

# **STUDY ON THE COST OVERRUNS IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA**

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## **Abstract**

Cost is among the major considerations throughout the project life cycle. The gap between the cost at completion and that originally estimated known as cost overrun can be regarded as one of the most important parameters reflecting the success of projects. Despite its proven importance, it is common to see construction projects failing to complete within the originally estimated cost. Cost overrun is a frequent phenomenon and is associated with most of the projects in the construction industry in Sri Lanka. This trend is seen in the other developing countries where these overruns sometimes exceed 100% of the original cost of the project.

The objective of this study are: to identify various factors influencing cost overrun at pre-construction and construction phases of road projects; to rank the factors identified based on their significance and identify the critical factors contributing to cost overruns and to make recommendations to overcome critical identified factors in future road projects

Factors influencing cost overruns in road projects were identified during the literature survey and the information gathering sessions and a questionnaire was prepared considering those factors. A survey was carried out to identify significant factors influencing cost overruns in Road Projects. Delays in making payment, delays due to utility relocation, design changes during construction phase, cost escalation and land acquisition related issues have been identified as critical factors influencing cost overruns in road projects.

Conclusions and recommendations are made to overcome the critical factors influencing cost overruns in the future road construction projects.

**Key Words:** Cost, Overrun, Construction, Road Projects

# 1. Introduction

Road development in the country, which was left behind especially in Northern and Eastern provinces during the last few decades due to the war, has now been considered as a priority item in the government development programme. The National Road Master Plan has already been prepared, which focuses on the construction and rehabilitation of highways, reduction of traffic congestion, road maintenance and bridge rehabilitation & reconstruction.

It has become an urgent necessity for further investment in road network, thus the development of road network has become a major determinant factor in attracting new investments to the country. In line with this allocation of funds for road development has been increased rapidly. Figure 1.1 shows variation of total allocation and expenditure in each year from 2000 to 2010 (Ministry of Highways, 2010).

Road Development Authority (RDA) is the state establishment responsible for the maintenance and development of the National Highway Network, comprising - the Trunk (A Class) and Main (B Class) roads - planning, designing and construction of new highways, bridges and expressways to augment the existing network. Table 1.1 Shows details of road km in each province in Sri Lanka (Road Development Authority, 2011).

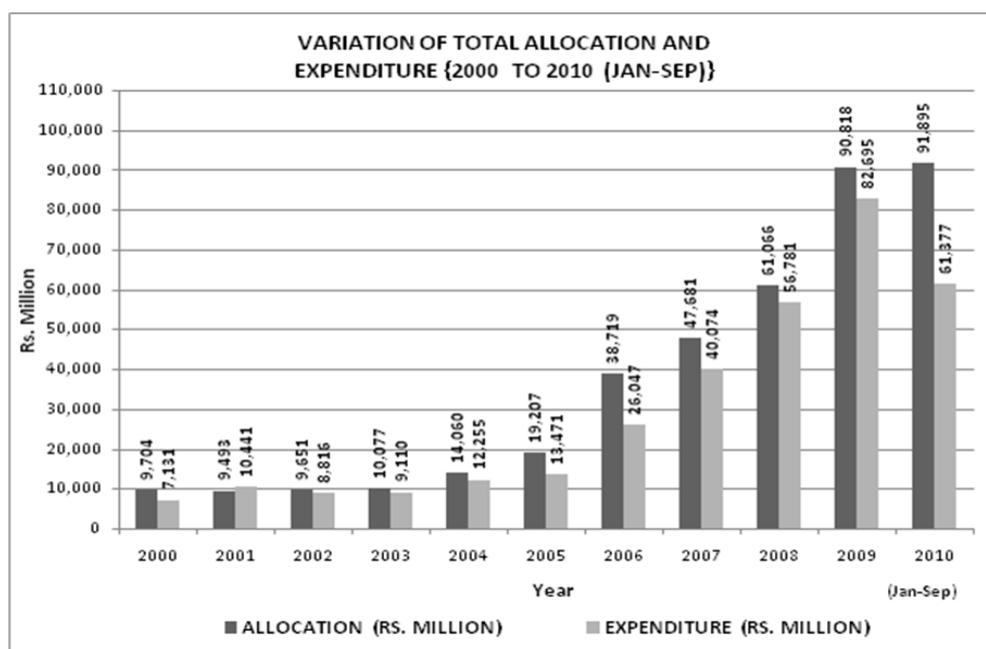


Figure 1.1: Allocation of Funds from Year 2000 to 2010 for the Development of Roads

Since, the rehabilitation and development of the road network is undertaken mainly from donor funds at a very high cost, the RDA should ensure that adequate economic returns are achieved from the investments made on road development projects. Proper planning should be done to achieve the expected returns and need to consider the factors, which would likely to impact negatively such as,

cost overruns, time overruns, scope changes in order to maximize the returns and also to minimize wastage of funds.

*Table 1.1: National Road kilometres in Each Province in Sri Lanka*

<i>Province</i>	<i>National Roads (in Km)</i>	<i>Provincial Roads (in Km)</i>	<i>Local Roads (in Km)</i>
<i>Western province</i>	<i>1,556</i>	<i>1,945</i>	<i>11,295</i>
<i>Southern Province</i>	<i>1,336</i>	<i>1,643</i>	<i>8,201</i>
<i>Sabaragamuwa Province</i>	<i>1,121</i>	<i>1,130</i>	<i>7,254</i>
<i>North Western Province</i>	<i>1,275</i>	<i>2,118</i>	<i>13,384</i>
<i>Central Province</i>	<i>1,716</i>	<i>2,433</i>	<i>8,283</i>
<i>North Central Province</i>	<i>1,144</i>	<i>1,771</i>	<i>5,485</i>
<i>Uva Province</i>	<i>1,161</i>	<i>1,839</i>	<i>4,447</i>
<i>North East (Northern) Province</i>	<i>1,259</i>		
<i>North East (Eastern) Province</i>	<i>1,148</i>	<i>2,653</i>	<i>6,310</i>
<i>Total</i>	<i>11,716</i>	<i>15,532</i>	<i>64,659</i>

It was reported during the data collection stage that majority of projects have not been completed within the agreed time and cost, resulting cost overruns.

## **2. Objectives**

Objectives of the study are:

- To identify various factors influencing cost overrun at pre-construction and construction phases of road projects.
- To rank the factors identified based on their significance and identify the critical factors influencing cost overruns
- To make recommendations to overcome the critical factors in future road projects

## **3. Literature Review**

Design changes resulted in construction delays can cause critical problems for the developer and the contractor who may incur higher expenses for costs of materials or due to the delays in material deliveries. As a result, all alternatives proposed by the architect or developer should be evaluated and estimated separately from other construction items (Roachanakanan, 2005).

Project schedule is a significant element in developing an estimate by identifying the sequence of activities and illustrating the interrelationship of all activities needed to complete the construction. It also shows the availability of project personnel, weather conditions, project resources, and the owner's requirements. One of the main purposes of planning and scheduling a project is to translate the work schedule into a cost schedule or budget (Creedy, 2006).

Critical factors influencing cost overruns are:

1. Unpredictable weather,
2. Inflationary material costs,
3. Inaccurate material estimates,
4. Project complexity,
5. Lack of information about the site geography,
6. Lack of contractors experience on certain type of projects,
7. Unfamiliarity with local regulations, (Roachanakanan, 2005)

Possible causes of cost overruns from the beginning of projects include omission of some items and out-of-date cost estimates. The cost information such as labour rates, equipment rates and material costs used in estimating should be accurate. These can be obtained from historical data, past projects, a proprietary database, or current material costs (Roachanakanan, 2005).

It was revealed at the informal discussion had with project participants attached to employer, consultant and contractor organizations that: changes to rules and regulations, delay in issuing instructions and approvals, mistakes in the tender documents, land acquisition issues, delay in relocating utilities, insufficient time for bidders to prepare tenders, delays in making advance payments and other payments, errors in the original measurements and poor document management are some of the important factors that influence the cost overruns in road projects.

## **4. Methodology**

Questionnaire Survey was carried out to gather data from the selected respondents for the study. Frequency Occurrence Index (FOI), Rank Agreement Factor (RAF), Percentage Disagreement and Percentage Agreement methods were used to analyse the data and to rank the factors influencing the cost overruns.

### **4.1 Questionnaire Survey**

Detailed questionnaire was prepared using the information gathered during the literature survey and informal discussions with key project participants and distributed among the selected respondents in the road construction industry such as clients, contractors and consultants in North Central Province (NCP), Central Province (CP) and Western Province (WP).

The following factors were included in the Questionnaire to gather information from the respondents:

1. Design errors
2. Scope definition
3. Design changes during construction
4. Bad Weather conditions
5. Project key staff
6. Changes to rules and regulations by the authorities
7. Project complexity
8. Delay in issuing instructions and approvals

9. Errors in the BOQ
10. Inaccurate quantities in the BOQ
11. Mistakes in the tender documents
12. Land acquisition issues
13. Delay in shifting existing utilities
14. Insufficient time for bidders to prepare tender
15. Delays in making payments
16. Unrealistic work schedule
17. Errors in original measurements
18. Poor document management
19. Cost escalation

Table 4.1 shows the number of Questionnaires distributed among the different divisions of Road Organizations and the numbers received.

*Table 4.1: Distribution of the Questionnaire and the Numbers Received*

<i>Organization</i>	<i>Number of Questionnaires Distributed</i>	<i>Number of Questionnaires Received</i>
<i>Road Development Authority NCP</i>	<i>19</i>	<i>19</i>
<i>Road Development Authority WP</i>	<i>14</i>	<i>9</i>
<i>Road Development Authority CP</i>	<i>14</i>	<i>7</i>
<i>Provincial Road Development Authority NCP</i>	<i>10</i>	<i>3</i>
<i>Road Development Authority Funded Projects</i>	<i>10</i>	<i>4</i>
<i>Road Development Authority Expressway Projects</i>	<i>5</i>	<i>2</i>
<i>Total</i>	<i>72</i>	<i>44</i>

## **4.2 Frequency Occurrence Index**

The Frequency Occurrence Index (*FOI*) has been using extensively in research work to rank factors from different groups in a survey (Kandegedera and Malaikrisanachalee, 2008) and therefore this method was used to analyse the responses received.

The *FOI* of the factors contributing to cost overruns in projects as perceived by respondents has been calculated and the factors were ranked according to the *FOI*.

The frequency of occurrence index (*FOI*) is calculated using the following expression:

$$\text{Frequency of occurrence index} = \frac{\sum w}{AN}$$

(0 ≤ index ≤ 1)

Where,

$w$  = weighting given to each factor by the respondents and it ranges from 1 to 5 where,

- 1. = Very often
- 2. = Often
- 3. = Medium
- 4. = Rare
- 5. = Never

$A$  = Highest weight (i.e. 5 in this case)

$N$  = Total number of respondents

Where  $\bar{x}$  = Mean value

$$SD = \sqrt{\frac{\sum (w - \bar{x})^2}{N}}$$

Where SD = Standard Deviation

### 4.3 Rank Agreement Factor

In order to quantify the degree of agreement in ranking between different groups of participants, Rank Agreement Factor (RAF) was used (Kandegedera and Malaikrisanachalee, 2008). This shows the average absolute differences in rank of the factors. For any two groups, let the rank of the  $i$  th item in Group 1 be  $R_{i1}$  and in Group 2 be  $R_{i2}$ ,  $N$  be the number of items and  $j = N - i + 1$ . Then, the 'Rank Agreement Factor' is defined as:

$$RAF = \frac{\left[ \sum_{i=1}^N |R_{i1} - R_{i2}| \right]}{N}$$

With a maximum RAF:

$$RAF_{Max} = \frac{\left[ \sum_{i=1}^N |R_{i1} - R_{j2}| \right]}{N}$$

The 'Percentage Disagreement' is defined as:

$$PD = \frac{\sum_{i=1}^N |R_{i1} - R_{i2}|}{\sum_{i=1}^N |R_{i1} - R_{j2}|} * 100$$

The 'Percentage Agreement' is then given as:

$$PA = 100 - PD$$

A higher value of RAF will suggest a lesser agreement between any two groups. A rank agreement factor of zero would mean perfect agreement.

## 5. Results and Discussion

### 5.1 Discussion

Respondents were requested to allocate marks from 1-5, for each factor in the questionnaire and using the marks FOI for each factor was calculated. Ranking was done based on the calculated FOI and Table 5.1 shows the top five ranked factors based on FOI.

*Table 5.1: Top Five Cost Overrun Factors Ranked on FOI*

<i>Cost overrun factor</i>	<i>FOI</i>	<i>Rank</i>
<i>Payment delays</i>	<i>0.498</i>	<i>1</i>
<i>Delay in shifting existing utilities</i>	<i>0.527</i>	<i>2</i>
<i>Cost escalation</i>	<i>0.551</i>	<i>3</i>
<i>Design changes during construction</i>	<i>0.555</i>	<i>4</i>
<i>Issues in Land acquisition</i>	<i>0.571</i>	<i>5</i>

Payment delays are ranked as number 1 according to the results in Table 5.1 and the responses confirmed that this is a significant factor in road projects. Most of the road projects are funded by the government, and due to various reasons funds will not be provided in time, causing delays in payment. These delays will eventually affect the contractor's cash flow and finally end up with poor progress of construction works.

A delay due to utility relocation is the second highest ranked factor as shown in Table 5.1. Majority of road construction projects start before relocation of utilities and delays to construction works are inevitable due to these reasons. It is very important that during design stage scope of utility relocation to be identified and starts the relocation process to avoid any delays to construction activities.

The third ranked cost overrun factor is the cost escalation. Cost escalation refers to the increase in the amount of money required for a project over and above the original budget. Cost escalation is mainly due to changes in the cost of labour, material, plant and other construction activity related costs and no party has a control over the cost escalation. This is mainly due to inflation and is the most critical cost overrun factor among other factors. Increasing of prices for Labour and Material is a common issue. Therefore, to avoid cost escalation, proper planning at the procurement stage is vital. At the construction phase, the contractor should carryout construction works without allowing it to drag unnecessarily. A standard cost escalation formula is included in all construction contracts in Sri Lanka for this purpose and funding provisions under contingencies are used to settle the cost due to cost escalations.

Design changes during construction is the fourth ranked cost overrun factor as shown in Table 5.1 Inadequate site investigation is the main cause for design changes. Therefore, adequate investigations are necessary to do a complete and accurate design. If this issue is not addressed at the design stage there will be additional costs incurred by the employer.

The fifth ranked cost overrun factor is land acquisition and related issues. Majority of road construction projects are delayed due to the land acquisition and objections from the land owners for take over their lands. Impact on land acquisition in road construction is very serious and it delays the road construction activities significantly resulting cost overruns. Therefore, it is important to introduce mechanisms to overcome this issue at the planning stage. It is essential to introduce a national policy and also to amend the land acquisition related acts and laws to enable the road authorities to carryout land acquisitions faster. Early and timely actions to plan, identify and implement land acquisitions related issues are also important to resolve this problem.

Mean value for each factor was calculated using the marks allocated to each factor by the respondents. Table 5.2 shows the Cost overrun Factors ranked based on Mean Values.

*Table 5.2: Cost Overrun Factors Ranked Based on Mean Value*

<i>Cost overrun factor</i>	<i>Mean value</i>	<i>Rank</i>
<i>Payment delays</i>	<i>2.488</i>	<i>1</i>
<i>Delay in shifting existing utilities</i>	<i>2.634</i>	<i>2</i>
<i>Cost escalation</i>	<i>2.756</i>	<i>3</i>
<i>Design changes during construction</i>	<i>2.775</i>	<i>4</i>
<i>Issues in Land acquisition</i>	<i>2.854</i>	<i>5</i>

Both methods used for the analysis show similar results and therefore it can be concluded that the methods used to analyse data are acceptable.

Agreement and disagreement between senior engineer's and young engineers are computed and compared. At the group selection it was assumed that those who have ten years experience and more as senior members and others as junior members. Rank agreement factor (*RAF*) between young engineers and senior engineers is 3.5. The maximum Rank Agreement factor recorded is 10.1. Therefore, percentage agreement is 65.35%. Hence; the percentage of agreement (*PA*) is higher than 50%, which means majority of members in both groups are in agreement with the top five ranked factors for cost overruns in road construction projects.

## **6. Conclusions and Recommendations**

### **6.1 Conclusions**

Cost overruns are predominant in road construction projects in Sri Lanka and during this study an effort was taken to highlight critical factors influencing project cost overruns, through a Questionnaire Survey. Critical cost overrun factors that were observed according to the respondents' perceptions are



payment delays, delay in relocation of existing utilities, cost escalation, design changes during construction and issues in land acquisitions.

To verify the accuracy of the results, two different methods of analysis were carried out during the study and those methods are: Frequency occurrence index (*FOI*) and mean value (*MW*). Further, rank agreement factor (*RAF*), percentage agreement (*PA*) and percentage disagreement (*PD*) factors were used to verify the adequacy of results. *RAF* and *PA* between senior engineers and young engineers' category were 3.5 and 65.35% respectively which shows higher agreement between the two groups selected.

## 6.2 Recommendations

In order to avoid payment delays in road projects, it is recommended to provide a realistic time period in the conditions of contract clearly indicating the specific time periods for each party to prepare, recommend and certify the claims. Also to prepare an accurate financial plan indicating the amounts of funds required with the dates of disbursement and regular update of these plans.

Identification of the scope of utility relocation with the assistance and the support of the utility authorities at the pre construction stage is recommended to avoid these delays. Further it is recommended to form an effective Utility Committee comprising of members representing all project groups including representatives from the utility authority.

A realistic cost escalation factors should be calculated by accurate prediction of the future cost escalation and the amount of funds required should be included in project estimates.

Sufficient time period should be provided for the designs and especially for the design review to avoid design changes during construction.

Early identification of the lands to be acquired for the project is an important requirement to avoid these delays. Providing training on Land Acquisition Procedure for the project staff and effective co-ordination with the authorities e.g. Divisional Secretary are recommended.

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