IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Developing the Framework for Cost Optimization Strategy through Time Management And There Technological Approaches with Special Reference to Small – Scale Commercial Project

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Abstract:

Effective time management and cost efficiency are vital issues in small-scale commercial construction projects, particularly in swiftly expanding cities such as Pune. This research analyzes the complex connection between time lags and cost fluctuations, investigating particular methods to reduce delays and improve cost-effectiveness. The research assesses the applicability of various modern and traditional methodologies, including AI, Lean Construction, Six Sigma, BIM, Critical Path Method (CPM), and Program Evaluation and Review Technique (PERT), to small-scale projects through analysis. It underscores the significance of incorporating advanced tools for bigger projects while stressing more straightforward, budget-friendly methods for smaller initiatives. Using case studies and unbiased data, this study establishes a thorough framework that provides stakeholders with actionable advice for reducing costs via efficient time management. The research highlights the importance of a flexible, cohesive optimization approach, focused on achieving prompt project delivery, resource effectiveness, and budget efficiency, thereby offering significant insights to construction project management.

Index Terms -

Cost optimization, Time management, Construction strategies, small- scale commercial project. Time-delay optimization, Adaptive project management strategies.

I. INTRODUCTION

The main aim of the construction industry is to finish projects on schedule and within budget, with effective time control and cost efficiency as critical foundations. India's construction sector, the third-largest driver of economic growth, is quickly expanding because of urbanization, infrastructure advancement, and rising population. Especially in urban areas such as Pune, small-scale commercial ventures frequently encounter difficulties arising from disorganized management techniques, scarce resources, and disregard for contemporary practices. Delays and budget overruns, common in projects, greatly affect stakeholders, highlighting the necessity for efficient time and cost management techniques. Although high-rise projects gain from strong financial and management systems, small-scale projects frequently do not have specialized project managers or organized frameworks, resulting in inefficiencies. Sophisticated tools like Building Information Modelling (BIM) and conventional techniques like Critical Path Method (CPM) emphasize the opportunities for improving project results. This research seeks to tackle these issues by exploring the interconnected dynamics of time and cost, investigating the reasons for delays, and suggesting a detailed framework to improve project schedules and expenses, ensuring quality and safety while boosting overall efficiency.

II. Relevance Study:

This study is important because it addresses the significant issues of time and cost management in small-scale commercial construction projects, which frequently experience delays resulting from inadequate planning, mismanagement of resources, and insufficient professional supervision. Through the use of Lean Construction, Just-in-Time (JIT) delivery, Building Information Modeling (BIM), Critical Path Method (CPM), and Value Stream Mapping (VSM), the study emphasizes methods to maximize resources, minimize waste, and improve schedules. Highlighting organized management, it offers practical insights for enhancing efficiency, reducing expenses, and guaranteeing on-time project completion, fostering sustainable and efficient project management approaches.

III. Aim:

To develop a simple and effective framework for optimizing cost and managing time in small-scale commercial construction projects by addressing delays, resource inefficiencies, and unstructured practices.

IV. Objectives:

- To examine the connection between time delays and cost overruns in minor commercial construction projects.
- To assess the relevance of modern and traditional management approaches.
- To create an all-encompassing system for optimizing costs and managing time.
- To suggest workable and flexible management approaches for minor projects.

V. Research Methodology:

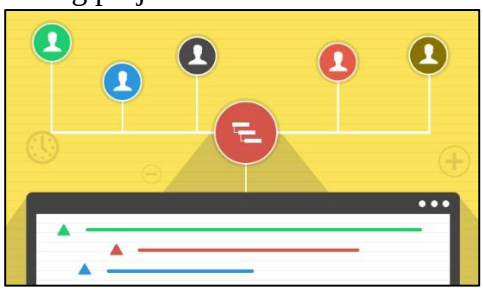
To attain the specified goal. The subsequent methodology has been created. The subsequent steps are taken.

- Background study and problem statement.
- An analysis of the cost reduction approach via time management, focusing specifically on small-scale commercial projects.
- Examine both modern and traditional approaches such as Lean Construction, BIM, AI, Six Sigma, CPM, and PERT to assess their efficiency.
- Leverage insights to create a flexible and cohesive framework for optimizing time and costs specifically for small-scale projects.
- Summary and suggestions.

VI. Project Management Charts

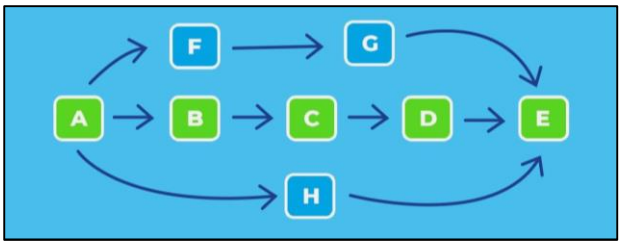
a) Gantt Chart:

The Gantt chart is the most commonly employed tool for managing and controlling projects. It offers a distinct illustration of project timelines, displaying the connections among different tasks and activities along with their coordination with the broader project schedule. A Gantt chart is fundamentally a straightforward bar chart that is simple to comprehend. Tasks are shown on the vertical axis, whereas the horizontal axis indicates the time duration, allowing it to be a useful tool for monitoring progress and handling project timelines.



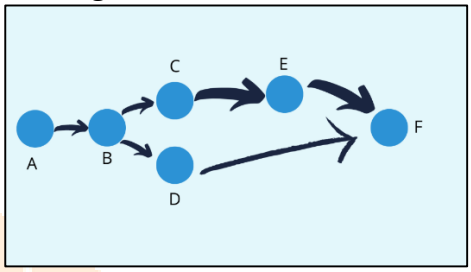
b) Critical Path Method (CPM):

The Critical Path Method (CPM) entails developing a project model that outlines tasks, their timeframes, and relationships. It assists in identifying the longest route to project completion by pinpointing critical tasks along with their start and end times. CPM supports decision-making by emphasizing essential tasks that influence the project timeline and provides quick monitoring, enabling simultaneous execution of tasks on the critical path, thereby shortening the overall project duration. This method is essential for enhancing time and cost efficiency in small-scale projects



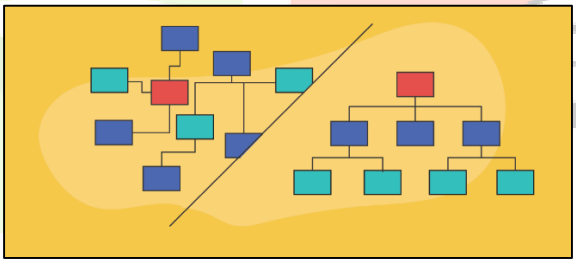
c) PERT CHART:

A PERT chart, or Program Evaluation and Review Technique, is an essential tool for overseeing project activities. It employs circles to depict activities and arrows to indicate progress. PERT charts assist in recognizing essential and non-essential tasks, along with simultaneous activities that can be executed together to accelerate project completion without straining resources. This method is particularly effective in enhancing time and cost efficiency in small-scale projects, fitting seamlessly with strategies for efficient time management and cost reduction.



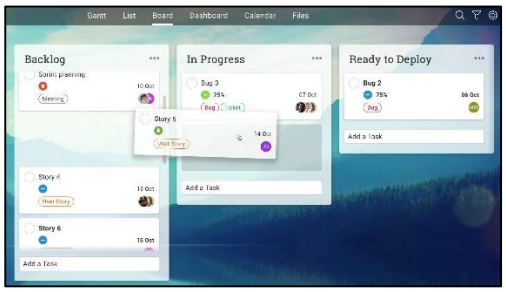
d) WORK BREAKDOWN STRUCTURE (WBS):

A Work Breakdown Structure (WBS) assists in dividing a project into manageable tasks by pinpointing main deliverables and sub-deliverables. This comprehensive task map enables the team to outline work more distinctly, making sure risks and timelines are considered, which assists in budgeting and managing the project. As the project advances, tasks are consistently improved for enhanced clarity. In the realm of cost efficiency and time control for minor projects, a properly organized WBS guarantees effective resource distribution, minimizes risks, and aids in reliable budget predictions.



e) KANBAN:

Kanban is a visual management tool that arranges tasks on a board, optimizing workflow by balancing responsibilities and restricting work in progress (WIP). It highlights ongoing delivery and prioritizes responsibilities, improving teamwork and productivity. By concentrating on top-priority tasks, it guarantees seamless advancement through phases. Utilizing Kanban in your thesis regarding cost optimization and time management for small projects can aid in minimizing inefficiencies and guaranteeing prompt delivery.

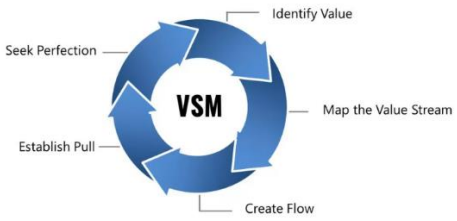


f) LAST PLANNER SYSTEM (LPS):

A lean construction instrument aimed at enhancing planning dependability and minimizing inconsistencies in construction timelines. It entails joint planning with the final planners, the individuals executing the tasks, to develop more reliable and effective project workflows.

g) VALUE STREAM MAPPING (VSM):

A lean-management approach for assessing the present condition and planning a future condition for the sequence of activities that deliver a product or service from its inception to the customer. VSM aids in recognizing non-value-added tasks, removing bottlenecks, and improving workflow effectiveness.



h) JUST-IN-TIME (JIT) DELIVERY:

A strategy for managing inventory that coordinates raw-material orders from suppliers with production timelines. Businesses obtain products solely when required in the manufacturing process, minimizing inventory expenses.

VII. DATA COLLECTION

- **CASE STUDY -1**

OMICRON COMMERZ, a G+8 structure in Pune featuring two basement levels, provides high-quality column-free office spaces that meet global standards. It also includes areas for corporate offices, eateries, cafes, co-working spaces, and retail showrooms. This modest commercial project faced a 320-day delay, with an overall expenditure of ₹2,88,34,934. The distribution of primary expenses encompasses ₹73,22,608.22 for RCC tasks, ₹34,34,650.92 for masonry and plastering, ₹22,07,116.22 for flooring and tiling, and ₹18,21,060.00 for waterproofing, along with other undertakings. The project encountered setbacks caused by various factors, including tough soil conditions while digging, alterations in structural design impacting foundation tasks, shortages of materials (especially steel and cement), and procurement delays reliant on the client. Labor inefficiencies, insufficient training, weather-related interruptions, and ineffective management

practices exacerbated these problems, affecting both the schedule and expenses. Mistakes in equipment operation, quality assurance oversights, and the need for rework intensified delays, especially during final phases such as plaster drying, tile installation, and lintel assembly. Moreover, poorly aligned plumbing and electrical configurations along with design discrepancies caused considerable technical challenges.

To address these challenges, a strong framework that combines Building Information Modelling (BIM) with lean construction principles was utilized. BIM allowed for the early detection and correction of design flaws, enhanced visualization, and promoted resource optimization, while lean construction strategies improved workflows and fostered better coordination among stakeholders. This twofold method emphasized the necessity of careful planning, continuous monitoring, and quality control to tackle inefficiencies, minimize delays, and achieve cost efficiency in small-scale commercial endeavors. This research highlights the importance of incorporating contemporary project management tools and techniques to enhance performance and financial security.

- **CASE STUDY -2**

The building is a G+7 commercial structure located in a densely populated area. The ground and first floors house a shopping complex, while the second to fourth floors feature rented office spaces. The remaining floors are dedicated to a luxurious hostel with 300 rooms, including a terrace floor. Despite its strategic location in a densely populated urban area, the project faced delays of 450 days, with a total cost of ₹6,18,02,925. Key activities contributing to the cost included ₹1,07,39,087.35 for RCC work, ₹40,91,520.12 for masonry and plastering, ₹37,40,229.00 for flooring and tiling, and ₹1,78,72,789.00 for electrical work, among others. Delays were attributed to site-specific challenges such as hard strata during excavation, structural changes affecting foundations, and material shortages exacerbated by reliance on client-supplied steel and cement. Labor inefficiencies, poor training, and weather-related disruptions further slowed progress, particularly during curing, finishing, and tile-laying stages. Inefficient management, delayed design approvals, and inadequate cost monitoring compounded these issues, while errors in plumbing and electrical layouts introduced technical setbacks.

To tackle these challenges, the project utilized the Critical Path Method (CPM) to identify and rank essential tasks, guaranteeing effective resource distribution and compliance with project schedules. Moreover, lean construction methods, such as Value Stream Mapping (VSM), were used to improve workflows, remove non-value-adding tasks, and minimize bottlenecks. These approaches improved material movement, boosted task efficiency, and shortened cycle times.

VIII. FRAMEWORK FOR OPTIMIZATION FOR SMALL SCALE PROJECTS

SR.	Indicators	Attributes	Scope
1	Initial Assessment and Planning	Project Scope Definition	• Clearly define the project objectives, deliverables, and constraints. • Establish the key performance indicators (KPIs) for measuring optimization success.
		Stakeholder Identification	• Identify all stakeholders, including clients, contractors, subcontractors, • Suppliers, and regulatory bodies.
		Feasibility Study and Risk Assessment	• Feasibility Study: Evaluate technical, financial, and operational aspects. • Risk Assessment: Identify risks and develop mitigation strategies.
2	Data Collection And Management	Data Gathering	• Collect Historical Data: Analyse costs, schedules, resources, and outcomes of similar projects. • Gather Real-Time Data: Use sensors, IoT devices, and project management tools.
		Data Management Systems	• Data Management: Use systems to store, process, and analyse data. • Ensure Data Quality: Maintain consistency and accessibility with standardized protocols.
		Data Analytics	• Data Analytics: Use tools to identify trends and insights. • Predictive Analytics: Forecast issues and improve decision-making.
3	Technological Integration	Building Information Modelling (BIM)	• Adopt BIM: Create digital project models for better visualization and coordination. • Use BIM Tools: Perform clash detection, simulation, and process optimization.
		Automation and Robotics	• Automation: Use technology for repetitive, labour-intensive tasks. • Robotics: Enhance precision, reduce errors, and boost efficiency.
		Advanced Project Management Tools	• Utilize project management software with real-time tracking, resource management, and collaboration tools, seamlessly integrated with other systems for efficient information flow.
4	Optimization Techniques	Lean Construction	• Applying lean construction principles, such as just-in-time delivery, prefabrication, and continuous improvement, helps eliminate waste and maximize value in construction projects.
		Optimization Algorithms	• Utilizing optimization algorithms like genetic algorithms, particle swarm optimization, and linear programming can enhance resource allocation, scheduling, and cost management efficiency in construction projects.
		Value Engineering	• Conduct value engineering workshops to identify cost-saving opportunities without compromising quality. • Engage cross-functional teams to brainstorm and evaluate alternative solutions.
5	Implementation	Pilot Projects	• Start with pilot projects to test new optimization techniques and technologies. • Gather feedback and refine approaches based on pilot project outcomes.

	and Monitoring	Training and Capacity Building	• Invest in training programs to enhance workforce skills in using new technologies and techniques. • Foster a culture of continuous learning and improvement.
		Continuous Monitoring and Feedback	• Implement a robust monitoring system to track project progress against KPIs. • Collect and analyse feedback from stakeholders to identify areas for improvement.
6		Risk Mitigation Strategies	• Develop and implement risk mitigation strategies based on the initial risk assessment. • Use scenario planning and contingency planning to prepare for potential disruptions.
	Risk Management and Compliance	Regulatory Compliance	• Ensure adherence to all applicable regulations and standards at every project phase. • Regularly update compliance measures to reflect evolving regulations.
		Post-Project Evaluation	• Evaluate the project post-completion to assess optimization effectiveness. • Document lessons learned and best practices for future reference.
7	Evaluation and Continuous Improvement	Benchmarking and Best Practices	• Compare project outcomes with industry benchmarks to pinpoint strengths and improvements. • Share best practices to foster knowledge transfer and standardization.
		Feedback Loop	• Create a feedback loop to gather insights from completed projects. • Use feedback to refine and enhance the optimization framework.

IX. CONCLUSION:

Small-scale commercial projects frequently neglect the significance of appointing a dedicated project manager or team, resulting in delays and budget overruns. Proper time management, frequent schedule revisions, and project monitoring are crucial to avoid these problems. Project management tools can enhance efficiency by offering centralized data access, allowing real-time monitoring of tasks, and ensuring compliance with schedules. Instruments such as BIM improve collaboration and visualization, whereas lean construction reduces waste and increases value. Adaptive strategies and optimization techniques, although faced with challenges such as elevated costs, intricate implementation, and data quality problems, provide substantial advantages. Effective communication is crucial for preventing delays, and productive meetings with specific agendas and follow-up actions guarantee responsibility. Collaborating with clients early to establish KPIs and milestones promotes project success, and incorporating lessons learned along with best practices enhances results. Tackling human elements, utilizing contemporary technology for data handling, and ensuring risk consciousness are vital for cost optimization and efficient time management in small-scale projects.

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