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A Study on Cost Optimization of Construction Projects by Using Advanced Methods and Materials

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Abstract
Cost Optimization is a continuous process that should be carried out throughout the construction period to ensure that the cost of the project is within an allotted budget. Time and cost are two of the most critical factors in any construction project. Construction cost tends to increase with the project duration. The objective of this study was to find out the factors that contribute to the optimization of construction costs in building construction projects in India. The study was conducted during the period from April 2020 to September 2024. Data were collected through field observation, in-depth interviews, focus group discussions and questionnaire surveys were the major tools for the investigation of this study. The findings were analysed in nine categories: project related factors, design related factors, owner related factors, consultant related factors, contractor related factors, material related factors, labour related factors, equipment related factors, and external factors. The study found some key factors related to time and cost overrun, optimizing cost of construction and the strategies to optimize project costs. The most important strategy to optimize the construction cost are effective cost planning and control, development of proper monitoring and tracking system, sound working environment, recording daily work progress, using time cost trade off, follow plan-do-check-act quality policy, hire skilled labour and effective supervision. The study concludes that constructability and value engineering principles should be adopted in construction projects.

Keywords: Cost Optimization, Cost Performance, Construction Management, Cost Planning, Financial Planning, Cost Control

Introduction

India is a developing country and in the economy of country construction projects and industries play a vital role. Time and cost are two major factors in a construction and they are used for planning a project. This has increased the importance of time and cost optimization in construction projects. It is necessary to estimate the cost and time of each activity through which the whole duration and total cost of the project are determined to complete the planning task. Optimization is a systematic effort made to improve profit margins and obtain the best results under given circumstances or situations. "Cost Optimization can be defined as the achievement of real and permanent reduction in the unit cost of services provided without

damaging their suitability for the in planned use”. There is availability of various techniques for optimization and project control software, still many construction projects do not achieve their cost and time objectives. Optimizing performance of the different techniques adopted at one stage of the construction process may not be beneficial if the methods used are not to up the efficient level. Hence it is required to follow and implement the techniques in every stage of the construction process with the analyses of the information available. The methodology and the type of the used in a construction is also plays very important role for the successful completion of a project many construction project managers and contractors find difficulties like poor planning of project, poor material, labor shortages, increased cost of material, delays in deliveries, wastage of material, over budgeting, unexpected weather changes, lapse in management and control, loss of material, poor communication etc.
This results into cost and time overruns, conflicts in project. So, there is need to study costs included in projects and to identify cost reduction or cost control techniques for carrying construction projects effectively. Reduction of cost of construction is a constant goal for construction industry. One way of reducing construction cost is to develop innovative technologies as well as methodologies to increase productivity. Due to cost reduction techniques cost of project is managed so that contractor does not suffer losses while carrying different activities of the projects.

Need of Optimization

The optimization of time and cost is necessary as it could minimize both the time and total cost of project. This optimization in time and cost helps to achieve the greatest benefit. Cost optimization in construction project involves strategically managing and reducing costs while ensuring that quality, safety, and project timelines are not compromised. This process requires through planning, continuous monitoring, and flexibility. Below are the key steps and strategies involved in optimizing construction costs.

1. Initial Planning and Design Optimization: Detailed project planning, Value engineering, Optimized space utilization.
2. Accurate Budgeting and Cost Estimate: Detailed cost breakdown, Use of historical data, Contingency planning.
3. Effective Procurement Strategies: Competitive bidding, Bulk purchasing, Material substitution, Supplier relationships.
4. Optimize Labour Costs: Efficient workforce management, Use of skilled labour, Modular construction and prefabrication.
5. Technology Integration: Building information modelling (BIM), Construction management software, Drones and automation.
6. Efficient Project Scheduling: Critical path method (CPM), Avoid downtime, Lean construction practices.
7. Material and Equipment Optimization: Just-in-time (JIT) delivery, Reduce waste, Proper equipment utilization.
8. Contract Management: Fixed price contracts, Incentive-based contracts, avoid change orders.
9. Monitor and Control Costs Throughout the Project: Cost tracking, Variance analysis, Regular audits.
10. Risk Management: Identify risks early, Risk contingency funds.
11. Post Construction Analysis: Final cost review, Lessons learned.

Summary of Key Strategies

1. Optimize design with value engineering.
2. Accurate and detailed cost estimation.
3. Smart procurement and material management.
4. Efficient labor utilization and advanced scheduling.
5. Technology integration for better control and decision making.
6. Risk management and contingency planning.

Statement of the Problem

In many construction projects, project managers and contractors find difficulties like poor planning of project, poor material, labor shortages, increased cost of material, delays in deliveries, wastage of material, over budgeting, unexpected weather changes, lapse in management and control, loss of material, poor communication etc. This result into cost and time overruns conflicts in project. So, there is need to study costs included in projects and to identify cost reduction or cost control techniques for carrying construction projects effectively. Reduction of cost of construction is a constant goal for construction industry. One way of reducing construction cost is to develop innovative technologies as well as methodologies to increase productivity. Due to cost reduction techniques, cost of project is managed so that contractor does not suffer losses while carrying different activities of projects. The principal aim of this study is to optimize cost of construction projects.

Aim of Study

India is a country where every family dreams of staying in the house they own. But with the current increase in land costs, construction material prices and labor charges, it is becoming difficult for middle class families to fulfil their dream of living in their own homes. So, I thought of putting forward some conclusion that can be helpful for such families to build the house of their dreams. Reduction of cost of construction is a constant goal for construction industry.

Objective of the Study

1. To study different construction projects with respect to cost and material, this includes residential project, infrastructure project and industrial projects.
2. To minimize total cost of construction projects with respect to different factors (direct, indirect and overhead cost).
3. To study cost reduction methods and advanced materials for construction projects.
4. To compare cost of projects before and after using advanced methods and materials.

Literature Review

Shanmugapriya S., Dr. Subramanian K. (October 2013): Time overruns and Cost overruns has been a major issue in many Indian construction projects. The objective of this paper to study significant factors causing Time overruns and Cost overruns in Indian construction projects. The result accomplished from the survey revealed that the major cause for time overruns are contract modification, material market rate, and high level of quality requirement and the major cause for cost overruns are, change in material specification, high transportation cost, and escalation of materials price.

T. Subramani, P S Sruthi, M. Kavitha (June 2014): This paper highlights on identifying and analyzing the causes of cost overrun in construction. The results carried out from survey showed that, poor contract management, slow decision making, poor schedule management, increase in material/machine prices poor design/ delay in providing design, rework due to wrong work, long period between design and time of bidding/tendering and wrong estimation/ estimation method are the major causes of cost overrun.

Hisham Said, Khaled El-Rayes, (June 2011): The authors suggested new model of construction logistics planning to enable the optimization and integration of critical planning decisions of material procurement and also of the material storage on construction site. To check the capability of CLP model one example was analyzed. After the analysis the results obtained that material procurement decisions are affected by the criticality of construction activities consuming the material, site space available, material procurement and site layout constrains.

Kale R, Gore G. N, Salunke J. P, (January 2014): Main objective of this paper is cost optimization of bridge including the material. As per the authors the optimization is made for the different grade of steel and concrete. for this they applied direct design method for analyzing the structure. The methodology adopted by them is Nonlinear Programming Problem (NLPP) By Using MATLAB Software with SUMT (Sequential Unconstrained minimization technique). Authors found that there is a significant savings in cost overrun.

R. Taur, V. Devi (Oct 2009): The study point out the various aspect of prefabricated building methodology for low housing. For this different prefabrication techniques with their advantage and importance are given by authors. In a building the foundation, walls, doors and windows, floors, roofs are the most important components which can be analyzed individually based on the needs. There is need for improving the speed of construction and reducing the construction cost. The methods of construction systems suggested by authors are as follows prefabricated roofing components like precast RC planks, structural block walls, precast hollow concrete panels, precast concrete/Ferro cement panels, mortar less block walls.

Summary of Literature Review

On reviewing the above literatures, the following points were observed:

1. Time and Cost Trade-off: Studies emphasize the need to incorporate float consumption in time and cost analysis to account for risks associated with non-critical activities, improving the consistency and effectiveness of optimization.
2. Cost Overrun Factors: Inefficient project management, inadequate planning, resource misallocation, and regulatory changes are identified as major contributors to cost overruns.
3. Cost Management Strategies: Traditional methods like budgeting and cost estimation, along with modern approaches like activity-based costing and big data analytics, are discussed for managing expenditures.
4. Life-Cycle Costing: The literature highlights the importance of considering future operation and demolition costs during the initial design phase to make informed decisions and optimize overall project costs.
5. Optimization Techniques: Various mathematical and software-based models are explored for optimizing construction costs, including those that consider different materials and techniques.
6. Resource Allocation: Proper planning and scheduling are crucial for effective resource allocation and smooth project execution, ultimately impacting cost.
7. Advanced Construction Techniques: The use of advanced techniques and materials can significantly reduce construction costs, particularly in residential, infrastructural, and industrial projects.

8. Need for Optimization: Optimization is essential for achieving cost-effectiveness, ensuring quality, maximizing value, and improving profit margins in construction projects.

Methodology

Literature review was first conducted to find factors causing construction project cost overruns. This helped to conduct a survey to find out the causes related to the cost overruns in construction industries in India. Achieving these goals require a research methodology. These are the key stages involved in conducting this study.

- Identifying the problem
- Specifying research objectives
- Specifying research scope
- Data collection
- Literature research
- Questionnaire
- Interaction with contractors
- Collection of feedback / inputs from contractors
- Data analysis
- Results
- Conclusion and Recommendation

Designing and Collecting Data through Questionnaire Survey

The questionnaire (consisting of 45 questions) was designed based on factors identified as majorly added to the causes of cost overrun, the effects of cost overrun and the methods to minimize cost overrun with reference to the literature reviewed and analyzed. A questionnaire survey was adapted towards assessing the insight of contractors and clients of the relative importance of causes and effects of construction cost overrun. Questionnaire survey was conducted as a source of primary data. A cross-sectional survey method was chosen because of the time limitation of this study. Information collected through the literature review was used to generate questionnaire surveys. The survey was conducted by using 'Google form', and this was forwarded to the potential or identified contractors via email or WhatsApp to save time and money, Face-to-face interviews with contractors were also conducted in few cases wherever the contractor was interested to give response and feedback.

Data Collection

We have forwarded the questionnaire to 45 contractors across Karnataka. However, we have received the responses from 35 contractors regarding cost overrun in the work and optimize cost flow in the construction project.

Rating scale

Each questions asked are rated on a scale from strongly agree to strongly disagree, starting with the rating system was given as follows;
Strongly Agree – 5, Agree - 4, Can't say – 3, Disagree – 2, Strongly Disagree – 1

Table 1: Questions asked to Contractor

Q. No	Questions
1	Use of value engineering helps in reducing project cost without affecting quality.
2	Early contractor involvement during design stage reduces cost overruns.
3	Adopting life-cycle cost analysis helps in better cost optimization.
4	Delays in project approval negatively affect cost optimization.
5	Proper risk allocation in contracts reduces unnecessary costs.
6	Use of Building Information Modelling (BIM) improves cost efficiency.
7	Competitive bidding leads to better cost optimization.
8	Poor planning at the design stage increases project cost.
9	Prefabrication and modular construction reduce total project cost.
10	Skilled labour and trained workforce are essential for cost optimization.
11	Cost optimization measures sometimes affect the quality of construction.
12	Transparent communication between stakeholders reduces extra costs.
13	Regular cost audits help in maintaining cost control.
14	Use of sustainable materials leads to long-term cost savings.
15	Delays in payment from clients affect cost optimization strategies.
16	Early risk identification helps in minimizing construction costs.
17	Proper selection of subcontractors reduces project cost and speedup the project completion time.
18	Use of framework contracts helps in cost optimization.
19	Lump-sum contracts promote cost control more effectively than cost-plus contracts.
20	Improper allocation of risks between parties increases project costs.
21	Delay in material supply leads to increase in project costs.
22	Adoption of lean construction methods improves cost efficiency.
23	Skilled labour improves cost optimization compared to unskilled labour.
24	Poor site management increases project costs
25	Regular monitoring of site progress helps in minimizing wastage.
26	Effective safety management reduces hidden costs.
27	Lack of equipment maintenance increases construction costs.
28	Rework due to poor quality control increases overall project costs.
29	Digital technologies reduce cost overruns.
30	Construction automation contributes to cost efficiency.
31	Use of project management software improves budget monitoring.
32	Innovative construction materials reduce lifecycle costs.
33	Lack of awareness about modern tools hinders cost optimization.
34	Client involvement at each stage improves cost control.
35	Poor decision making by client negatively affects cost optimization.
36	Collaboration between contractor, consultant, and client ensures cost efficiency.
37	Regular meetings and reviews help in reducing direct and indirect costs.
38	Conflicts among stakeholders increase project expenditure.
39	Delay in financing from banks affects cost optimization.

40	Fluctuation in material prices impacts project cost significantly.
41	Timely release of money by client reduces cost overruns.
42	Unforeseen taxation changes increase project cost.
43	Delays in approvals from government agencies increase project cost.
44	Clear contract documentation helps in minimizing extra costs.
45	Using recycled materials helps in cost optimization.

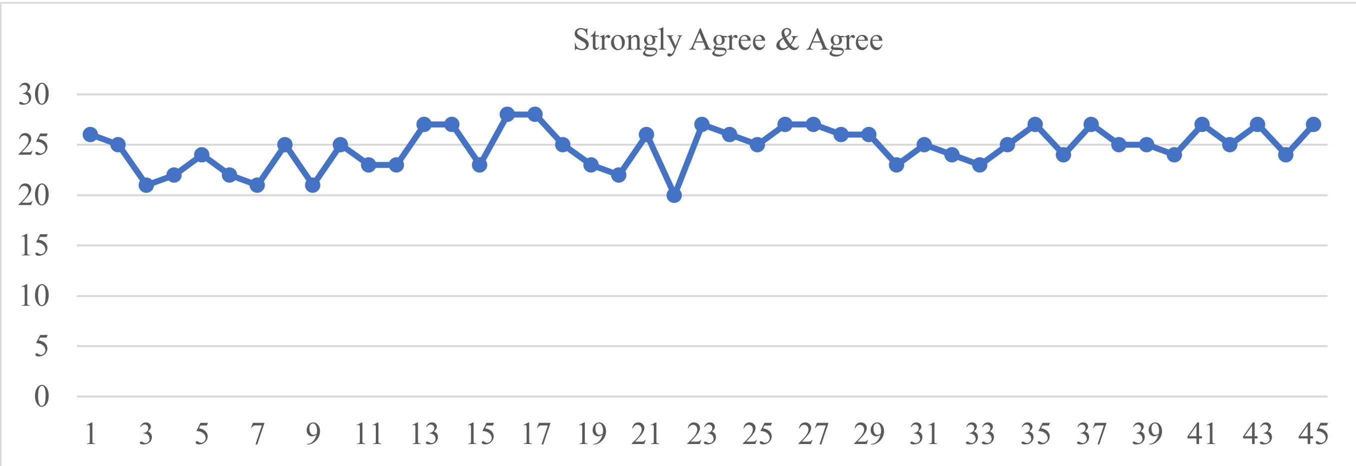
Result and Analysis

Table 2: Result Analysis Chart

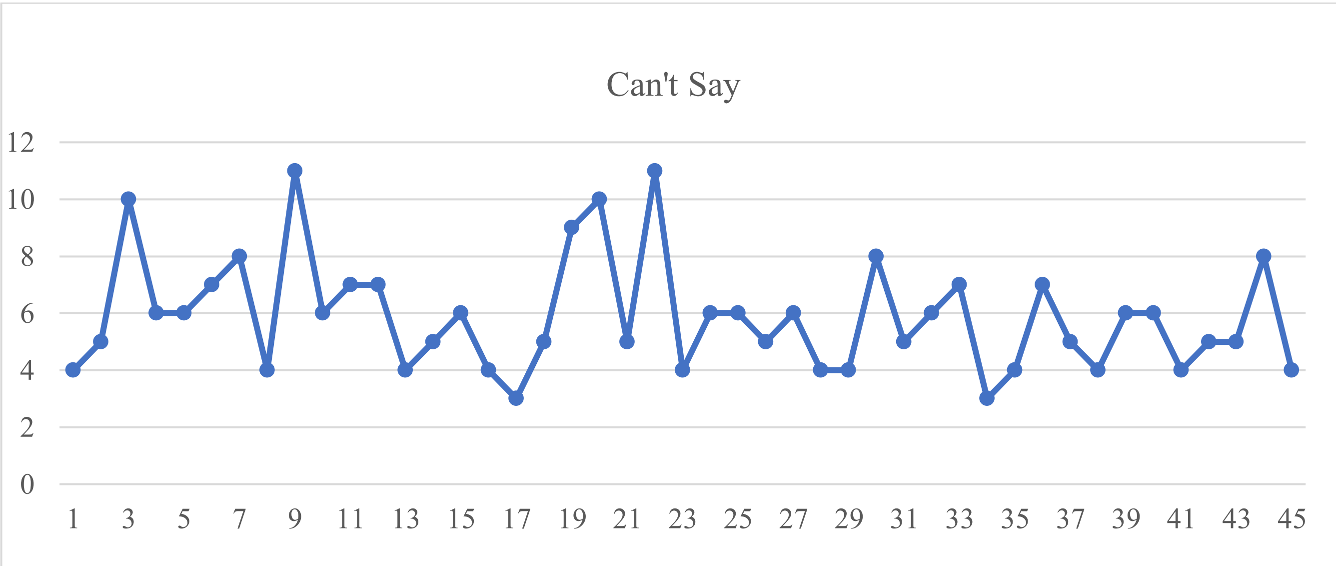
Q. No	Number of Contractors 5 & 4 (Agree)	Number of Contractors 3 (Can't say)	Number of Contractors 2& 1 (Disagree)
1	26	4	5
2	25	5	5
3	21	10	4
4	22	6	7
5	24	6	5
6	22	7	6
7	21	8	6
8	25	4	6
9	21	11	3
10	25	6	4
11	23	7	5
12	23	7	5
13	27	4	4
14	27	5	3
15	23	6	6
16	28	4	3
17	28	3	4
18	25	5	5
19	23	9	3
20	22	10	3
21	26	5	4
22	20	11	4
23	27	4	4
24	26	6	3
25	25	6	4
26	27	5	3
27	27	6	2
28	26	4	5
29	26	4	5
30	23	8	4
31	25	5	5

32	24	6	5
33	23	7	5
34	25	3	6
35	27	4	4
36	24	7	4
37	27	5	3
38	25	4	6
39	25	6	4
40	24	6	5
41	27	4	4
42	25	5	5
43	27	5	3
44	24	8	3
45	27	4	4

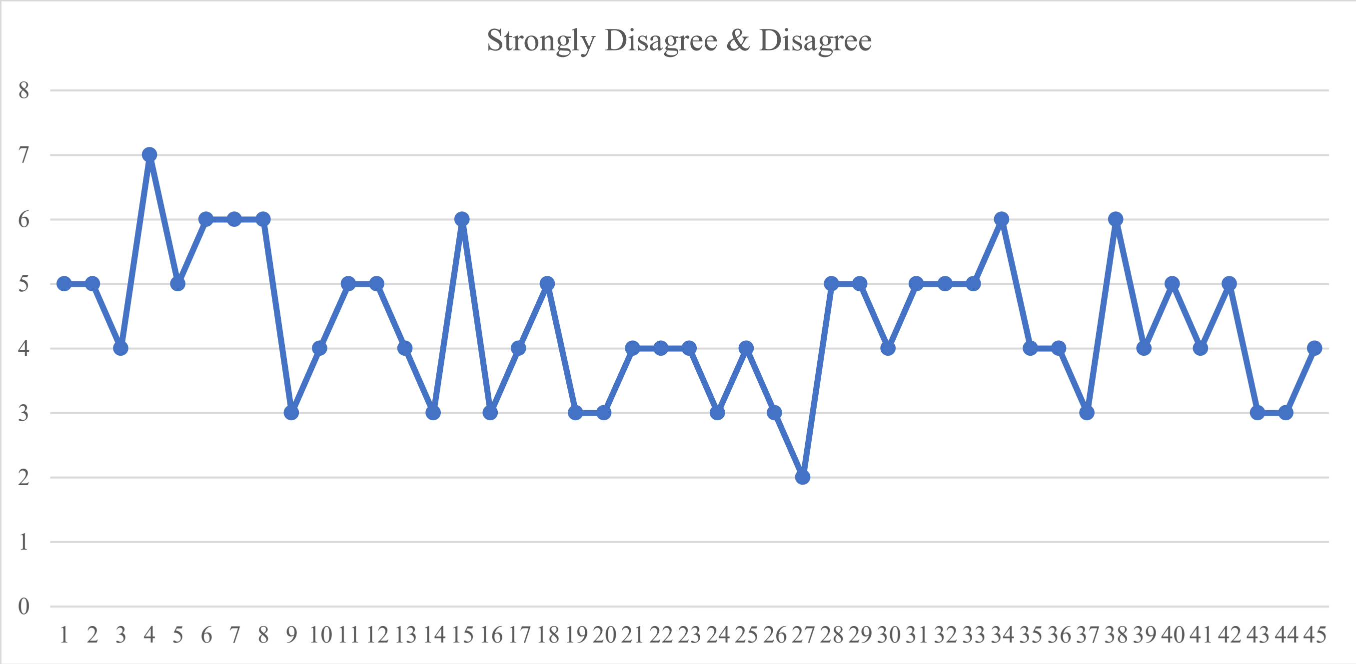
Graph No. 1: Number of Contractors agreed for questions



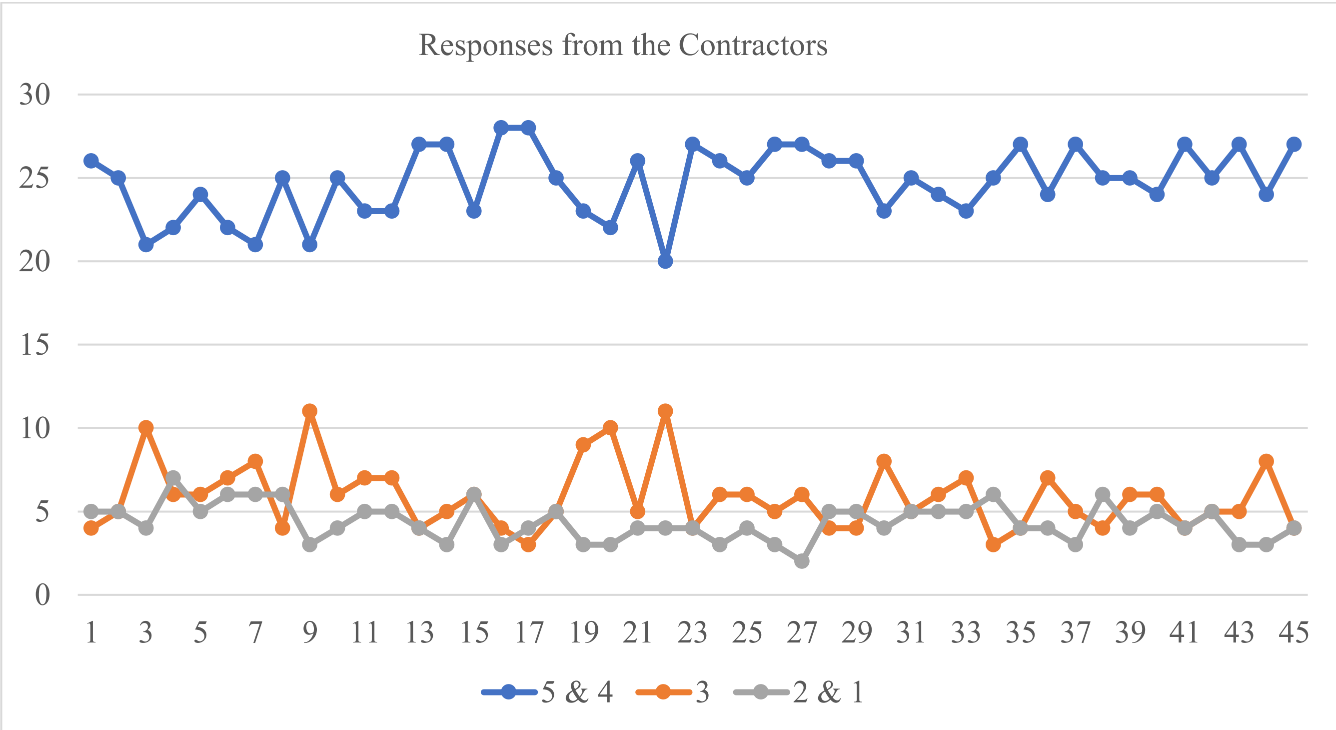
Graph No. 2: Number of Contractors mentioned as can't say



Graph No. 3: Number of Contractors disagreed for the questions



Graph No. 4: Graph showing pattern of agree, disagree and can't say mentioned by Contractors



Conclusion and Recommendation

We have contacted 45 companies out of which 35 are responded. After collecting the data, we have analyzed the outputs received from the contractors. In this project, 5-point indicators were used such as Strongly agree, Agree, can't say, Disagree and Strongly disagree. After going through all the 45 questions related to the cost optimization of construction projects, all the 45 questions were found to be agreed by contractors as per their real situation which was highlighted in this project work and questionnaires. Very few contractors were in dilemma, hence responded "can't say". In this project, in the questionnaires, focus was given to advanced method and materials for cost optimization of the construction projects because, if proper advanced method and environmentally friendly sustainable material are not used then the direct, indirect and overhead cost will increase multiple times which will increase the overall project cost. Also, it may affect the quality of workmanship and quality of construction, which may affect the project duration in addition to cost.

More than 80% of the contractors have agreed for using value engineering early involvement of the contractors, adoption of life cycle cost analysis, risk identification and allocation, use of Building Information Modelling (BIM), good planning and scheduling, prefabrication and modular construction, skilled manpower, clear communication between stakeholders, use of green and sustainable materials, selection of experienced subcontractors, efficient site management, digital and mechanized technologies, construction automation involvement of client and contractor in the design stage, regular review meetings, timely payment of bills, use of recycled materials and drafting and maintaining well written contract documents from inception to completion and handing over of the project.

Below are the key findings of the research work:

- 70% of the contractors have expressed their willingness to use prefabricated structure and modular construction methods to speed up the construction work and reduce the cost.
- 73% of the contractors have said that improper allocation of risk between the parties will increase the project cost.
- 77% of the contractors are willing to adopt automation technology in construction for increasing efficiency and to achieve optimization in time and cost. This intern will solve the problems with shortage of skilled labours and the time and cost involved in the training of unskilled labours. However, adoption of automation technology requires initial investment by the contractor which may not be afforded by small or medium contractors.
- It was also noticed that fluctuation of material prices affects project cost significantly, hence in order to achieve cost optimization, the contractor should make well written contract with material suppliers for the timely delivery of materials at the same cost which was fixed in the beginning itself. At the safe time loan procedure with banks should be arranged in the beginning itself to avoided delay in cash flow.

Recommendations

- Optimization of time and cost is very much necessary to have a better control over the resources (Manpower, Material, Machines, Money and Minute).
- Implementation of the project as per the planning and scheduling prepared before the start of the project is very much important.
- Adoption of life cycle cost analysis, risk identification and allocation is important.
- Building Information Modelling (BIM) tool should be adopted.
- Good planning and scheduling, clear communication between stakeholders, use of green and sustainable materials, selection of experienced subcontractors should be given more focus.
- Involvement of client and contractor in the design stage should be encouraged.
- Regular review meetings should be conducted on every week.

References

1. Shanmugapriya S., Dr. Subramanian K (October 2013) "Investigation of Significant Factors Influencing Time and Cost" International Journal of Emerging Technology and Advanced Engineering.
2. Salunkhe. A, Patil R., (Jan-2014) "Effect of Construction Delays on Project Time Overrun: Indian Scenario" Ijret: International Journal of Research in Engineering and Technology.
3. T Subramani, P S Sruthi, M Kavitha, (June. 2014) "Causes of Cost Overrun in Construction" Iosr Journal of Engineering.
4. Hisham Said, Khaled El-Rayes, (June 2011) "Optimizing Material Procurement and Storage on Construction Sites" Journal of Construction Engineering and Management.