delay in planned activity and lack of co-ordination between construction parties as shown in table 4. In order to minimize impact of these factors on cost overruns, framework may be proposed as solution.

5.1 Price escalation of raw materials

Price escalation of raw material could cause cost overrun of projects was found as rank number 1, by client and contractor

in questionnaire survey. Price escalation may be termed as an increase in the cost of construction work performing in a later period of time at a cost higher than originally anticipated in the bid. The suggestive framework is proposed as shown in figure 2 based on after discussion with some of the construction experts/ professional by the authors. In this frame work, if price escalation clause is given in tender document, then it should be borne by client in case material cost has increased. Contractors tendency is least bothers above project progress because escalated cost would be paid by Client. This results into project cost overrun and some time project has slow down due to money shortage. On the other hand, price escalation is not to be included in tender document to then contractor would have to anticipate inflation cost and may quote higher bid with due consideration. There could be three possibilities if inflation is included in the tender document as shown in figure 2.

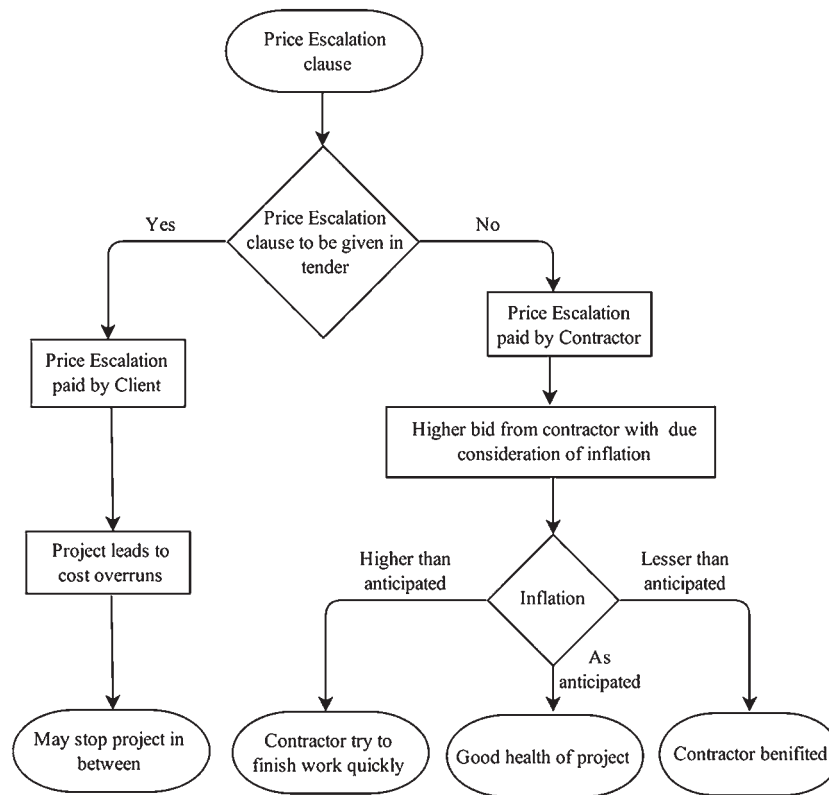


Figure 2. Proposed solution to reduce price escalation of raw material.

- i. If actual inflation is higher than anticipated inflation then the contractor tries to finish project quickly by employing more resources to the project.
- ii. If actual inflation is same as anticipated inflation then project runs smoothly as expected and health of the project would be good.
- iii. If actual inflation is lesser than anticipated, then contractor would get benefit from the lesser inflation.

By considering above points, it may be proposed to remove as price escalation clause so that contractor will start taking risk. Above condition is suitable when the government starts their projects on time so that bid would not get obsolete, government pays the running bills in fast tract basis in order to maintain working capital of contractor, government maintains the same policies wherever it affects prices of construction materials.

5.2 Delay in planned activity

A construction delay is anything that obstructs the ability of a contractor to maintain a schedule. From the questionnaire survey, it was ranked second overall in cost overrun factors. Evidences showed that projects went to cost overrun when it suffered from delay. Any schedule delay makes the initial cost estimates outdated as price escalation of material bound to happen. Thus, it resulted into cost overruns. Generally,

construction delay has occurred from any of the construction team members such as client, consultant and contractor as shown in figure 3. Significant factors affecting delay are non-timely payment to contractor, design revision, not providing drawing on time, poor site management and supervision, etc.

Factor responsible for delay is given in figure 3. Reasons for the each factor could be inflation and political interference, non-timely payment to the contractor, changes in clients requirement, etc. as shown in figure 3. To prevent delays, solution is proposed as follows:

- i. Client should freeze his requirement in initial phase of project in order to prevent frequent changes in design.
- ii. Contractor should give managerial training for staff so as to improve efficiency of managerial and supervisory staff.
- iii. Designer should increase staff to provide drawing on times.
- iv. Government should try to control inflation.

5.3 Lack of co-ordination between construction parties

Lack of co-ordination between construction parties might be the reason for the cost overrun due to gap in communication present among client, contractor and consultant. There are various problems observed due to communication

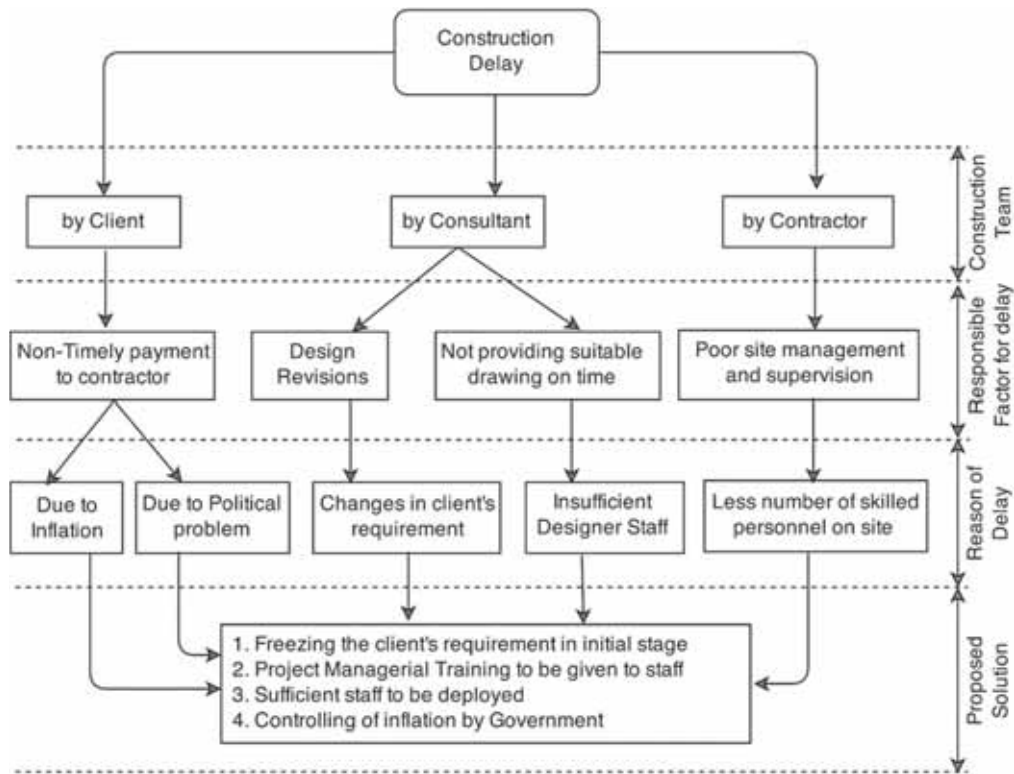


Figure 3. Framework to mitigate delay in planned activity.

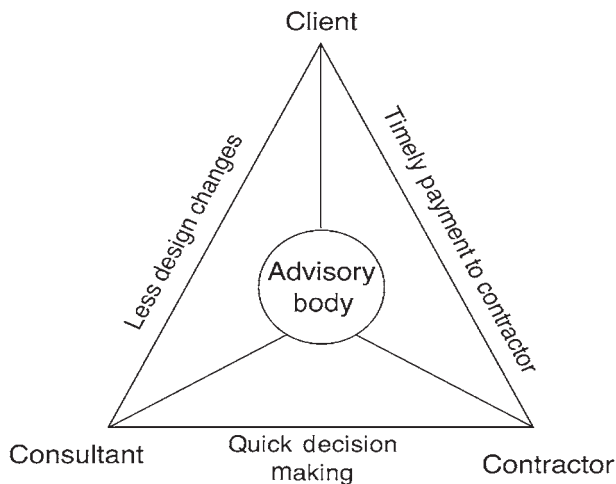


Figure 4. Proposed solution to overcome lack of co-ordination between construction parties.

gap such as frequent changes in design occurs due to gap present between client and consultant, delay in decision making due to gap present between consultant and contractor and non-timely payment to contractor due to gap present between client and contractor.

To overcome these three problems, one additional body is suggested in this framework which called as 'advisory body' as shown in figure 4. Advisory body

would help client and consultant for freezing specification and fixing the requirement so that less design changes. Advisory body would also play role between client and contractors by releasing quick bills and removing disputes on bills related issues. Hence, it may be proposed to have an additional body which connects client, consultant and contractor to take care of problems stated above.

6. Conclusions

Following conclusions could be drawn based on study:

- i. From the opinion of responded across India, it could be concluded that the top three factors affecting cost overruns are price escalation of raw material, delay in planning activity and lack of co-ordination among construction parties. The opinion on these factors was found as similar and important across India as it was verified using ANOVA method.
- ii. The questionnaire survey for cost overrun is applicable for all the regions of India as there were no significant differences among construction professionals working across India.
- iii. Three components client control component, project management component, and contractor control component were extracted using factor analysis.

- iv. The suggestive framework for price escalation of raw materials, delay in planning activities and lack of co-ordination among parties, which is given in figure 2, figure 3, and figure 4 could be useful for planning of new project in the construction.
- v. It is suggested in figure 2 to remove price escalation clause from the contract document as most of the professionals have the opinion that major cause of cost overrun was price escalation and if it is removed from the tender document that might have saved the project from the cost overruns.
- vi. Based upon figure to figure 3, it was suggested that client should freeze his requirement in the initial stage, sufficient staff should be deployed and managerial training to be given to his staff to improve on second important factor as delay in planned activities.
- vii. In figure 4, it was suggested to deploy a new body called as 'advisory body' which acts as a client's representative which would helps to reduce a communication gap among the parties in construction work.

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