CHAPTER 104

Planning and PMC for Repair of a Building through MSP

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ABSTRACT

Although the construction sector has adopted software like Microsoft Project and Primavera, these software can be used in the Repair and Rehabilitation sector too. The aim of this study is to plan, schedule and monitor various activities or tasks involved in the repair work of an existing residential building in Mumbai. This study leverages Microsoft Project for creating a detailed Work Breakdown Structure (WBS), Baseline schedule and tracking project progress through Earned Value Analysis (EVA). Key objectives include evaluation of labour productivity, material costs and their coverage, improving time and cost efficiency and developing reusable templates for similar repair projects. The present work bridges the gap in existing studies by integrating EVA into repair contexts and providing structured frameworks for future use. After analyzing all the information gathered, further allocation of time and resources is done. Results of this study reflect that the planning software can prove to be a tool to the site engineers as well as for the project management consultants and contractors in the Repair sector to plan, monitor and control the project. The outcomes emphasize the significance of structured planning, monitoring and application of modern tools for successful project execution.

Keywords: Repair; Microsoft project; WBS; EVA; Project monitoring; Project control.

1.0 Introduction

1.1 Planning and scheduling

Planning and scheduling are critical aspects of construction management that significantly influence the success of a project. Planning ensures that resources such as labor, materials and equipment are available when needed, reducing downtime and preventing bottlenecks. Proper scheduling helps in tracking expenses and managing the budget by anticipating costs and ensuring resources are used efficiently. Effective scheduling helps in setting realistic timelines and milestones, which ensures the project stays on track and meets deadlines. Anticipating potential delays and planning for contingencies helps mitigate risks and keeps the project timeline intact.

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Planning includes setting quality benchmarks and ensuring that the work meets these standards throughout the construction process. Regular inspections can be planned and scheduled to ensure ongoing quality control and adherence to specifications. Comprehensive planning involves identifying potential risks and developing strategies to mitigate them, reducing the likelihood of project disruptions. Scheduling allows for the integration of contingency plans to handle unexpected issues without significant impact on the overall project timeline. Detailed schedules facilitate better communication and coordination among various stakeholders, including contractors, subcontractors, suppliers and clients. Regular updates to the schedule allow for clear tracking of progress, helping all parties stay informed and aligned. Planning includes ensuring that all necessary permits are obtained and that inspections are scheduled at appropriate times, ensuring compliance with local regulations. Proper scheduling ensures tasks are sequenced efficiently, reducing idle time and increasing productivity on site. Identifying and optimizing critical paths and workflows can significantly enhance the efficiency of the construction process. Clear planning and scheduling help set realistic expectations with clients regarding project timelines and deliverables. Regular updates and adherence to the schedule provide transparency, building trust and satisfaction with the client.

1.2 Tracking and monitoring

EVA is a project management technique used to measure the performance and progress of construction projects. It integrates project scope, time and cost to provide a clear view of project health. By comparing the planned work with the actual work completed and the costs incurred, EVA helps in determining whether a project is on track, behind schedule, or over budget. This method allows project managers to forecast future performance and make informed decisions to keep the project aligned with its objectives. In construction, EVA is especially useful due to the complexity and scale of projects, ensuring efficient resource allocation and control. Earned Value Analysis (EVA) can be highly beneficial in the repair and rehabilitation work of an existing residential building by providing a structured way to monitor progress, control costs and manage timelines.

Monitoring Project Progress: In repair and rehabilitation work, unforeseen issues like structural damages or out-dated systems can delay progress. EVA allows project managers to track how much work has been completed compared to the original plan. By comparing “earned value” (the value of completed work) with “planned value” (what should have been completed by that time), managers can see if the project is on schedule or falling behind. Repair and rehabilitation projects often face budget overruns due to unexpected costs, like hidden damage or additional materials. EVA helps by comparing the actual cost of work performed (“actual cost”) with the value of work completed (“earned value”). If the project is over budget, this discrepancy will be highlighted early, allowing for corrective actions before costs spiral out of control. EVA gives insight into whether the resources (labor, materials, etc.) are being used effectively. If the analysis shows poor performance indices, managers can adjust resource

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allocation, redistribute tasks, or optimize workflows to ensure efficiency. Time is critical in repair work, especially when residents may need to move back in. The Schedule Performance Index (SPI) provided by EVA helps determine if the project is behind schedule. If the SPI is below ONE, it signals delays and managers can re-evaluate timelines, increase manpower, or re-prioritize tasks to bring the project back on track. EVA allows project managers to predict the future performance of the project, such as the estimated final cost and completion date, based on current trends. This is particularly useful in rehabilitation projects where conditions can change as the work progresses, enabling better planning and adjustments. In summary, EVA helps maintain control over time, budget and resources, ensuring that repair and rehabilitation work stays aligned with project goals and is completed efficiently.

2.0 Literature Review

Poor-quality materials and lack of skilled labor affect maintenance, while waterproofing and modern materials like polyurethane improve durability (Hussain *et al.*, 2024). Primavera P6 enhanced project duration by ensuring systematic prioritization and tracking (Harshavardhan *et al.*, 2023). Safety and health are top priorities, with Breakdown Maintenance (BM) and Corrective Maintenance (CM) being the most effective strategies (Kheradranjbar *et al.*, 2022). Earned Value Management (EVM) improved real-time performance assessment and project corrections (Hasan *et al.*, 2021). Seismic retrofitting using CFRP sheets and reinforced concrete jacketing enhances structural safety (Wang *et al.*, 2021). COVID-19-related delays led to cost overruns, with improved scheduling and automation recommended as solutions (Sasane *et al.*, 2020). A data-driven model for estimating repair schedules achieved a 97% accuracy rate (Park *et al.*, 2019). Microsoft Project optimized scheduling, resource management and cost estimation (Gauns *et al.*, 2019). Preventive and condition-based maintenance reduce long-term costs and extend building life (Mandlik *et al.*, 2019). Visual inspection and non-destructive testing revealed poor concrete quality and corrosion, leading to recommendations such as epoxy grouting (Bhoir *et al.*, 2019). Mobile apps improve maintenance efficiency by reducing repair times and enhancing service accessibility (Singh *et al.*, 2020).

Effective planning minimizes project delays and cost overruns (Sudha *et al.*, 2020). The Analytical Hierarchy Process (AHP) helps prioritize rehabilitation, with 92% of building components requiring some form of repair (Nowogonska, 2020). Poor planning resulted in a ₹6.7 million cost overrun, but Microsoft Project helped improve tracking (Pathak *et al.*, 2015). Strengthening timber and masonry elements while preserving architectural integrity is a key focus in rehabilitation (Kaptan, 2015). Structural audits using NDTs are essential, with rehabilitation involving crack repair, corrosion protection and seismic upgrades (SS Chandar, 2014). Structural issues due to poor-quality materials and corrosion were resolved using polymer-modified mortar and jacketing (Singh, 2012). Cracks caused by design flaws, moisture and poor materials can be addressed through epoxy injection and sealing (More *et al.*, 2017).

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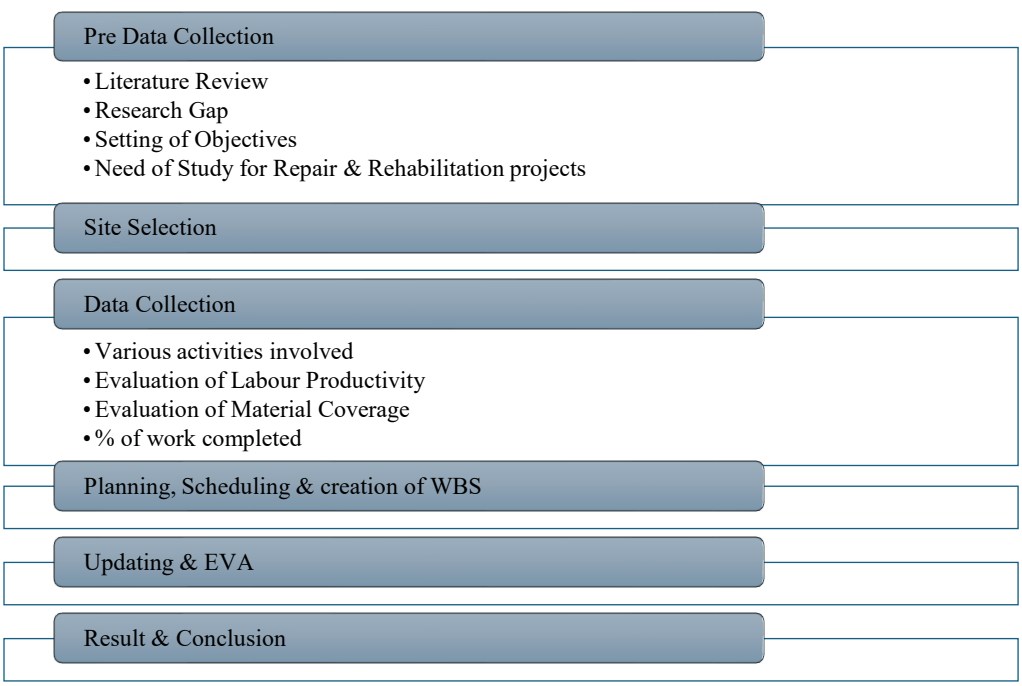
BIM enhances maintenance management, cost efficiency and long-term planning (Omar *et al.*, 2018). In the present work repair of two multi-storeyed buildings is chosen for Project Monitoring.

3.0 Methodology

The methodology of this study follows a structured approach to ensure effective planning, scheduling, and monitoring of repair and rehabilitation work at Pearl Heights and Saidham CHSL. The process begins with Pre-Data Collection, which involves selecting the topic, conducting a literature review, identifying the research gap, setting objectives, and establishing the need for the study. Site Selection focuses on identifying the residential buildings where the study is conducted. Data Collection involves analyzing various activities, preparing the Bill of Quantities (BOQ), identifying materials and their coverage, and assessing the percentage of work completed. The next phase, Planning, Scheduling, and Creation of WBS, involves structuring the project activities using Work Breakdown Structure (WBS) and scheduling them in Microsoft Project (MSP). Updating & Earned Value Analysis (EVA) is carried out after milestone completion to evaluate project performance in terms of cost and schedule. Finally, the study concludes with a Result & Conclusion, summarizing key findings and providing insights for improving future repair projects.

Figure 1: Methodology Flowchart



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4.0 Site Selection

The study focuses on two residential buildings, Pearl Heights and Saidham CHSL, selected based on their structural conditions and the need for rehabilitation. Pearl Heights, located at Andheri West, Mumbai and Saidham CHSL, situated at Kandivali West, Mumbai, were chosen due to visible signs of structural deterioration caused by aging, environmental exposure and load-induced stress. These sites provide a practical setting for analyzing real-world challenges in structural repairs and rehabilitation. The selection was also influenced by accessibility and feasibility for implementing scheduling techniques using Microsoft Project (MSP).

5.0 Data Collection and Analysis

The data collection process for this study involved a detailed assessment of the selected residential buildings, Pearl Heights and Saidham CHSL, focusing on their structural conditions, repair needs and scheduling requirements. Site inspections were gathered to ensure a comprehensive understanding of the rehabilitation scope. A Work Breakdown Structure (WBS) was developed to systematically organize the project activities and streamline scheduling using Microsoft Project (MSP).

5.1 Repair activities

The WBS for the rehabilitation project includes the following key activities:

- *Erection of scaffolding:* Setting up scaffolding for safe access to external surfaces.
- *Tap testing:* Identifying weak plaster areas through sound-based testing.
- *Breaking of loose plaster:* Removing deteriorated plaster to prepare the surface for treatment.
- *Polymer treatment:* Applying polymer-based bonding agents to enhance durability.
- *Plastering:* Reapplying cement plaster to restore the building's surface.
- *Grill painting:* Coating metal grills with protective paint to prevent corrosion.
- *Painting (Exterior):* Applying weather-resistant paint to the external façade.
- *Removal of scaffolding:* Dismantling scaffolding after exterior work completion.
- *Internal painting:* Repainting interior surfaces to improve aesthetics.
- *Tremix concrete flooring:* Repairing or replacing damaged flooring using Tremix concrete technology.

Further, a detailed breakdown of all these key activities was carried out to establish a baseline schedule. This breakdown included identifying dependencies, estimating task durations, allocating resources and defining critical milestones. The baseline schedule serves as a reference for monitoring progress, comparing planned versus actual timelines and ensuring timely project

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completion. By structuring the rehabilitation process systematically, this study aims to enhance scheduling accuracy, optimize resource utilization and improve project efficiency.

5.2 Evaluation of labour productivity

The aim of the project was to evaluate labor productivity and the coverage of different materials used in repair activities at the selected sites. A systematic assessment was conducted by tracking labor efficiency, task durations and material consumption across various repair activities such as plastering, polymer treatment, painting and flooring. Data was collected through on-site observations, work logs and productivity measurements, ensuring accuracy in performance evaluation. Table 1 shows labour productivity which was evaluated by analyzing observations from two different project sites before applying the findings to the current repair and rehabilitation work. These past site observations helped in understanding key factors affecting productivity, such as scattered work locations, labour mismanagement, and delays in material supply. By comparing planned versus actual work progress at these sites, patterns of inefficiencies were identified. The insights gained from these evaluations were later used to optimize workforce planning, improve scheduling, and enhance overall labour efficiency in the ongoing projects.

Table 1: Evaluation of Labour Productivity

Activity	Productivity
Breaking of loose plaster	80 to 90 sq.ft/Labour/Day
Polymer work	60 to 70 sq.ft/Labour/Day
Dash Coat	80 to 90 sq.ft/Labour/Day
Plastering work	80 to 90 sq.ft/Labour/Day
Painting work	1400 to 1600 sq.ft/Labour/Day
Base coat	1800 sq.ft/Labour/Day
MS grill painting	7 to 8 litres/Labour/Day
Scaffolding erection	40 Bamboos/Labour/Day

5.3 Evaluation of material coverage

Table 2 shows material coverage which was identified by collecting data from various contractors and engineers who had experience in similar repair and rehabilitation projects. Their insights helped in understanding material consumption patterns, estimating coverage efficiency, and identifying common issues such as wastage, procurement delays, and improper allocation. By analyzing this data, key inefficiencies were addressed, leading to better material planning and optimized resource utilization in the ongoing projects. This approach ensured that materials were used effectively, reducing waste and improving overall project cost efficiency.

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Table 2: Evaluation of Material Coverage

Material	Coverage
Rust remover	75 sq.ft/Ltr
Rust converter	75 sq.ft/Ltr
Polyalk EP	80 sq.ft/Ltr
Readymix polymer	15 sq.ft/Bag
HackAid plast	60 sq.ft/Ltr
Readymix Plaster (2 coats)	9 to 10 sq.ft/Bag
China Chips	8 sq.ft/Box
WP chemical	55 sq.ft/Ltr
Bamboo (1000 No.s)	32 to 35 sq.ft
Base coat	950 sq.ft/Drum
Top coat	1250 sq.ft/Drum
Zinc primer	180 sq.ft/Ltr
Oil paint	185 to 225 sq.ft/Ltr
Primer	2000 sq.ft/Drum
Crack X paste	90 to 92 sq.ft/kg
Crack X powder	120 to 125 sq.ft/kg
Damp proof	200 sq.ft/Drum
Tile primer	150 q.ft/Ltr

6.0 Planning, Scheduling and Creation of WBS

After scheduling the rehabilitation activities for Pearl Heights and Saidham CHSL using Microsoft Project (MSP), the baseline cost and baseline duration were determined for each site. The baseline cost represents the estimated financial requirement for completing the project as per the planned schedule, while the baseline duration indicates the total time expected for project completion. For Saidham CHSL, the baseline cost was calculated as ₹5,114,384.73, with a baseline duration of 119 days. Similarly, for Pearl Heights, the baseline cost was determined to be ₹9,024,411, with a baseline duration of 222 days. These baseline values serve as reference points for tracking project progress, comparing actual versus planned costs and durations and ensuring that the rehabilitation activities remain on schedule and within budget. Regular monitoring against these baselines allows for timely adjustments in resource allocation and project execution strategies, enhancing overall efficiency and control.

7.0 Updating and EVA

After completing the first milestone of both projects, an Earned Value Analysis (EVA) was conducted to evaluate project performance in terms of schedule and cost efficiency. The

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analysis revealed distinct trends for Pearl Heights and Saidham CHSL. As shown in Figure 2 For Pearl Heights, the Schedule Variance (SV) and Cost Variance (CV) were both negative, indicating that the project is behind schedule and over budget.

Figure 2: Variance Over Time (Saidham CHSL)

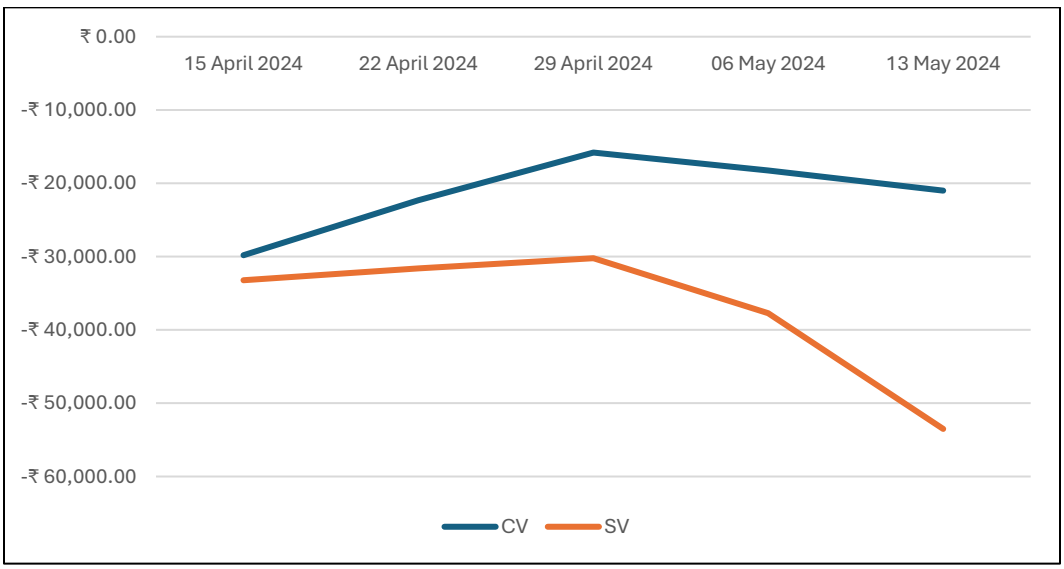

Figure 3: Variance Over Time (Pearl Heights)

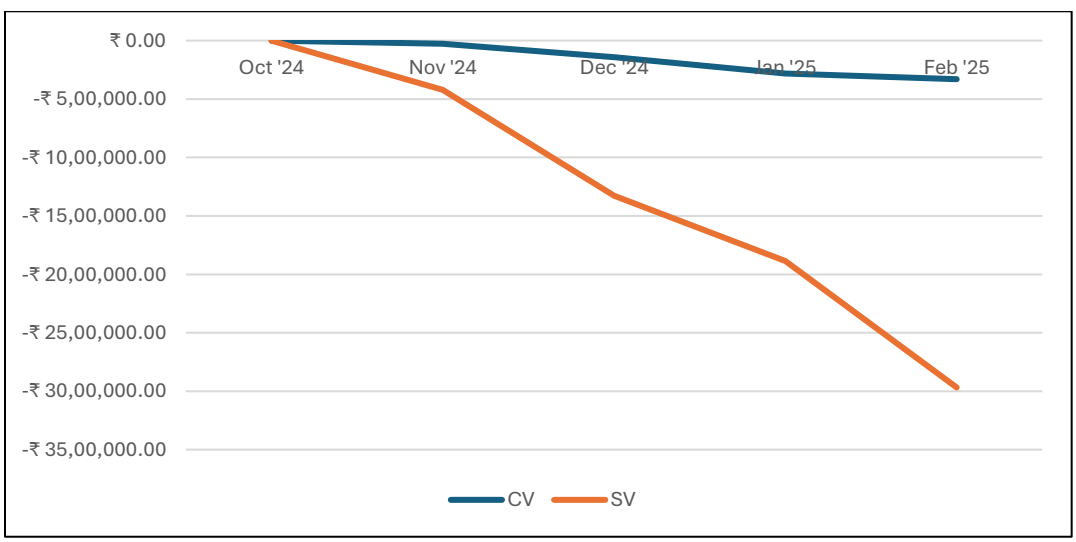

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Figure 4: Earned Value Over Time (Saidham CHSL)

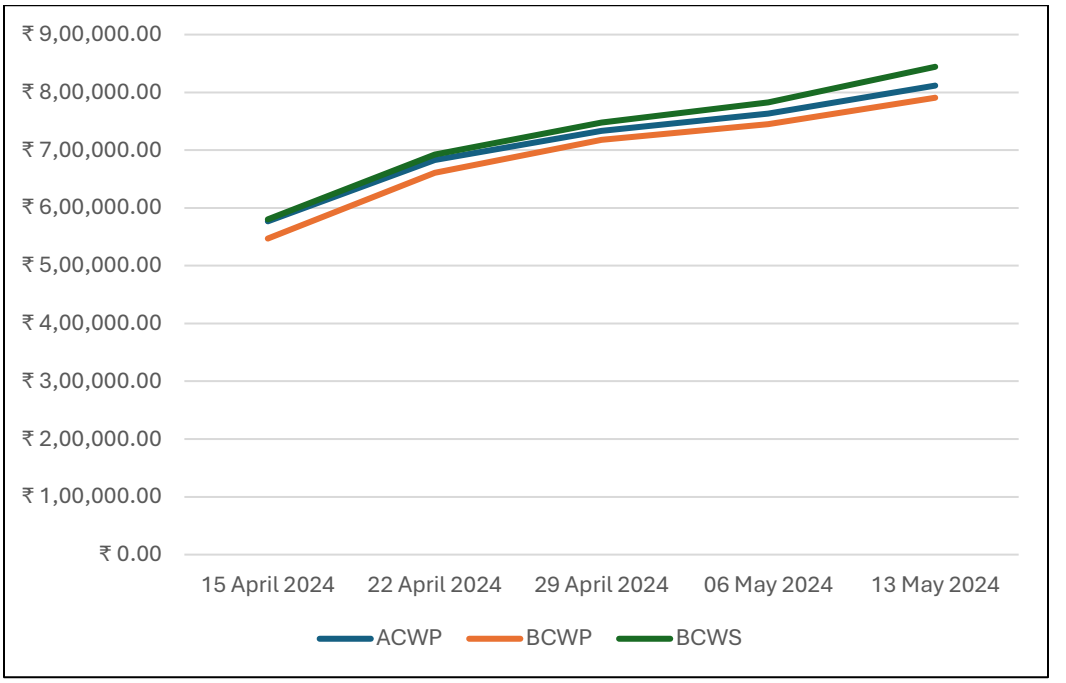

Figure 6: Earned Value Over Time (Pearl Heights)

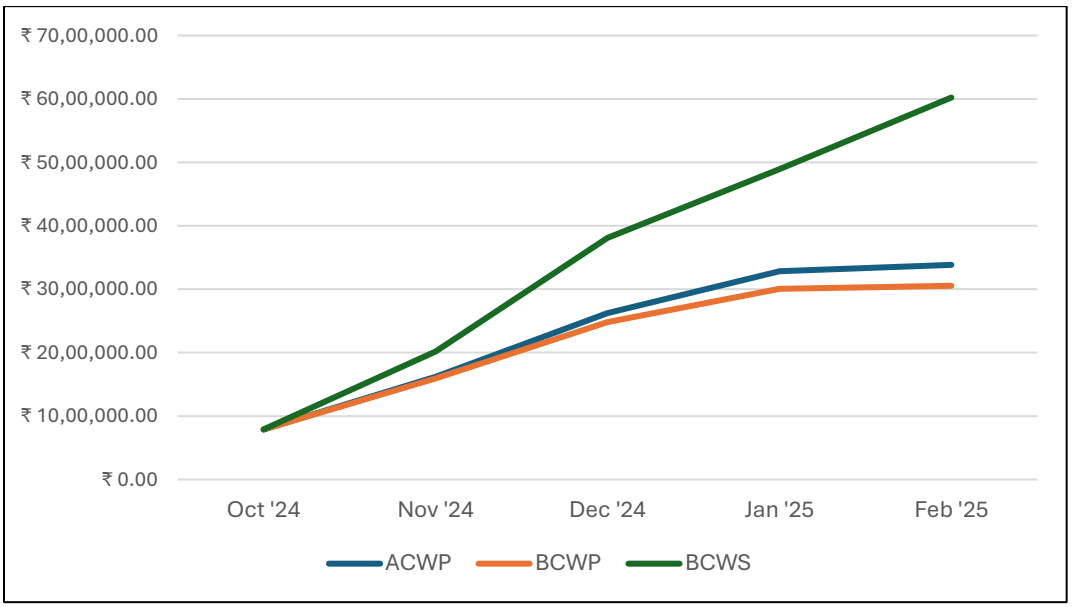

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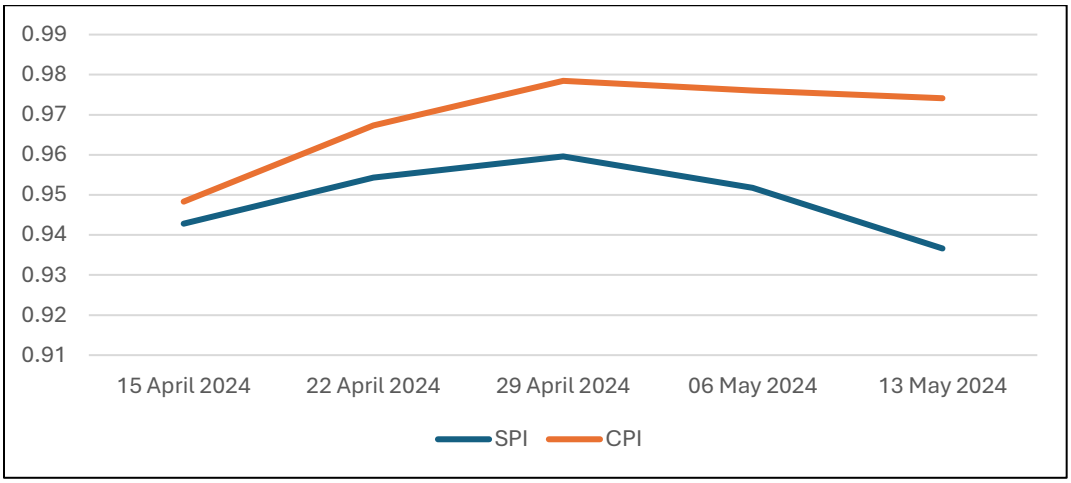
Figure 7: Indices Over Time (Saidham CHSL)



Additionally, the Variance at Completion (VAC) was also negative, suggesting that the project is expected to exceed its planned budget by the time of completion. In contrast, as shown in Figure 3 for Saidham CHSL, the SV was negative, implying a delay in progress, but the CV was positive, meaning the project is currently under budget. Furthermore, the VAC for Saidham CHSL was positive, indicating that the project is expected to be completed within the allocated budget. These findings highlight the need for corrective actions at Pearl Heights to mitigate cost overruns and delays, while for Saidham CHSL, efforts should focus on improving scheduling efficiency to bring the project back on track.

Figure 8: Indices Over Time (Pearl Heights)

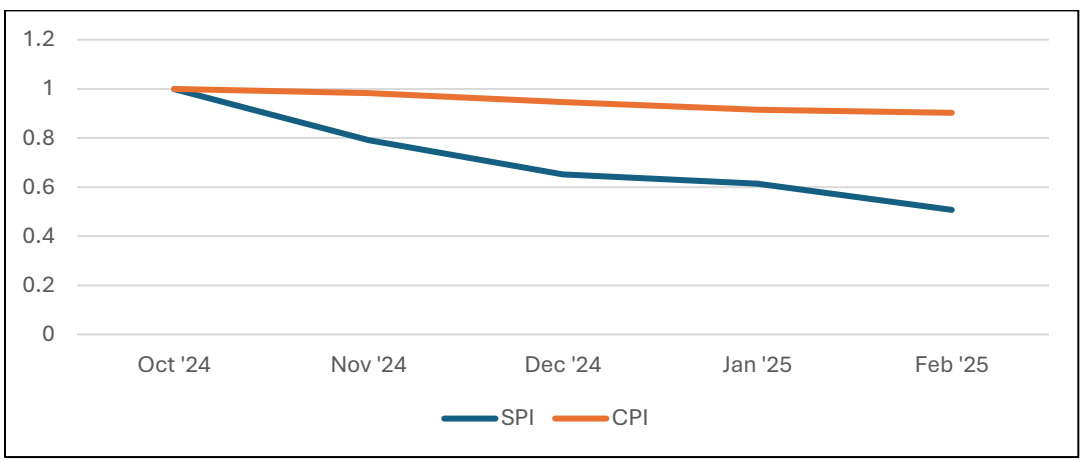


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Figure 7 & Figure 8 shows Indices Over Time for Saidham CHSL & Pearl Heights respectively. Figure 5 & Figure 6 shows Earned Value over time for Saidham CHSL & Pearl Heights respectively. Table 3 presents key Earned Value performance metrics calculated based on project cost and schedule data. These values, derived using standard EVM formulas, provide insights into cost and schedule variances, efficiency indices and future performance expectations. Table 4 presents Earned Value Performance Metrics for two projects, Saidham CHSL and Pearl Heights, detailing key cost and schedule performance indicators, including Actual Cost of Work Performed (ACWP), Budgeted Cost of Work Performed (BCWP), Budgeted Cost of Work Scheduled (BCWS), and Budget at Completion (BAC). These metrics provide insights into project efficiency, cost control, and schedule adherence.

Table 3: Earned Value Performance Indicators

Metric	Saidham CHSL	Pearl Heights	Interpretation
Cost Variance (CV)	₹18,586.12 (Positive)	-₹224,945.04 (Negative)	Saidham CHSL is under budget; Pearl Heights is over budget.
Cost Variance % (CV%)	2.27%	-7.37%	A positive CV% means cost efficiency; Pearl Heights is over budget by 7.37%.
Schedule Variance (SV)	-₹124,069.35 (Negative)	-₹2,968,176.29 (Negative)	Both projects are behind schedule, Pearl Heights significantly more.
Schedule Variance % (SV%)	-13.16%	-49.29%	Saidham CHSL is 13.16% behind schedule; Pearl Heights is almost 50% delayed.
Cost Performance Index (CPI)	1.02 (>1, Efficient)	0.93 (<1, Over Budget)	Saidham CHSL is cost-efficient; Pearl Heights is over budget.
Schedule Performance Index (SPI)	0.87 (<1, Delayed)	0.51 (<1, Severely Delayed)	Both projects are behind schedule, Pearl Heights critically.
To-Complete Performance Index (TCPI)	1.02 (On track)	1.11 (Requires higher efficiency)	Pearl Heights needs much better cost control.
Variance at Completion (VAC)	₹46,352.79 (Positive)	-₹725,188.21 (Negative)	Saidham CHSL is expected to complete under budget, while Pearl Heights will exceed budget.
Estimate at Completion (EAC)	₹4,849,625.94	₹9,749,599.21	Expected total cost at completion.
Estimate to Complete (ETC)	₹4,049,588.58	₹6,470,911.46	Additional cost required to complete the project.
Delay in project	0 days (but lagging in work progress)	7 days delay	Pearl Heights has a delay of 7 days.

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Table 4: Earned Value Performance Metrics

Project	ACWP	BCWP	BCWS	BAC
Saidham CHSL	₹800,037.36	₹818,623.48	₹942,692.83	₹4,895,978.73
Pearl Heights	₹3,278,687.75	₹3,053,742.71	₹6,021,919.00	₹9,024,411.00

8.0 Result

- Saidham CHSL is under budget; Pearl Heights is over budget.
- A positive CV% means cost efficiency; Pearl Heights is over budget by 7.37%.
- Both projects are behind schedule, Pearl Heights significantly more.
- Saidham CHSL is 13.16% behind schedule; Pearl Heights is almost 50% delayed.
- Saidham CHSL is cost-efficient; Pearl Heights is over budget.
- Both projects are behind schedule, Pearl Heights critically.
- Pearl Heights needs much better cost control.
- Saidham CHSL is expected to complete under budget, while Pearl Heights will exceed budget.
- Expected total cost at completion.
- Additional cost required to complete the project.
- Pearl Heights has a delay of 7 days.

9.0 Causes of Delay

The reasons for Delays caused which were observed during the execution are as under:

- *Society decisions:* Decision-making delays by the housing society significantly impacted project timelines. Frequent discussions, approvals and changes in work scope led to interruptions in the planned schedule. The lack of quick consensus among society members caused further delays in mobilizing resources and executing tasks on time.
- *Work spread across multiple small patches, reducing labour productivity:* The repair work was not concentrated in a single area but was spread across multiple small patches. This scattered nature of work made it difficult to maintain a steady workflow, as labourers had to frequently move between different locations. As a result, there was a significant drop in productivity, leading to delays in project execution.
- *Labour mismanagement:* Inefficient allocation and supervision of labour contributed to productivity losses. Lack of proper coordination among workers and frequent idle time caused delays in task execution. Poor scheduling of shifts and improper workforce distribution further aggravated the issue.
- *Delays in material supply:* Timely availability of materials is crucial for maintaining workflow, but procurement delays disrupted progress. Vendor-related issues, supply chain

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constraints and late approvals for material procurement resulted in work stoppages. These interruptions forced rescheduling of activities, leading to overall project delays.

- *Non-cooperative behaviour by residents:* Resistance from residents created multiple roadblocks in project execution. Complaints about noise, inconvenience and restricted access to certain areas led to work stoppages and rescheduling of tasks. Some residents refused to cooperate with site teams, delaying critical activities that required access to specific building sections.
- *Delays due to equipment shifting:* The use of the same equipment at multiple sites caused frequent shifting delays. Since certain essential equipment was required at different locations, its movement had to be coordinated carefully. However, logistical challenges and scheduling conflicts led to delays in execution, affecting overall project timelines.
- *Consultants misleading:* Incorrect or unclear instructions from consultants led to execution errors and rework. Misinterpretation of project requirements, last-minute changes and poor coordination between consultants and contractors resulted in confusion and delays. In some cases, additional approvals were required due to conflicting guidelines, further affecting project timelines.

10.0 Conclusion and Recommendations

The study successfully analyzed the planning, scheduling and execution of repair and rehabilitation work at Pearl Heights and Saidham CHSL. Using Microsoft Project (MSP), a structured Work Breakdown Structure (WBS) was developed and baseline schedules were established for both sites. Earned Value Analysis (EVA) revealed delays and cost variations, highlighting key project challenges such as society decision-making delays, labour mismanagement, equipment shifting issues and material supply disruptions. Based on these findings, a standardized planning and scheduling template was developed to improve efficiency in similar future projects. The study emphasizes the importance of proactive planning, efficient resource management and continuous monitoring to minimize project delays and cost overruns. After analyzing and studying the project results, following are the recommendations made to tackle the time and cost overruns:

- *Improve stakeholder coordination:* Establishing clear communication channels between contractors, consultants and society members is essential to reducing decision-making delays and ensuring smoother project execution.
- *Enhance labour management:* Proper workforce scheduling and supervision should be implemented to optimize productivity and minimize idle time, ensuring timely completion of activities.
- Ensure timely material procurement: Maintaining a buffer stock of critical materials and streamlining procurement processes can help prevent supply delays and disruptions in workflow.

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- *Optimize equipment utilization:* Efficient planning of equipment allocation is necessary to minimize shifting delays between sites, ensuring that work progresses without unnecessary interruptions.
- *Regular project monitoring:* Conducting frequent progress reviews using EVA and baseline comparisons will help identify delays early and allow for timely corrective actions, improving overall project efficiency.
- *Use standardized scheduling templates:* Implementing the developed planning template for future projects can improve scheduling accuracy, streamline project management and enhance resource utilization.

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