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Priority Indexing of Factors Affecting Cost Overruns using AHP Technique

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Abstract: This research work has been aimed to find out the causes that are causing cost overruns in the construction projects. This research activity was entirely assessed through questionnaire survey. Various literatures have been reviewed for assessment and evaluation of factors that are causing cost overruns in construction projects. The respondents were selected from various construction occupancy mainly architects, builders, contractors, structural engineers and various consultancy firms. The results accomplished from survey revealed that the major causes of delays and cost overruns during construction projects are the escalation of the materials prices and discontinuity of funds. The overall ranking analysis are indicating that Technical Drawings, Government Policies, Increase in Expenses, Festivals, Investigation or Tests and Specifications are most critical factors, that are responsible for construction cost overruns in South Gujarat specially in Tapi and Surat District.

Keywords:AHP technique, Construction Industry, Cost Management, Cost Overruns, Consistency Ratio, Global Weights, Local Weights, Ranking.

I. INTRODUCTION

Construction industry is a very complex industry in which cost is the most crucial factor ultimately governing the completion of the project within the planned budget as well as stipulated time. Construction industry are facing large amount of cost overruns affecting the success of project. Despite of the construction project management there has been a need arisen to investigate out the various causes of cost overruns as it hinders the progress of construction project. Firstly, in order to control the cost overruns it is necessary to analyse the crucial reasons of various causes of cost overruns by knowing the opinions from the persons that have been involved in construction industry.

II. ANALYTICAL HIERARCHY PROCESS (AHP)

The analytic hierarchy process (AHP) is a structured technique for organizing and analysing complex decisions. AHP is a multiple criteria decision-making tool that has been used in almost all the applications related with decision-making. The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach and was introduced by Saaty. Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analysed independently. Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analysed independently. Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time, with respect to their impact on an element above the min the hierarchy. The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. In the final the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent healternatives relative ability to achieve the ,so they allow a straight forward consideration of the various courses of action. The results have been derived by using a Pair wise Scale comparison through which the matrices have been

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generated. Through which accordingly the Local & Global weights have been calculated and based on this Ranking was done for various criteria's that were affecting cost overruns.

III. LIST OF CRITERIA

For the purpose of this research work the factors of cost overruns have been classified into 5 main criteria along with the various sub criteria after studying various literatures of Cost Overruns which are listed below:

- 1. Finance Capabilities:** - Construction materials, Additional costs, Estimation, Funding problems, Natural calamities, Bankruptcy, Indemnities.
- 2. Planning:** -Planning, Failure to identify problems, Additional work, Supplementary / additional agreement, Suspension of work ordered by the engineer, Ambiguities or discrepancies of documents.
- 3. Execution:** -Quantity estimate, Specifications, Construction materials, Mistakes, Poor communication, Complexity.
- 4. Government Policies:** -Legislation, Policies, Increase in Expenses.
- 5. Technical Capabilities:** - Investigation / Tests, Drawings, Changes, Contractor.
- 6. False Measure:** -Festivals, Natural Calamities, Strikes, Diseases.

I. SAMPLE SIZE CALCULATION^[5]

According to the targeted area the total number of available population is 3488 which comprises of 355 Architects, 2186 Builders, 485 Structural engineers and 462 Contractor. To obtain statistically representative sample size of the population following equation used:

$$n = \frac{m}{1 + \frac{m-1}{N}}$$

Where n,m and N represents the sample size of limited, unlimited and available population respectively. m is calculated by following equation.

$$m = \frac{z^2 * p * (1 - p)}{\epsilon^2}$$

Where z= the statistic value for the confidence level used, i.e.1.96 and 1.645 for 95% and 90% confidence level respectively; p=the value of population that estimated and e= the sampling error to estimated. Because the value of p is unknown Sinichetal. (2002)suggest the value 0.5 to be used in sample size.

$$m = \frac{1.96^2 * 0.5 * (1 - 0.5)}{0.05^2} = 385$$

Here confidence level is taken as 95%.

Now,

$$n = \frac{385}{1 + \frac{385-1}{3488}} = 350$$

This, study approached 60 respondent through various communication medium due to time constraint.

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Table I: Questionnaire Supplied In This Format

Respondents	Surat	Tapi
Architects	9	6
Builders	9	6
Structural engineers	9	6
Contractors	9	6
Total	36	24

Table II: Shows Received Responses

Respondents	Surat	Tapi
Architects	7	5
Builders	7	4
Structural engineers	6	4
Contractors	6	8
Total	26	21

II. RESULT ANALYSIS

A. Consistency Ratio (CR) Values

	R1	R2	R3	R4	R5	R6	R25	R26	R27
Matrix 1: - Criteria's	0.09225633	0.09955651	0.09678218	0.09043773	0.09043773	0.08184882	0.08326363	0.09637811	0.09043773
Matrix 2: - Financial Capabilities	0.09777662	0.09481519	0.10701663	0.09475241	0.09628289	0.09762497	0.08367801	0.10034655	0.09475241
Matrix 3: - Planning	0.09535926	0.09924949	0.0898855	0.09727843	0.08767047	0.09266523	0.0771067	0.08839713	0.09727843
Matrix 4: - Execution	0.09329748	0.0930302	0.08169082	0.09905689	0.10057641	0.09906505	0.09666565	0.09236303	0.09905689
Matrix 5: - Government Policies	0.06066411	0.04789272	0.02018336	0.04789272	0.07602551	0.02018336	0.06872916	0.06103974	0.04789272
Matrix 6: - Technical Capabilities	0.0952381	0.07175926	0.08922284	0.04817156	0.07122182	0.06465343	0.09948102	0.099847	0.04817156
Matrix 7: - False Measures	0.08384992	0.07172252	0.09412239	0.04306479	0.08641975	0.08597884	0.06097292	0.08930153	0.04306479

Fig.1: CR for respondents for Structural Engineer

	R7	R8	R9	R10	R11	R24	R28	R29	R30
Matrix 1: - Criteria's	0.09471941	0.09637811	0.09043773	0.08513878	0.09043773	0.08833803	0.09955651	0.08833803	0.08834012
Matrix 2: - Financial Capabilities	0.10034655	0.10062023	0.08070495	0.09463843	0.08367801	0.09463843	0.09481519	0.09463843	0.09628289
Matrix 3: - Planning	0.08839713	0.09415593	0.09221433	0.07369893	0.0771067	0.07369893	0.09924949	0.07369893	0.08767047
Matrix 4: - Execution	0.09236303	0.08949829	0.09580239	0.08676686	0.09666565	0.08676686	0.0930302	0.08676686	0.10057641
Matrix 5: - Government Policies	0.06103974	0.01778872	0.0598659	0.08725394	0.06872916	0.08725394	0.04789272	0.08725394	0.07602551
Matrix 6: - Technical Capabilities	0.099847	0.08758288	0.07859996	0.09385151	0.09948102	0.09385151	0.07175926	0.09385151	0.07122182
Matrix 7: - False Measures	0.08930153	0.05393321	0.08076132	0.08456823	0.06097292	0.08456823	0.07172252	0.08456823	0.08641975

Fig.2: CR for respondents for Architect

	R12	R13	R18	R19	R21	R22	R23	R31	R32	R33
Matrix 1: - Criteria's	0.08184882	0.08833803	0.09043773	0.08326363	0.09637811	0.09225633	0.08184882	0.08184882	0.09669344	0.08834012
Matrix 2: - Financial Capabilities	0.08070495	0.09628289	0.09475241	0.08367801	0.10034655	0.09777662	0.08070495	0.08070495	0.09762497	0.09628289
Matrix 3: - Planning	0.09221433	0.08767047	0.09727843	0.0771067	0.08839713	0.09535926	0.09221433	0.09221433	0.09266523	0.08767047
Matrix 4: - Execution	0.09580239	0.10057641	0.09905689	0.09666565	0.09236303	0.09329748	0.09580239	0.09580239	0.09906505	0.10057641
Matrix 5: - Government Policies	0.0598659	0.07602551	0.04789272	0.06872916	0.06103974	0.06066411	0.0598659	0.0598659	0.02018336	0.07602551
Matrix 6: - Technical Capabilities	0.07859996	0.07122182	0.04817156	0.09948102	0.099847	0.0952381	0.07859996	0.07859996	0.06465343	0.07122182
Matrix 7: - False Measures	0.08076132	0.08641975	0.04306479	0.06097292	0.08930153	0.08384992	0.08076132	0.08076132	0.08597884	0.08641975

Fig.3: CR for respondents for Builder

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	R14	R15	R16	R17	R20	R34	R35	R36	R37	R38	R39	R40
Matrix 1: - Criteria's	0.08326363	0.09669344	0.08834012	0.08513878	0.08184882	0.08326363	0.08184882	0.08834012	0.09225633	0.09678218	0.08833803	0.08513878
Matrix 2: - Financial Capabilities	0.09463843	0.09481519	0.09628289	0.10062023	0.08070495	0.08367801	0.08070495	0.09628289	0.09777662	0.10701663	0.09463843	0.10062023
Matrix 3: - Planning	0.07369893	0.09924949	0.08767047	0.09415593	0.09221433	0.0771067	0.09221433	0.08767047	0.09535926	0.0898855	0.07369893	0.09415593
Matrix 4: - Execution	0.08676686	0.0930302	0.10057641	0.08949829	0.09580239	0.09666565	0.09580239	0.10057641	0.09329748	0.08169082	0.08676686	0.08949829
Matrix 5: - Government Policies	0.08725394	0.04789272	0.07602551	0.01778872	0.0598659	0.06872916	0.0598659	0.07602551	0.06066411	0.02018336	0.08725394	0.01778872
Matrix 6: - Technical Capabilities	0.09385151	0.07175926	0.07122182	0.08758288	0.07859996	0.09948102	0.07859996	0.07122182	0.0952381	0.08922284	0.09385151	0.08758288
Matrix 7: - False Measures	0.08456823	0.07172252	0.08641975	0.05393321	0.08076132	0.06097292	0.08076132	0.08641975	0.08384992	0.09412239	0.08456823	0.05393321

Fig.4: CR for respondents for Contractor

B. Local Weights And Global Weights

NO	CRITERIA	LOCAL WEIGHT	NO	SUB- CRITERIA	LOCAL WEIGHT	GLOBAL WEIGHT
A	FINANANCE CAPABILITIES	0.156231108	A1	CONSTRUCTION MATERIAL	0.169740183	0.02662
			A2	ADDITIONAL COST	0.127367109	0.01990
			A3	ESTIMATION	0.141346512	0.02208
			A4	FUNDING PROBLEMS	0.09715265	0.01518
			A5	NATURAL CALAMITIES	0.123344143	0.01927
			A6	BANKRUPTCY	0.094633779	0.01478
			A7	INDEMNITIES	0.137608062	0.02150
B	PLANNING	0.155787687	B1	PLANNING	0.16596628	0.026
			B2	FAILURE TO IDENTIFY PROBLEMS	0.149207544	0.023
			B3	ADDITIONAL WORKS	0.128573821	0.020
			B4	SUPPLEMENTART OR ADDITIONA AGREEMENT	0.16275552	0.025
			B5	SUSPENSION OF WORK ORDER	0.128340417	0.020
			B6	AMBIGUITIES OF DOCUMENTS	0.166831894	0.026
C	EXECUTION	0.154634488	C1	QUANTITY ESTIMATE	0.17836436	0.027581281
			C2	SPECIFICATIONS	0.181120107	0.028007415
			C3	CONSTRUCTION MATERIAL	0.163406128	0.025268223
			C4	MISTAKES	0.148403626	0.022948319
			C5	POOR COMMUNICATION	0.103811225	0.016052796
			C6	COMPLEXITIES	0.124220354	0.019208751
D	GOVERNMENT POLICIES	0.121897284	D1	LEGISLATION	0.196938317	0.024006246
			D2	POLICIES	0.340034701	0.041449307
			D3	INCREASE IN EXPENSES	0.308506871	0.03760615
E	TECHNICAL CAPABILITES	0.139542737	E1	INVESTIGATIONS	0.241270211	0.033667506
			E2	DRAWINGS	0.297310326	0.041487497
			E3	CHANGES	0.162636698	0.02269477
			E4	CONTRACTORS	0.190125009	0.026530564
F	FALSE MEASURES	0.134250088	F1	FESTIVALS	0.257753108	0.034603377
			F2	NATURAL CALAMITIES	0.178566089	0.023972513
			F3	STRIKES	0.205701355	0.027615425
			F4	DIEASES	0.222879125	0.029921542

Fig.5: Local & Global weights of all Respondents

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C. As Per Ranking

RANKING OF CRITERIA		
RANK	SUB- CRITERIA	GLOB WEIGHT
1	DRAWINGS	0.0415
2	POLICIES	0.0414
3	INCREASE IN EXPENSES	0.0376
4	FESTIVALS	0.0346
5	INVESTIGATIONS	0.0337
6	DIEASES	0.0299
7	SPECIFICATIONS	0.0280
8	STRIKES	0.0276
9	QUANTITY ESTIMATE	0.0276
10	CONTRACTORS	0.0265
11	CONSTRUCTION MATERIAL	0.0265
12	AMBIGUITIES OF DOCUMENTS	0.0260
13	PLANNING	0.0259
14	SUPPLEMENTART OR ADDITIONA AGREEMENT	0.0254
15	CONSTRUCTION MATERIAL	0.0253
16	LEGISLATION	0.0240
17	NATURAL CALAMITIES	0.0240
18	FAILURE TO IDENTIFY PROBLEMS	0.0232
19	MISTAKES	0.0229
20	CHANGES	0.0227
21	ESTIMATION	0.0221
22	INDEMINTIES	0.0215
23	ADDITIONAL WORKS	0.0200
24	SUSPENSION OF WORK ORDER	0.0200
25	ADDITIONAL COST	0.0199
26	NATURAL CALAMITES	0.0193
27	COMPLEXITIES	0.0192
28	POOR COMMUNICATION	0.0161
29	FUNDING PROBLEMS	0.0152
30	BANKRUPTCY	0.0148

Fig.6: Ranking done through AHP

III. CONCLUSION

The construction industry is complex industry as it has numerous amounts of parameters that all are needed to be managed for the successful completion of the project. Despite of the various project management techniques it was seen that construction industries were facing huge amount of cost overruns. Thus, construction industry needs judicious attention regarding the cost overruns that are occurring in the construction industry. Present approach has certain short comings and it is improved by application of scientific technique. After studied the an ecdotal literature to analyze the short comings of the present approach, **Analytical Hierarchy Process (AHP)** method was selected to find out the crucial causes of cost overruns that are affecting the successful completion of the project. According to the Analytical Hierarchy Process, Development of the Criteria Framework in Indian context was prepared. After analyzing the various causes, amongst which 10 most crucial criteria that are causing cost overruns were:

1. Drawings,
2. Policies,
3. Increase in Expenses,
4. Festivals,
5. Investigation,
6. Diseases,
7. Specifications,

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8. Strikes,
9. Quantity Estimate
10. Contractors

If these crucial factors causing cost overruns are controlled to some extent then overall project cost overruns can be controlled to some extent. The knowledge and significance of cost overruns causes and the way it is affecting construction projects might prove to be beneficial amongst the various stakeholders that have been involved in construction industry.

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