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CONSTRUCTION PLANNING AND EFFICIENT BUDGET ORIENTED SCHEME IN HIGHWAY CONSTRUCTION PROJECTS

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Abstract: The role of the construction industry plays in socio-economic development is significant. The construction industry has a significant multiplier effect on the economy as a whole. Cost is one of the primary measures of a project's success. This thesis presents a new optimization –based approach to the long term planning of road networks. The traditional approach to the road network planning problem focuses on defining the investment decisions that will optimize the network efficiency under a given budget. The investment decisions can consist of either improving existing roads or adding new roads to an existing road network. The use of contingency in construction provides a tacit acknowledgement of the perennial problem of cost overruns in the delivery of projects. The effects of these cost overruns are adverse consequences such as projects becoming non-viable or in extreme cases being abandoned. The immediate as well as other stakeholders associated with the project suffer the socio-economic impact of this adverse consequence. To some extent the cost overruns can be deemed as being symptomatic of inadequate planning and budgeting of projects that in turn is a consequence of accuracy of costing data employed for estimating project budgets. Understanding the nature and factors that account for the overruns should assist in establishing more accurate project costs. The aim of the study is to explore the nature and scale of project cost overrun in construction to provide information for planning future projects. The study will utilize project data from road schemes to establish the magnitude of the cost overrun. In this paper we proposed an efficient budget oriented optimized cost overgrow scheme in Construction Technology and Management (CTM) system. Our proposed scheme solved the cost overgrow problem and improved the overall effect of the construction industry projects. The experimental results of our proposed scheme showed the effectiveness compared with existing works.

Index Terms **– Cost Overgrow, Delays, CTM, Construction projects.**

I. INTRODUCTION

Cost is one among the first measures of a project's success. Project planning is all about accuracy. With about 30% of projects failing due to imprecise cost estimates. Inaccurate forecasts concerning costs, resources, benefits and estimated durations can bring project risks that might impact your organization's profit and growth opportunities. Cost overrun is an unexpected change in the project budget that ends up increasing the total project cost. The cost overruns often represent symptoms of inadequate planning and budgeting for the projects, which, in turn is a consequence of accuracy of costing data employed for estimating project budgets. Within this paper, explore the nature of budget overrun and present the interim results from an investigation into the scale of construction project cost overrun. The study employed project data from road schemes to establish a generic function for the magnitude of cost overrun. The generic function of cost overrun can be employed to provide information for planning future projects on the most likely levels to incorporate for improved budget certainty. This paper presents a model designed to integrate the planning and efficient budget phases of highway construction projects. The model automatically generates the work breakdown structure (WBS) and precedence network respecting job logic and stores a list of construction operations typically encountered in highway projects.

Construction sector is a catalyst for economic growth as it stimulates development in other sectors. It is essential that this infrastructure is continually developed and upgraded to meet with the ever growing population and demand. However, construction projects are plagued by a phenomenon of global occurrence: "Delays & Cost Overruns".

Time delays and cost overruns are among the most common phenomenon in the construction industry. The effects of delays in construction projects are not confined to the construction industry but influence the overall economy of a country. Even with today's advanced technology and management understanding of project management techniques, construction projects continue to suffer delays and project completion dates still get pushed back.

The objective of this paper is to bring out the critical causes of construction project delays in developing and developed economies, bring out the gaps in earlier research and also discuss the scope and directions of future research work aimed at limiting the root causes of delay and improve the construction project delivery timelines.

II. OBJECTIVES

The aim of the present study was to investigate the increasing frequency of cost overruns and time delays on highway projects and to provide recommendations for addressing the situation. In the course of such investigations, it is expected that the following specific objectives will be addressed:

- Identification of the main causes of cost & time overgrow and their overall effects for public highway construction projects.
- Identification of the relationship between rates of cost overgrow and contract amount.
- Forwarding recommendations to minimize or to avoid cost overgrow and frequency of its occurrence and hence it reduces its consequential effects on highway projects.

III. LITERATURE REVIEW

Delay occurs when the progress of a contract falls behind its scheduled program. It may be caused by any party to the contract and may be a direct result of one or more circumstances. A contract delay has adverse effects on both the owner and contractor (either in the form of lost revenues or extra expenses), often raises the contentious issue of delay responsibility and may result in conflicts that frequently reach the courts.
With regard to remedial measures, there are three types of delay (Rowland, 1981):
Excusable delay: the contractor is given a time extension but no additional money.
Concurrent delay: Neither party recovers any damages.
Compensable delay: the contractor recovers monetary damages.

Majid and McCaffer (2018) provided similar categories of delay, on the basis of identified responsible parties:
Compensable delay: responsibility borne by the client.
Non-excusable delay: responsibility borne by the contractor.
Excusable party delays: acts of god or a third party.

Chan and Kumaraswamy (1995) observed that in 111 building and civil engineering projects completed in Hong Kong between 1990 and 1993, the average time overrun was exceeding 20%, and only 40% government buildings, 25% private sector buildings and 35% of civil engineering works were completed within schedule.
According to Sambasivan and Soon (2007), in 2005, about 17.3% of the 417 government projects in Malaysia experienced delays of more than 3 months or were abandoned & were considered sick. Koushki et al. (2005) in the study of 450 private residential housing projects in Kuwait, found that more than 56% of the projects did not complete on scheduled time, about 54% of the projects were delayed by four months or more, one-third of the projects were delayed by more than six months.

Jacoby (2001) with FHWA carried out a study on construction contract change orders. The study was completed in April 2001 and was based on 74 projects with a minimum cost of $10 million and cost overruns of more than 25%.

Assaf et al. (2006) conducted study on causes of delays in construction projects in Eastern province of Saudi Arabia through questionnaire survey of contractors & consultants. In their study, 76% of the contractors & 56% of the consultants specified a delay ranging (between 10% to 30% and about 25%) of the consultants specified a delay of 30% to 50% of original contract duration. Elinwa and Joshua (2001) found that degree of occurrence of time overrun in Nigeria is between 80% and 90%.

3.1 Causes of Time Overruns

- Materials-related delays
- Labor-related delays
- Equipment-related delays
- Financial delays
- Improper planning
- Lack of control
- Subcontractor delays
- Poor coordination
- Inadequate supervision
- Improper construction methods

3.2 Factors Affecting Cost Overruns

- Project Size
- Difference between the selected bid and government estimate
- Type of construction
- Level of competition

IV. RESEARCH METHODOLOGY

The research describes trends in the dependent variables used in the various models based on the data obtained from 858 projects. It describes time delays both in terms of liquidated damages and in time delays in days. A detailed description of the cost overrun trends classified by categories gives an explicit overview of cost overruns. It also provides a detailed description of the trends in change of scope.

4.1 Data and Sources of Data

Table 4.1 Distribution of Contracts by state

S No	State/UTs	No. of Projects	Estimated Population	Approximate Total Km Length
1	Andhra Pradesh	58	91,702,478	6,912
2	Arunachal Pradesh	6	1,711,947	2,537
3	Assam	47	35,998,752	3,909
4	Bihar	41	128,500,364	5,358
5	Chhattisgarh	32	32,199,722	3,605
6	Goa	21	1,521,992	293
7	Delhi	16	19,301,096	157
8	Gujarat	33	70,400,153	6,635
9	Haryana	34	28,900,667	3,166
10	Himachal Pradesh	5	7,503,010	2,607
11	J & K	14	14,999,397	2,423
12	Jharkhand	24	40,100,,376	3,367
13	Karnataka	78	69,599,762	7,335
14	Kerala	19	34,698,876	1,782
15	Madhya Pradesh	37	85,002,417	8,772
16	Maharashtra	48	124,904,071	17,757
17	Manipur	19	3,436,948	1,750
18	Mizoram	9	1,308,967	1,423
19	Nagaland	9	2,073,074	1,548
20	Odisha	28	47,099,270	5,762
21	Punjab	26	30,501,026	3,274
22	Rajasthan	23	79,502,477	10,342
23	Tamil Nadu	23	83,697,770	6,742
24	Telangana	21	38,157,311	3,795
25	Tripura	4	4,184,959	854
26	Uttarakhand	15	11,700,099	2,949
27	Uttar Pradesh	39	231,502,578	11,737
28	West Bengal	17	100,896,618	3,664
Total		**858**		

4.2 Theoretical framework

Data items are discussed below:

Cost Overrun = Final Amount - Original Bid Amount.

Cost Overrun Rate = Cost Overrun / Original Amount.

Time Delay = Last Day of Work – Expected Last Days of Work.

Contract Duration = Last Day of Work – Notice to Proceed Date (in days).
Difference between the First and Second Bid = (Second Low Bid – Original Bid Amount) / Original Bid Amount.
Difference between the Engineer's Estimate and the Bid = (Engineer's Estimate – Original Bid Amount) / Original Bid Amount.
Proportion of Inclement Days = Number of Inclement Days/Total Project Duration in Days

The methods used to collect and develop the database for the statistical analysis of the cost overrun, time delay and change order data. Most of the data were obtained from the NHAI contracts division. A total of 29 data items were established. The study uses data period of approximately seven years.

4.3 Descriptive Statistics

To avoid the undue delay and cost overrun for National Highways projects and the period of completion of the projects in tune with the advancement of technology and international best practices, we are formulated the budget format following time schedule for civil works and completion of works.

4.3 Index of Budget

Table 4.2**:** Index of Budget

Index - Budget		
Sr No	**Item Description**	**Remarks**
1	**Management Summary**	
2	Project Data	
3	Budget Summary	
4	Cash Flow	
5	Quaterwise Summary	
6	Monthwise Summary	
7	Assumption Sheet	
8	Comparision – DC (Budget vs Tender)	
9	Comparision – IDC (Budget vs Tender)	
10	**BOQ & Planning**	
11	Schedule-G	
12	Quantitative BOQ	
13	Work Plan	
14	Physical Plan	
15	**Costing**	
16	Budgeted Rate	
17	Direct Cost Analysis	
18	Monthwise Material Requirement	
19	Material Rate Analysis	
20	Equipement Analysis	
21	Sub contractor Rates	
22	Material Rates	
23	Equipement Norms	
24	SC Rate Working	
25	SC Orders	
26	**Costing Inputs/Calculations**	
27	Girder	
28	PQC	
29	Leads	
30	Crushing Rate	
31	Earthwork Rates	
32	Quantity Calculations	
33	Quantity Calculations1	
34	Dropdown	

35	**IDC Expenses**	
36	IDC Expenses	
37	IDC Calculations of Departments	
38	Design Charges	
39	Machinery	
40	Key Staff	
41	Operators	
42	Helpers	
43	Card Holders	
44	QA/QC Lab	
45	Furniture Items	
46	Camp Construction	
47	Transportation Charges	

Table 4.2 shows that the index of Budget which categorically includes project data, budget summary, cash flow, BOQ Planning, physical plan of civil work of financial year, costing, calculations and indirect expenses which have machinery, staff salary, operators and transportation charges.

4.4 Budget Summary

Table 4.3: Budget Summary

Summary		R0 (Tender Base Rates)		Tender	
Sr. No.	**DESCRIPTION**	**AMOUNT**	**% WRT RECEIVABLE AMOUNT**	**AMOUNT**	**% WRT RECEIVABLE AMOUNT**
A	**Total Receivable Amount**	**820**		**670**	
B	**Price Escalation**	**-**			
C	**Net Receivable Amount (Without GST) Quantitative**	**820**	**100.00%**	**670**	**100.00%**
D	**Total Direct Cost**	**396.552**	**48.36%**	**426.723**	**63.69%**
E	**Escalation**	**-**		**-**	
F	**Total Indirect Cost (Without GST)**	**189.584**	**23.12%**	**168.44**	**25.14%**
G	**Equity Infusion**	**114.882**	**14.01%**		
H	**Design saving**	**-**		**(19.56)**	**-2.92%**
I	**Total Expenses**	**701.018**	**85.49%**	**575.66**	**85.92%**
J	**Profit W/O Cash flow (Quantitative)**	**118.982**	**14.51%**	**94.34**	**14.08%**
L	**Cash Flow Interest Effect**	**(17.95)**	**-2.19%**		
M	**Profit with Cash flow**	**136.94**	**16.70%**	**94.34**	**14.08%**

Table 4.3 indicates the summary of budget which have difference between the budget base rate and tender rates. Through this summary format we can find out the profit with cash flow and we get the total expenses of project which includes direct cost, indirect cost and escalation.

4.5 Comparison of Direct Cost

Table 4.4: Comparison Direct Cost

Direct Cost Comparison: *Budgeted Expenses*

Item Description	Tender Amount as per Tender Qty (1)	Budget Amount as per Design Qty (2)
Total	**426.723**	**396.552**
BILL No. 01: SITE CLEARENCE	0.57	0.69
BILL No. 02: EARTHWORKS	114.54	120.67
BILL No. 03: SUB-BASES AND BASE COURSE	11.4	7.90
BILL No. 04: RIGID/BITUMINOUS COURSES	156.4	143.2
BILL NO. 06: RE WALL	2.24	1.94
BILL NO. 07A: DRAINAGE WORKS	10.2	8.4
BILL NO. 07B: PROTECTION WORKS	13.34	11.48
BILL NO. 08: TRAFFIC SIGNS, MARKINGS AND ROAD APPURTENANCES	42.94	35.44
BILL NO. 12: MISCELLANEOUS	10.98	8.08
BILL NO. 13: Toll Plaza	13.65	11.65
BILL No. 14: Wayside Amenities	0.34	-
BILL No. 15: Smaller Parking Spaces	-	0.59
BILL NO. 17: Canal Realignment	-	0.13
BILL NO. 18: Utility Shifting	7.76	14.68
BILL NO. 5A: New Culverts (HPC / BC / SC)	10.54	14.51
BILL NO. 5C: New Minor bridges (MNBR)	42.31	39.67
BILL NO. 5E: New Major bridges (MJBR)	22.34	21.30
BILL NO. 5H: Flyover / Viaduct	7.28	9.81
BILL NO. 5J: Vehicular Underpass (VUP)	8.22	7.97
BILL NO. 5K: Light Vehicular Underpass (LVUP)	23.17	19.47

Table 4.4 shows the direct cost comparison of budgeted expenses. In budget expenses includes all civil works which has to be done by the contractor, material used for the civil works, machinery used to carry out the tasks, sub-contractor expenses, other utility works like shifting of electrical poles and water pipelines and calculation of royalty paid for soil and aggregate. Through these expenses we can calculate the difference between the design and tender amount.

4.6 Comparison of Indirect Cost

Table 4.5: Comparison of Indirect Cost

Sr. No.	Item Description	R0 Budget	Tender	Difference (Budget-Tender)
1	Carting & Transportation	95,799,873	49,667,552	46,132,321
2	Temporary Structures	113,716,826	55,274,436	58,442,390
3	Furniture & Fixture	3,347,900	4,221,060	(873,160)
4	Electrical Installation	34,206,118	37,746,620	(3,540,503)
5	Printing & Stationery	5,283,330	2,161,795	3,121,535
6	Computer/Network/It	13,296,452	8,400,000	4,896,452
7	Land Rent, Agreements, Brokerages	10,409,388	15,091,920	(4,682,533)
8	Insurance & Claims	32,969,899	21,935,588	11,034,312
9	Taxes And Levies	351,795,402	294,790,179	57,005,223
10	Head & Regional Expenses	351,795,402	294,790,179	57,005,223
11	Salaries & Benefits	298,864,324	223,215,002	75,649,321
12	Local Labour Expense	51,714,610	24,643,507	27,071,103
13	Staff Welfare	1,310,750	3,001,947	(1,691,197)
14	Kirana Vege. Milk Out Side Lunch Etc.	21,478,820	17,314,128	4,164,692
15	LPG, Firewood, Etc.	3,946,305	1,923,792	2,022,513
16	Utensil, Mixer Etc.	295,000	144,284	150,716
17	Water Distribution	5,655,225	3,600,000	2,055,225
18	Legal & Professional Fees	807,917	10,808,973	(10,001,057)
19	Bank & Financial Charges	7,955,892	8,101,071	(145,180)
20	Local Conveyance & Travelling	21,742,659	20,962,219	780,440
21	Telephone & Communication	742,600	1,500,482	(757,882)
22	Staging & Shuttering	41,744,052	-	41,744,052
23	Miscellaneous Expense	-	-	-
24	Surveying & Levelling	11,400,000	31,024,000	(19,624,000)
25	Testing & Quality Control	8,585,267	4,800,000	3,785,267
26	Safety And Security	21,097,095	29,380,754	(8,283,660)

27	Tools & Tackles	-	480,000	(480,000)
28	RTO Expense	3,540,324	480,000	3,060,324
29	Contingency Expense	257,980,000	165,000,000	92,980,000
30	Dismantling & Refurbish	15,000,000	3,600,000	11,400,000
31	Routine Maintenance Upto Completion	-	4,800,000	(4,800,000)
32	Idle Charge	-	14,739,629	(14,739,629)
33	Defect Liability Period	-	-	-
34	Work Shop Expense	1,991,893	5,612,928	(3,621,035)
35	Royalty Expenses	923,754,648	1,111,015,098	(187,260,450)
Sub-Total		2,712,227,969	2,470,227,143	242,000,826

4.7 Physical Plan

Table 4.6: Physical plan

Item	Stage for Measurement of Physical Progress	Unit	Qty		Whtg in % to Contract Price	Amount	Amount (Cr)	Rate / Unit	Rate (Cr)	Mar.22	Apr.22	May.22	Jun.22	Jul.22	MS-I Aug.22	Sep.22	Oct.22	Nov.22	Dec.22	Jan.23	MS-II Feb.23	Mar.23
	Availability of Land in Km.								**Monthwise**	9.6		4.0	2.3			3.2		2.0	3.0	2.2		
	B- New realignment/bypass			##########	**59.27%**				**Cumm.**	9.6	9.6	13.6	15.9	15.9	15.9	19.1	19.1	21.1	24.1	26.3		
	(1) Earthwork up to top of the sub-grade	Km	24.36	3,70,94,46,912	31.24%	3,70,94,46,912	370.94	15,22,69,895	15.23			0.40	2.13	-	-	0.98	0.71	2.24	3.33	0.33	1.49	3.79
	(2) Granular works (Sub-Base ,Shoulders)	Km	24.36	29,74,31,308	2.50%	29,74,31,308	29.74	1,22,09,323	1.22			0.40	1.13	-	-	0.98	0.71	2.24	3.33	0.33	1.49	3.79
	(3) Shoulders	Km	24.36	1,11,68,234	0.09%	1,11,68,234	1.12	4,58,447	0.05									2.06	2.17	1.73	2.06	2.16
	(4) Bituminous work	Km	-	-	-	-																
	(5) Rigid Pavement	Km	-	-	-	-																
	(a) DLC	Km	24.36	52,81,77,077	4.45%	52,81,77,077	52.82	2,16,81,256	2.17							1.50	2.00	1.00	1.95	1.46	2.20	3.43
	(b) PQC	Km	24.36	2,49,16,97,138	20.98%	2,49,16,97,138	249.17	10,22,82,219	10.23									1.50	1.24	1.46	2.20	2.09
	C- New culverts, minor bridges ,Underpasses, overpasses on existing road , realignment,bypasses			41,16,90,081	**11.10%**	-																
Road works including culverts, minor bridges, underpasses, overpasses, approaches to ROB/RUB/ Major Bridges / Structures (but excluding service roads)	**(1) Culverts**	Nos.	124.0	41,16,90,081	3.47%	41,16,90,081	41.17	33,20,081	0.33	-	-	7.00	7.00	1.00	3.00	7.00	13.00	13.00	8.00	8.00	10.00	14.00
	(2) Minor Bridges			90,63,76,710	-	-																
	(a) Foundation	Nos.	58	43,79,74,127	3.69%	43,79,74,127	43.80	75,51,278	0.76	-	7.00	12.00	5.00	-	1.00	9.00	11.00	7.00	2.00	3.00	1.00	-
	(b) Sub-Structure	Nos.	58	29,09,42,864	2.45%	29,09,42,864	29.09	50,16,256	0.50	-	-	4.00	10.00	2.00	2.00	1.00	4.00	8.00	12.00	6.00	3.00	1.00
	(c) Super Structure (Including crash Barrier etc complete)	Nos.	30	17,74,59,719	1.49%	17,74,59,719	17.75	59,15,324	0.59	-	-	-	-	-	-	1.00	2.00	4.00	2.00	4.00	6.00	6.00
	(5) Grade Seperated Structures			-	-	-																
	(a) Underpasses -VUP			12,79,43,388	**1.08%**	-																
	(i)Foundation	Nos.	6	5,91,78,633	0.50%	5,91,78,633	5.92	98,63,106	0.99	-	1.00	2.00	1.00	-	1.00	1.00	-	-	-	-	-	-
	(ii) Sub-Structure	Nos.	6	2,16,85,970	0.18%	2,16,85,970	2.17	36,14,328	0.36	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-
	(ii) Super Structure (Including crash Barrier etc complete)	Nos.	6	4,70,78,784	0.40%	4,70,78,784	4.71	78,46,464	0.78	-	-	-	1.00		1.00	1.00	1.00	1.00	-	-	-	-
	(a) Underpasses -LVUP			18,15,00,161	**1.53%**	-																
	(i)Foundation	Nos.	18	8,51,56,080	0.72%	8,51,56,080	8.52	47,30,893	0.47	-	-	2.00	2.00	1.00	1.00	1.00	3.00	4.00	2.00	1.00	1.00	-
	(ii) Sub-Structure	Nos.	18	2,93,02,056	0.25%	2,93,02,056	2.93	16,27,892	0.16	-	-	-	2.00	2.00	1.00	1.00	1.00	3.00	4.00	2.00	1.00	1.00
	(iii) Super Structure (Including crash Barrier etc complete)	Nos.	18	6,70,42,025	0.56%	6,70,42,025	6.70	37,24,557	0.37	-	-	-	-		2.00	1.00	1.00	1.00	3.00	4.00	2.00	1.00
	(a) Underpasses -SVUP			27,22,50,241	**2.29%**	-																
	(i)Foundation	Nos.	34	12,77,34,120	1.08%	12,77,34,120	12.77	37,56,886	0.38	-	4.00	6.00	2.00	3.00	6.00	3.00	2.00	3.00	1.00	1.00	2.00	1.00
	(ii) Sub-Structure	Nos.	34	4,39,53,084	0.37%	4,39,53,084	4.40	12,92,738	0.13	-	-	4.00	6.00	2.00	3.00	6.00	3.00	2.00	3.00	1.00	1.00	2.00
	(iii) Super Structure (Including crash Barrier e	Nos.	34	10,05,63,037	0.85%	10,05,63,037	10.06	29,57,736	0.30	-	-	-	4.00		2.00	3.00	6.00	3.00	2.00	3.00	1.00	1.00
	(c) Flyover			18,37,86,450	**1.55%**	-																
	(i)Foundation	Nos.	10	6,51,51,236	0.55%	6,51,51,236	6.52	65,15,124	0.65	-	1.00	3.00	3.00	2.00	1.00	-	-	-	-	-	-	-
	(ii) Sub-Structure	Nos.	10	8,71,91,693	0.73%	8,71,91,693	8.72	87,19,169	0.87	-	-	1.00	2.00	3.00	3.00	1.00	-	-	-	-	-	-
	(iii) Super Structure (Including crash Barrier etc complete)	Nos.	6	3,14,43,520	0.26%	3,14,43,520	3.14	52,40,587	0.52	-	-	-	-	-	-	-	-	-	1.00	1.00	1.00	1.00
	(iv) Foot Over Bridge	Nos.		-	-	-																
	(c) New Major Bridges			57,64,75,041	**4.85%**																	
Major-Bridge works & ROB/RUB	(1) Foundation	Nos.		-	-	-																
	(a) Open foundation	Nos.	20	18,87,68,476	1.59%	18,87,68,476	18.88	94,38,424	0.94	-	4.00	4.00	1.00	-	-	2.00	4.00	3.00	2.00	-	-	-
	(b) Pile Foundation /Well Foundation	Nos.		-	-	-																
	(2) Sub-Structure	Nos.	20	28,12,58,468	2.37%	28,12,58,468	28.13	1,40,62,923	1.41	-	-	4.00	1.00		-	3.00	3.00	3.00	3.00	2.00	-	-
	(3) Super-Structure (Including Crashbarrier etc.Complete)	Nos.	16	10,64,48,097	0.90%	10,64,48,097	10.64	66,53,006	0.67	-	-	-	-	-	-	-	1.00	2.00	3.00	2.00	1.00	3.00
	Structure (Elevated sections,reinforced earth)			6,04,20,626	**0.51%**																	
Structures (Eleveated sections ,reinforced earth)	(1) Foundation	Nos.		-	-	-																
	(2) Sub-Structure	Nos.		-	-	-																
	(3) Super Structure (Including crash Barrier e	Nos.		-	-	-																
	(4) Reinforced Erath wall (Includes ,Approaches of ROB ,Underpasses , Overpasses,Flyover Etc)			-	-	-																
	(a) Casting of RE Panels	Sqm	14708	2,64,14,981	0.22%	2,64,14,981	2.64	1,796	0.00			2,250.00	#####	#####	#####	1,000.00	1,000.00	1,207.90				
	(b) Erection of RE Panels	Sqm	14708	3,40,05,645	0.29%	3,40,05,645	3.40	2,312	0.00								1,500.00	2,000.00	2,000.00	2,000.00	2,008.00	1,999.90
	Other Works			##########	**13.97%**																	
	(i) Service roads/Slip road (Connecting Road)	km	2.880	3,85,33,501	0.32%	3,85,33,501	3.85	1,33,79,688	1.34										0.19	0.31	0.23	0.60
	(ii) Toll Plaza	Nos	2.000	14,32,25,437	1.21%	14,32,25,437	14.32	7,16,12,719	7.16								0.20	0.20	0.20	0.20	0.30	0.30
	(iii) Road Side drains	km	101.01	26,88,59,257	2.26%	26,88,59,257	26.89	26,61,807	0.27									-	8.56	9.00	7.18	8.52	8.96
	(iv) Road signs, markings ,km stones, safety devices, road furnitures etc.	km				-	-															
	(a) Roadsigns, markings, Km Stones	km	26.300	33,05,25,175	2.78%	33,05,25,175	33.05	1,25,67,497	1.26													
	(b) Concrete Crash barrier/W-Beam Crash Barrier in road work	Km	101.14	55,75,76,772	4.70%	55,75,76,772	55.76	55,13,068	0.55									-	-	-	-	-
	(v) Project facilities			31,98,66,226		-																
	(a) Bus Bays	Nos	-			-																
Other W	(b) Truck lay -byes	Nos	-			-																
	(c) Rest Area	Nos	2.0	1,05,89,931	0.09%	1,05,89,931	1.06	52,94,966	0.53								0.20	0.20	0.20	0.20	0.20	0.20
	(vi) Repairs to bridges/structures					-																
	(vii) Road side plantation	Km	25.176	5,31,32,929	0.45%	5,31,32,929	5.31	21,10,460	0.21													
	(viii) Protection works					-																
	a) Boulder pitching on slopes/Turfing	Km	6.54	3,66,05,770	0.31%	3,66,05,770	3.66	55,97,213	0.56	-	-	-	-	-	-	-	-	0.55	0.58	0.47	0.55	0.58
	b) Toe/Retaining/Curtain Wall & Rigid Aprons	Km	2.02	21,95,37,596	1.85%	21,95,37,596	21.95	10,89,51,660	10.90	-	-	-	-	-	-	0.22	0.22	0.22	0.22	0.22	0.22	0.22
	(ix) Tunnel					-																
	(a) Excavation	Rmt				-																
	(b) Construction of support system including rock bolting,lining etc.	Rmt				-																
	(c) On complete Completion of Tunnel	Rmt				-																
	(x) Miscellaneous	LS				-																
	Electrical & Public Health Utilities			45,80,50,267	**3.86%**																	
	(a) EHT line	Km	6.7	35,59,56,525	3.00%	35,59,56,525	35.60	5,31,27,840	5.31		1.00	1.00	1.00		1.00	1.00	0.70					
	(b) EHT Crossing	Nos	4.0			-	-	-	-													
	(c) HT/LT lines,(Including transformers i	Km	9.35	7,06,16,312	0.59%	7,06,16,312	7.06	75,52,547	0.76		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.35			
Electrical & Public Health Utilities	**(d) HT/LT Crossings**	Nos	19.0	-		-	-	-	-													
	(e)Water Pipeline	Km	1.990	3,14,77,430	0.27%	3,14,77,430	3.15	1,58,17,804	1.58													
	(f) Water Pipeline Crossings	Nos	5.000			-																
	(g) Sewage line	Km																				
	(g) Sewage line Crossing	Nos																				
	Total			11,87,50,00,000	**100.00%**	**11,87,50,00,000**					**18.27**	**44.72**	**63.50**	**7.98**	**19.02**	**51.02**	**55.35**	**92.53**	**104.14**	**49.26**	**72.71**	**112.49**
									Cumm.		**18.27**	**62.99**	**126.49**	**134.47**	**153.49**	**204.51**	**259.86**	**352.38**	**456.52**	**505.79**	**578.50**	**690.99**

Table 4.6 shows the physical plan of particular financial year from March to February. The plan of each work breakdown structure element according to the schedule G of contract agreement between NHAI and Contractor is distributed throughout the year in months according to the element's way of construction, availability of manpower and availability of machinery and equipment.

From this format we can monitor executed quantity of particular item and compare it with planned quantity as well as we can monitor amount of work done in each month.

V. RESULTS AND DISCUSSION

This study analyzed the problem of cost overruns and time delays associated with NHAI projects. This was carried out using a variety of methods including a survey, literature review, and statistical analyses.

1. The survey revealed that NHAI's contract management performance in terms of cost overruns and time delays is generally similar to that of other state PWDs. Nevertheless, cost overruns and time delays in India represent a sizeable portion of agency costs, and even a marginal reduction can lead to substantial savings.

2. The study showed that between the years 2014 and 2021, 55% of all Indian NHAI contracts experienced cost overruns, and the overall cost overrun rate was 4.5% of the bid amount. With regard to cost overruns.

3. It was also determined that influential factors of cost overrun of highway contracts include the contract bid amount, difference between the winning bid and second bid, difference between the winning bid and the engineer's estimate, project type and location by state.

4. The developed models may be used to estimate the extent of future cost overruns on the basis of contract and project characteristics, and are therefore useful in long term budgeting and needs assessment studies.

5. With regard to time delay, it was also found that 12% of all NHAI contracts experience time delays, and the average delay per contract was 115 days. The study also determined average time delay for each type of contract. From the various statistical analyses, it was determined that factors influential to time delays are contract bid amount, difference between the winning bid and second bid, difference between the winning bid and the engineer's estimate, project type and location by district. Based on the results of the analysis, recommendations can be made for improving the management of projects and the administration of contracts in order to reduce time delays.

6. Using an array of statistical methods, the present research project explored the problem statement further. The magnitude of cost overrun, time delay and change of scope problems associated NHAI's construction projects were explored by investigating the relationships between these parameters and key characteristics of the bidding process, project, and environment. The descriptive statistics showed that the following change of scope types were the most critical in terms of frequency and cost: "errors and omissions, design related," "errors and omissions, quantity related," "constructability, construction related," "constructability, design related," and "changed field conditions, construction related." It was found that most of such change of scope reason categories were the responsibility of NHAI or its consultants, and therefore is within NHAI's capability to reduce the incidence of such change of scope by improving its contract management system. The descriptive statistics also indicated that cost overruns and time delays have been on the decrease since 2017. It was indicated that more time delays were experienced for maintenance projects compared to other project types, and for projects in the Maharashtra compared to those located at other states.

7. A major problem encountered during the course of the present study was existence of several change of scope for which no reason was assigned to change of scope. For approximately a third of all change of scope (representing one-half of amounts incurred on change of scope), no reason was assigned in the dataset. This suggests that there are a few lapses in the current management of change of scope at NHAI. The constructability reviews report from the Constructability Process Review Committee shows that a key need was the development of a process to determine the causes of change of scope.

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