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IMPACT AND ASSESSMENT OF SIX SIGMA ON CONSTRUCTION PROJECT FOR COST OVERRUN

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Abstract. Delays and expense overruns are major obstacles for construction industry in today's competitive market. Cost and time overruns are common in building projects of all kinds, regardless of industry, because of inefficient processes, decreased output, subpar quality standards & specs, & sloppy management. These delays and expense overruns have been the subject of a great deal of study, much of which has offered solutions. The purpose of this study is to examine factors that contribute to building projects taking longer than expected and costing more than expected, and to suggest a plan for reducing these risks in future through use of six sigma & 5S methodology.
Key words: construction estimate, cost overrun, building industry, client and contractor

INTRODUCTION

The construction industry has a significant impact on the economies of most advanced nations. It's a crucial section that provides information for boosting the business. Poor cost management & schedule management have both contributed to a significant decline in building industry's cost increases in recent years. This is rapidly growing into a major problem for the building sector. In both emerging & low-income countries, bad cost overruns contribute to rise in prices.

Concerning this issue, the scholar hopes to pinpoint the root causes of building projects running behind schedule. The benefits of using lean methods like six sigma and 5S in the building business to reduce risk have not been thoroughly studied. Construction quality methods like Six Sigma and 5S, respectively will be used to simplify the situation as much as possible. When applied to the building industry, these tools have potential to improve efficiency, cut down on quality problems, and enhance purchase administration, in order to save time and money.

OBJECTIVES OF STUDY.

- The goal is to examine many contributors to cost overrun and schedule blowouts, highlight their significance, and suggest ways to cut back on them.

- The goal is to use a number of different applications to assess the variables outlined in assessment and the Case Study. This involves determining and analyzing various cost increase criteria from interviewees' point of view.

REVIEW OF LITERATURE

Contractors have been advised to avoid a lack of labor by hiring enough workers, while developers were told to start start planning as quickly as project is granted and construction managers have been told to start overseeing the site immediately. It was recommended that the client side pay the provider on time, limit scope creep, and offer job to most qualified bidder. They requested that consultant carefully examine and accept the designs before distributing them, as well as that expert be adaptable but not skimp on quality. Assaf and Al-Hejji (2006) Cost Overruns relate to the real increase in costs beyond what was initially predicted by the quantity assessor or analyst. Overspending is commonly referred to as "cost increases" or "budget overruns" in the building business. Cost overruns are amount by which final price of an undertaking exceeds its estimated budgeted cost. (Kavuma et al., 2019)5.

To whom it was attributed the discovery of Reasons for budget overruns included increased spending on transportation, alterations to the materials' specifications, price increases for those materials, regular machinery and plant breakdowns, and additional revisions (S. Shanmugapriya, Dr. K. Subramanian 2013) 7 Looked into what causes construction projects to go over budget, and found things like poor planning, construction delays, changes to the project's scope, the late arrival of necessary raw supplies and machinery from contractors, a lack of available resources to deal with unexpected issues, a lack of foreign trade readiness and a lack of timely government decision-making, & inability of certain coordinating bodies to effectively handle the situation. (Sebastian Morris 1990)8.

Looking into the discrepancy between projected & real costs of a public works project. His objective was to compare real costs with budgeted ones. Using a number of approaches, he determined that technological, economic, psychological, & governmental variables all contributed to gap between real cost & expected cost. Based on his analysis, he determined that true cost of any building project would always exceed initial estimates. It's not just a matter of making a mistake when estimating costs, he said; deliberate deception is the more common cause. (Bent Flyvbjerg 2002)4.

We identified the five most influential causes of cost overruns in Vietnam, including owner financial troubles, inadequate site administration & oversight, insufficient project management help, contractor financial hardship, and design modifications. Several researchers (Le-Hoai et al., 2008) 6. We looked into what causes building initiatives in Nigeria to go over budget. Foreign supplies and plant items, extra works, lack of materials, incorrect estimate, selected vendors and freelancers, non-adherence to contractual terms, errors and inconsistencies in contractual terms, redesigns, weather, price volatility, funding and payments of full works, bad contractual manage are main causes of cost overruns. (Omoregie and Radford 2006)1.

Inaccurate or bad cost estimates were the primary contributor to budget overruns. Proper project pricing and funding is most important technique for keeping building costs under control. He came to conclusion that this issue of cost excess was not trivial and might lead to major issues in building business. (Ali.A.S. et al 2010)2.

METHODOLGY

Data has been gathered through in-depth interviews with members of construction sector. The scope of research is as follows:

- It has been determined which initiatives have experienced expense and schedule overruns.
- Detailed examination of all accessible plans, budgets, timetables, and work processes, as well as collection of all pertinent project data.
- The reasons for and effects of cost and time overruns were analysed by comparing projected plans with real performance.
- Used conversations or surveys to investigate what led to the cost overruns.
- Took inventory of all problems and recorded them.
- By conducting a poll of industry's architects, consultants, & contractors, we were able to pinpoint the root causes of time and budget overruns and propose a range of remedies to problems they caused.

FINDINGS OF THE STUDY

The following are some of the more tangible results of instances & survey:

Respondent's profile:

The questionnaires were distributed to owners, project manager, planning engineer, project engineer and site engineer of Indian construction industry. Participants in survey had all worked on a wide range of tasks over the course of their careers. Table1 provides a summary of features of poll respondents.

Parameter	**Percentage (%)**
Type of Designation	
Owners	11.8%
project manager	17.6%
planning engineer	17.6%
project engineer	27.5%
site engineer	25.5%
Type of project	
Residential	31.4%
Commercial	41.1%
Infrastructure	13.7%
Work Experience	
1-3 Yrs.	25.5%

3-5 Yrs.	29.4%
5-10 Yrs.	29.4%
10-15 Yrs.	11.8%

TABLE I. RESPONDENTS DEMOGRAPHICS

Relative Important Index (RII):

Relative Significance Index was used to determine the order in which variables were evaluated.

RII (%) = ∑W / (A*N)

Where:

RII = Relative Important Index

W = Weighting given to each respondent

A = Highest weight

N = Total number of respondents

Parameter	**Nil**	**Low**	**Moderate**	**High**	**Very High**	**Total Responses**		**Relative index (RII)**	**Rank**
Management related									
Availability of Labour & Agency	0	13	30	5	3	51	151	0.59	2
Team Members with Proper Staff	5	17	18	9	2	51	139	0.55	4
Availability of Raw Material	3	18	16	8	6	51	149	0.58	3
Cash flow Management	3	12	20	13	3	51	154	0.60	1
Tools & Equipment Shortage	9	26	14	2	0	51	111	0.44	5
Working Environment related									
Safety Arrangements	5	28	13	3	2	51	122	0.48	2
Working Place	6	14	26	3	2	51	134	0.53	1

Natural Disasters	12	30	7	1	1	51	102	0.40	3
Project related									
Project Duration	1	9	21	17	3	51	165	0.65	1
Delay Of Drawings	10	11	15	13	2	51	139	0.55	4
Design Changes	6	15	13	15	2	51	145	0.57	3
Material Shortages	7	13	22	7	2	51	137	0.54	5
Co-ordination with Subcontractor, Agency and Authorities	6	10	16	14	5	51	155	0.61	2
External factors									
Social Relevant	7	6	21	16	1	51	151	0.59	2
Financial Status of Stakeholders	5	17	18	11	0	51	137	0.54	3
Conceptual / Preliminary Approvals by the Authority	8	10	24	8	1	51	137	0.54	3
Communication among the Owner, Consultant and Contractor	1	16	20	10	4	51	153	0.60	1

TABLE II. RANKING OF CAUSE OF COST OVERRUNS

Ranking of causes of Cost Overruns:

Prioritization of variables was achieved through a hierarchical evaluation of their relative importance. Relative importance index (RII) values were used to evaluate the significance of the results for each response subset. From the responses, the top 8 causes of budget overruns are as follows: Controlling Financial Flows, Availability of Labour & Agency, Working Place, Safety Arrangements, Project Duration, Co-ordination with Subcontractor, Agency and Authorities, Social Relevant. All respondents concurred that market cost for materials should be first (RII = 51).

PROJECT SUMMARY AND CHARACTERISTICS

Table 3 below provides an overview & features of undertaking. Information on business endeavours was compiled. Construction upon business government project, which began on January 23, 2021, is focus of this job description

Name of Project	Developing of Sports Complex with Swimming Pool at Bilimora, India
Total Contract (INR)	8,11,14,288.36
Final Amount (INR)	8,58,47,158.07
Cost Increase (%)	6%
Project Start Date	23 Jan 2021
Project Completion Date	30 Sep 2023

Table III. Project Information

DATA COLLECTED AND DISCUSSION

Site plans, Microsoft Project timelines, minutes from monthly progress monitoring meetings, minutes from meetings with management database, a bill of materials for project, basic information, a list of experts, and a vendor list were all gathered. The summary on the reasons and solutions to schedule delay.

Various Causes of Cost Overrun:

- Governmental, and societal effects, delays, and so on are all examples of project-related variables.
- Contractor associated variables include bad vendors expertise, faulty planning, poor site management, poor implementation of sub-contractor, etc.
- Client comparable element includes sluggish decision making, false contract fulfilment length, delay in reimbursements, etc.
- Unavailability of essential resources is a major cause of the delay
- Having plans and agreements reviewed and approved by a consultant.
- Contractual variables involve delay owing to any discussion and conflicts during

project, information disparity between stakeholder's plan, etc.

- Labour and equipment variables comprise of insufficient labour supply, low output, lack of equipment, failure of equipment at busy hours, etc.
- Contracts component involves misunderstanding, modification orders, discrepancies, etc.
- External factors include things like new legislation, location modifications, temperature, etc.

Reasons Of Cost Overruns:

Description	**Reason for Cost Overruns Reason for**
Data Availability from Client/ Tendering Issues	➢ During the tender, the initial height of the plinth is normal, but during the execution, then after the height of the plinth is modified. ➢ No Drawings Provided for Changing Room. ➢ No Drawings Provided for Electrical Layout
Drawings & Specifications	➢ Late Approval ➢ Revision of IFCs Drawing ➢ Design Errors ➢ Missed co-ordination of Drawing No & approved IFC during Construction
Planning	➢ Wrong Estimate of Time as given by Client ➢ Co-ordination issue between different contractors ➢ Late Time Delivery of Materials ➢ Payment issues
Quality	➢ No proper training before the start of the activity ➢ Checklist not followed ➢ Improper Storage of materials at the site ➢ No SOP for a process
Execution	➢ Labour Shortage ➢ Unskilled Workers ➢ Strikes ➢ Safety Issues

CONCLUSIONS

Recent difficulties encountered by the building sectors are lower-profit margins, rivalry with several parties, finishing of project within specified time and expense that should additionally result in better quality. Due to these previously stated challenges, it is important to adopt building methods that can help in attaining consumer's need with best result in time and with the optimal cost.

The finest building technique can be described by finding underlying causes for an issue of a specific element of a project & subsequently implement the Define, Measure, Analyse, Optimize, Control (DMAIC) cycle of six sigma for problem classification. Issue of cost overruns is pervasive in building business and many types of study have been done in the past,

asserting different causes for the issue. The business seeks to attempt many changes in project progressions itself via numerous methods. For this idea, reliable means of progress had not yet been discovered. In this research, six sigma and 5S were merged with lean methodology to improve overall quality and productivity of a construction job. The purpose of this work is to bridge knowledge gap between implementation of lean techniques such as six sigma and 5S.

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