

# Analysis of Cost Overrun in Road Construction Activities – A Critical Review

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**Abstract** - Cost overruns are more common in infrastructure projects especially, more common in road construction activities. The impacts of cost overruns are very high in developing countries compared to developed countries. In fact 100% of projects are suffered by cost overruns in developing countries. For developing countries like India, Road construction activities are much affected by cost overrun due to various factors throughout the project cycle. The deviations between the actual cost incurred during construction phase and originally estimated cost is known as cost overrun and it is one of the most predominant factors affecting the successful completion of the overall project.

The main objective of this study, is 1) to identify various factors which are mostly influencing the cost overrun of the construction activities, 2) to rank the factors identifies based on their impact, 3) to find out the critical factor which are mostly affecting the construction activities, finally 4) to give recommendations to overcome the critical factors. Most predominant factors influencing the cost overruns are to be sorted out from the literature survey and those factors are to be considered for preparing questionnaire survey. Responses from various companies' clients, contractors, sub-contractors and concerned authorities are to be collected. Based on the data, statistical analyses are to be done, Ranking the factors according to scores obtained from the data collection. Finally top most influencing factors causing overrun, are to be found out, Recommendations and conclusions are to be made based on the analysis of data to overcome those critical factors in future road construction activities.

**Key Words:** Cost deviations in infrastructure, Cost overrun, Project cost control, Road projects, Infrastructure Projects.

## 1. INTRODUCTION

Next to United States, Indian road network is the second largest network in the world. It stretches about 48, 65,000 Kilometers in the year 2014 and also having a chance of increasing year by year. The Government of India takes initiatives to improve and increase the infrastructure facilities for better, smooth and modern transportation. It also increases the funds for investment for the growth and development of Infrastructure. Over the past few years the Indian economy has been in a phase of enhanced growth of about 8-10% per year. Indian construction industry is playing an important role in the economic growth of our

Nation; it widely involves high risk due to its varying nature of its construction activities. The success of the construction projects mainly depend on their accomplishment of essential factors such as cost, time and quality. In case cost and time are not properly planned and utilized, the project will not accomplish its goals and will cause failure to the overall project. In most of the Indian road construction activities, it was observed very few projects were completed in a planned manner within estimated cost. Due to the major problems and delays in construction, most of the projects were suffered from cost overrun issue due to many reasons such as ineffective planning, monitoring and execution of work. Better planning of cost and allocation of funds are to be achieved to complete the project task with high precession.

Now a days, Indian road projects are facing a lot of problems and difficulties from the starting phase till the completion of the projects. Throughout the project cycle, a series of issues and challenges are to be tackled by the construction activities. Rather than any other developing country, growth of Indian road projects is seriously affected by numerous issues. An immediate need for the future projects to avoid such problems is a good effective plan. It is essential to find out various critical factors which are mostly influencing the cost overruns, its origin, causes, and problems associated are also to be identified. Based on the study of the problems, remedies and recommendations to avoid such circumstances are to be suggested. There is no alternative to avoid the issue of cost overrun rather than above for future projects. Finding out the causes of cost overrun and rectification of the causes will be very useful to achieve the goals; scope of the project, to maximize the return on investment, to complete the project within actual budgeted cost and to minimize the wastage of funds, will avoid such critical instances to occur in future.

### 1.1 Definition of Cost Overrun

The difference or deviations between originally estimated cost during design stage and the actual cost incurred during construction phase is known as cost overrun. This is most important parameter for the successful completion of a project. If the total actual cost exceeds the budgeted cost which is estimated during design stage, it will affect the project completion time drastically and causes many issues also. So it is essential to control the cost for getting better performance. In this context the investigator felt need to study the problem of cost overrun in the road projects. An

attempt has been made to study the causes of cost overrun, so that unnecessary cost may be avoided.

## 1.2 Project Cost Control

Cost control is a challenging task in project budget. It provides cost related details and information for taking decisions to complete the project in a defined quantity of materials, in time, and within the budget. The information extracted from various sources and performance data is utilized for minimizing waste, updating current budget estimates, forecasting cost trends and making future decisions.

Cost control involves processing of details and reports of cost accounts gained from different operation divisions, relating it with standards, analysing the reasons for difference in deviations and presenting the results to monitor the project for making decisions for future.

There are two parties in construction projects, client and contractor; whose contributions are involved and they are dependent upon each other due to nature of work. The cost control objectives for both parties may differ. Client contribution begins with decisions during design, execution, commissioning stages. He formulates cost budget to the overall project and also plans his cash flow on the basis of forecasted pattern formulated during design stages. His aim is to minimize the cost of the project by effective cost control techniques. The contractor performs the contracted work and bears the amount of input resources for the execution of work. The input resources are expenses for interest rates, insurances, depreciation value, and cost of labour, materials and equipment. His aim is to maximize the profit by effective cost control techniques.

## 2. OBJECTIVE

Main objectives of this study are:

1. To identify the various factors which are mostly influencing the cost overruns in the construction phase of road projects.
2. To rank the factors based on their impact and significance.
3. To find out various critical factors which are mostly dominating the cost overruns.
4. To make recommendations to overcome or omit those critical factors in future road construction projects.

## 3. LITERATURE STUDY

Bent Flyvbjerg, et and all (2004), The study was based on sample of 258 road and rail infrastructure projects cost of US\$90 billion. They focused on 3 prime factors for the cost overruns. They concentrated on the factors such as length of project implementation phase, size of the project, type of

project ownership. They found out the major reason and risks for cost overrun were caused by length and the size of the project. Finally they concluded that public ownership was more critical in the type of ownership [1].

T.Subramani, P.S.Sruthi and M.Kavitha (2014), The study was based on the road projects in India. They found that inadequate project formulation, poor field investigation, bad cost estimates, poor planning during execution stage, inadequate equipment supply plan, lack of project management during the stage of execution, insufficient working, changes in scope of work, change of law and order were the major contributing factors for the cost overruns of road construction projects in India [2].

Abdullah Alhomidan (2013), The study was based on the 41 prime factors which were causing the overrun of cost in road projects, and conducted a survey to find out the most influencing factors. He concluded internal administrative problems, payment delays, poor communication between the project parties, delays in decision making were the most influencing factors for cost overrun [3].

Ibrahim Mahamid (2013), His study was based on the 45 factors that might cause delays in construction in West Bank of Palestine from contractors. By means of questionnaire he conducted a survey and found that financial status of contractors, payment delays by the owner, political situation and segmentation of Western Bank, lack of interaction between parties of project, lack of equipment efficiency, high competition in bids were the prime factors for the time overruns in Palestine [4].

Eng. S.B.Wijekoon (2011), His study was based on finding the prime factors which are most influencing the cost overrun in Northern and Eastern Provinces of Sri Lanka. He prepared the questionnaire based on 19 factors and a survey was conducted across the country. He concluded payment delays, delays in shifting existing utilities, cost escalation; design changes during construction, issues in land acquisition were the most predominant factors for cost overruns in Sri Lankan projects [5].

## 4. METHODOLOGY

The following section presents the research steps to achieve the mentioned objectives.

1. Various factors responsible for cost overruns were collected from literature study and they were sorted in a desired category.
2. A questionnaire was prepared with 30 items and a survey was conducted to gather the data from selected respondents to find out critical factors causing cost overruns.
3. Each factor was given a scale of 0 to 3, so that person could easily express the severity range or impact. i.e., 0 being the lowest and 3 being the highest.
4. The scale for impact is categorized into 4 types.
  - a. 0 for No effect.
  - b. 1 for Low effect.

- c. 2 for Medium effect.
- d. 3 for High effect.
- 5. Questionnaires were administered to a sample of 50 people selected from various Govt. authorities, contractors, subcontractors, site engineers and supervisors, of which 30 questionnaires were returned with completed responses.
- 6. The scale value obtained for each factors were found out and ranked based on Relative Importance Index (RII) and Mean Values (MV) of the responses are computed for their impact and significance.
- 7. Findings of the study based on the statistical analysis, are given.
- 8. Finally suggestions and recommendations are given to avoid the cost overruns in future road construction activities.

- 22. Financing and payment for completed works (Delays in payments).
- 23. Dependency on imported materials.
- 24. Unstable interest rate.
- 25. Excessive amendments of design and drawings.
- 26. The Contractual Failures.
- 27. Design errors.
- 28. Organizational or Institutional Failures.
- 29. Unrealistic work schedule.
- 30. Project key staff.

## 5. QUESTIONNAIRE SURVEY

The various factors of causes for cost overrun were collected from the literature study. Further, opinions were obtained from the various Govt. authorities, contractors, subcontractors, site engineers, supervisors, etc., were listed based on the category. Finally 30 factors were selected and considered for the questionnaire survey. The various factors are listed below.

### 5.1 Factors

1. Change in policy / law (Govt. policy).
2. Cost escalation.
3. Design changes during construction phase.
4. Increase in construction time accordingly increase in overhead cost.
5. Inefficient estimation during tendering.
6. Increase in quantities due to actual site condition.
7. Inefficient resource utilization.
8. Delays in shifting existing utilities.
9. Improper scheduling.
10. Non availability of materials in the construction zone.
11. Act of god (Rain, earthquake, etc.).
12. Labour strikes.
13. Public agitation.
14. Improper procurement schedule.
15. Insufficient time to prepare bid.
16. Increase in land cost/ land acquisition.
17. Delay in design and approval of design.
18. Implementing new technologies. (For superior performance so that maintenance cost can be reduced. But initial cost is high).
19. Non-performance of subcontractors and nominated suppliers.
20. Conflict between project parties.
21. Improper interpretation of Contract and specification.

### 5.2 Factors

Table 1. Shows the number of questionnaire distributed and received from the different types of organization.

Table - 1: Responds Received

Organization / Respondents	Number of questionnaire distributed	Number of questionnaire received
Highway Department	15	9
National Highway Authority of India	10	6
Private contractors	10	8
Engineers and supervisors	10	5
Others	5	2
Total	50	30

## 6. DATA ANALYSIS

### 6.1 Relative Importance Index Technique (RII)

Kometa et al. [6], used the Relative Importance Index method to find out importance of the various causes of delay of the project. The same method is adopted in this study. A four-point scale ranged from 0 (No effect) to 3 (High effect) will be adopted. It will be converted in terms of relative importance indices (RII) for each factor from the received responses.

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

Where, W represents the weightage provided by the respondents to each factor (ranging from 0 to 3), A represents highest impact value (i.e. in this case, 3 is the highest weightage given to the scoring the factor), and N represents respondents in terms of number.

The value of RII ranges from 0 to 3, higher the range value of RII, more importance for the causes of delays. The RII was used to find out the rank (R) for the different causes. Each individual response should be used to find out RII, finally rankings are provided in order to give a clear view to the cost overrun in Road construction projects.

## 6.2 Mean Value Technique (MV)

Eng. S.B. Wijekoon. [5], used Mean value based technique to rank the factors based on responses received. The investigator adopted the same Mean Value technique to find out the rank, for checking the accuracy of results. Like Relative Importance Index, a four point scale was used, based on the Mean Value of the responses for each factors obtained from the respondents, the ranks were given using the formula.

$$\text{Mean Value} = \frac{\sum W}{N}$$

Where, W represents the weightage provided by the respondents to each factor (ranging from 0 to 3), and N represents the total number of respondents.

Mean values were calculated for verifying the ranks with relative importance index to give a clear idea for confirming the results obtained from RII technique.

## 7. RESULTS AND INTERPRETATION OF DATA (RII TECHNIQUE)

The questionnaires prepared were given to various infrastructure organization professionals such as Govt. authorities, contractors, Engineers, site supervisors and other staffs involved in infrastructure projects in the southern part of India. The respondents were requested to readout the questionnaire and give scores from 0 to 3 based on the impact for each factor in the given handout. From the scores, Relative Importance Index for each factor was calculated, based on the RII, ranking was done and categorized in ascending order to find obtain the most critical factors. A total number of 50 questionnaires were distributed and a response of 30 numbers was received. The total percentages of response were calculated.

**Table - 2:** Percentage of Response

Respondents	Number distributed	Number received	Percentage of number distributed	Percentage of number received
Highway department	15	9	30	30
National Highway Authority of India	10	6	20	20
Private contractor	10	8	20	26.67
Engineers and supervisor	10	5	20	16.67
Other staffs	5	2	10	6.67
Total	50	30	-	-
Total percentage of response (30/50)*100 = 60%				

The ranks found out from RII were categorized and arranged below.

**Table - 3:** Rank Based on RII

Item no	Critical cost overrun factor	RII	Rank
1	Land acquisition and increase in land cost	0.833	1
2	Cost escalation	0.811	2
3	Financing and payments for completed works(delay in payment)	0.789	3
4	Force majeure (act of god)	0.744	4
5	Design changes during construction phase	0.722	5
6	Delays in shifting existing utilities	0.711	6
7	Increase in quantities due to actual site conditions	0.578	7
8	Non availability of construction materials	0.567	8
9	Design errors	0.544	9
10	Increase or unstable interest rates	0.522	10

### 7.1 Discussion

From the table 3, land acquisition is ranked at top. Most of the road projects are kept aside and are delayed due to objections from owners of the land. In the present scenario many projects are sanctioned by the Government, but after that it is not even started due to land issues at the initial phase of the project itself. The impact of land issues are getting serious now a days. It not only causes delay but also causes overrun of cost in the project. Therefore it is essential to formulate a strategy to overcome the issue in the initial stage itself. So introducing a national policy, widely in the country and also laws and amendment for land acquisitions are to be immediately implemented. Effective and timely plan and actions are needed to solve this problem in the earlier stages.

Second ranked cost overrun factor in road projects is the cost escalation. It means increase in price of money. It is caused due to price changes in the men (wages of labour), material, machinery and other construction related activity cost. This price change is mainly due to inflation and it is one of the predominant factors for the cost overrun in road projects. This uncontrollable cost is mainly applicable for labour wages and material price escalation. It seems there is no solution for this problem, but effective planning at the procurement stage will reduce the price escalation, a little amount. For avoiding this issue, a standard cost escalation method is adopted in construction contracts in the contractual stage itself and provisions for contingencies are also to be included in the contract to avoid cost escalations.

Delays in payments, financing for completed works are ranked at three among the various factors. Almost 95% of road projects are funded by Government organizations and due to various Government policies and reasons, funds will

not be given in time. This will reflect in the performance and progress of works. Due to the delays in payment, contractor will not be able to circulate the money and his cash flow is mainly affected.

Force majeure is ranked at fourth, next to delays in payments. This is also referred as Acts of god, it includes unexpected rain, earthquake, natural calamities, political and economic instabilities. There is no preventive measure for such happenings. Usually the contractor is advised to insure against such events during the contractual stage itself to avoid the cost overruns.

Fifth rank is given to the design changes during construction. Improper planning, inadequate site investigation, misinterpretation of data, unaware of future needs are some of the causes for design changes. So proper planning, adequate investigation of site and accurate design procedure are needed to execute the project with high precision. If the design stage is not carefully examined and properly monitored, it will make additional cost to rectify the errors.

Delays in shifting existing utilities are sixth highest ranked critical factor. Most of the road construction projects are started, before the utilities are relocated from the site. This is one of the unavoidable situations that cause delays in construction, which finally leads to overrun of cost. So it is necessary to plan the relocation process and schedule the projects according to that. It is the prime solution to avoid the cost overruns in the road projects.

Seventh highest ranked factor is, increase in quantity of materials due to actual site conditions. It occurs due to unexpected ground and terrain conditions. Because of improper assessment of ground conditions and nature of soil strata during preliminary survey, the actual quantity varies. Unexpected sub surface condition will also affect the quantities (i.e. increase). Changes in ground conditions may lead to several issues in moving machineries, in undertaking excavation, and in foundation laying. To avoid these problems, additional care is provided at preliminary and reconnaissance survey, if not, this leads to increase in total cost and time also.

Non availability of construction materials is ranked at eighth position in the table 3. During the periods when the levels of activity developments are unusually high in particular region, there might be chance shortage of materials used in the construction activities. If this is not anticipated in the planning stage itself, it will lead to increase in cost due to transportation of materials from far away areas. So provisions are given at contract at the stage of original cost estimate for avoiding the delays.

The ninth ranked cost overrun factor is design errors, it is caused due to designer's misinterpretation of data, carelessness, lack of technical knowledge, unaware of site

conditions, lack of practical experiences and to complete the work in time. It will seriously affect the project later during the construction phase. Additional costs are needed to make changes during construction due to demolition of constructed items. So designer should possess some qualification before he designs the projects. So that extra cost must be avoided.

Increase in interest rates or unstable interest is ranked at tenth position in cost overrun factor. Most of the projects are funded, initially by the banks. The clients periodically pay the amount only after the works get finished. So the contractor has to get the loan from the banks with some interest initially. Later he has to repay that amount to the banks. At that time of repayment, the interest rate will be different; in fact it is critical situation for the contractor to pay the extra amount for the new interest rates. So the contractor will demand additional amount from the client at the ending stage of project. It seems there is no solution to overcome this issue fully, but mentioning about the floating interest rates (Varying) in the contract document will avoid the contractor from getting any additional pressure at the time of repay.

## 7.2 Mean Value Calculation Method

The investigator further interested to compare the results obtained RII method with that of another statistical method, so the Mean Value method was used.

Mean Value (MV) method for each factor in the questionnaire was calculated using scores allocated by the respondents and were ranked based on the mean scores. The Mean Values are arranged in ascending order and tabulated in table 4.

**Table - 4:** Rank Based on Mean value

Item no	Critical cost overrun factor	RII	Rank
1	Land acquisition and increase in land cost	2.500	1
2	Cost escalation	2.433	2
3	Financing and payments for completed works(delay in payment)	2.367	3
4	Force majeure (act of god)	2.233	4
5	Design changes during construction phase	2.167	5
6	Delays in shifting existing utilities	2.133	6
7	Increase in quantities due to actual site conditions	1.733	7
8	Non availability of construction materials	1.700	8
9	Design errors	1.633	9
10	Increase or unstable interest rates	1.567	10

### 7.3 Comparison of Results

Relative Importance method and Mean Value method were applied separately and compared with each other for checking the accuracy of results.

**Table - 5:** Comparison of Rank Based on RII and MV

Item no	Critical Cost overrun factor	Rank based on RII	Rank based on Mean Value
1	Land acquisition and increase in land cost	1	1
2	Cost escalation	2	2
3	Financing and payments for completed works(delay in payment)	3	3
4	Force majeure (act of god)	4	4
5	Design changes during construction phase	5	5
6	Delays in shifting existing utilities	6	6
7	Increase in quantities due to actual site conditions	7	7
8	Non availability of construction materials	8	8
9	Design errors	9	9
10	Increase or unstable interest rates	10	10

From the Table.5 it is observed that both methods (RII and MV) used for analysis shows similar results. And therefore it is concluded that the methods used for analyzing data are acceptable.

## 8. CONCLUSION AND RECOMMENDATION

### 8.1 Conclusion

Cost overrun are the most common factor and predominant in road construction projects in India. And during these study efforts was taken to find out the most critical factor which was mostly influencing the Indian road projects. So a questionnaire survey was made across various Government and private organizations. From the study it was observed that many respondents mainly focused on completing the project within the budget to control the cost overrun. The most predominant factors from the study are based on respondents perspective which includes the issues in land acquisition, cost escalation of workers' wages and material, financing and payments for completed works (delays in payments), Force majeure (act of god), design changes during construction phase, delays in shifting existing utilities, increase in quantities of materials due to actual site conditions, non-availability of construction materials, design errors, unstable or increase in interest rates.

To verify the accuracy of results made from the questionnaire survey, two different methods for analysis were used during the analysis of study. And those methods are relative importance index method (RII), and mean value method (MV).

### 8.2 Recommendations

Early identification of lands to be acquired is the best solution to avoid the land acquisition of the project. Because, about 70% of lands are acquired before the work gets started, balance 30% is acquired periodically after the commencement of work. This is the major reason for land acquisition issues. By forming a new team especially for land acquisition and providing training for key staff will avoid this issue.

A realistic cost escalation factor should be considered on project estimates and early predictions of escalation cost based on future value of money in project estimates are the best solution to avoid cost escalation problems.

In order to avoid funding problems and payment delays, a realistic time period is mentioned in the contract, clearly indicating about time for the parties to prepare the claim and certification. Financial plan is also to be made that consist of date of disbursement and amount to be settled.

Force majeure is an unavoidable situation which cannot be determined earlier. It seems there is no solution for that. But there is a possibility of making provisions in the contract document, indicating about this issue. So that it will resolve the problem too much. Extra payments and extra time are calculated for tackling these types of disasters are also to be mentioned in the conditions of contract.

To avoid the design changes in construction stage, final approval of design is made before starting the work and getting authorization is also to be implemented.

After acquisition of land, the utilities removal plan is to be adopted at the pre-construction stage itself. Identify the scope of relocation with the help of support of utility authority is to be implemented to avoid this issue. Forming a committee inclusive of members from all departments in project is one of the solutions.

Sufficient time is to be given for preparing the tender and work out the quantities accurately after studying the tender document carefully, these are the powerful tool for avoiding the quantity increase in construction stages. Detailed work out of materials is carried out based on the initial and reconnaissance survey will avoid this critical issue.

Non availability of construction material issue can be avoided by preplanned purchase strategy. It includes purchasing of unique and rarely available raw materials and stored it in site earlier, before the task starts. It is the prime solution for the cost overrun issue.

Design errors can be omitted by appointing an experienced person for the role of designer and gave sufficient time to prepare the design. A separate panel comprising of design

professionals is to be made for cross checking and verifying of designs made by the designer.

Unstable interest rates cannot be avoided fully but can be reduced. By providing a provision clearly in contract condition adjusted with floating rate of interest, will avoid the loss of money for the contractor.

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