

Optimization of Time and Cost of a Residential Building (G+24) Using Primavera P6

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Abstract: Resource management or the practice of planning, scheduling, and assigning people, money, and technology to a project is very important. In this current world, construction projects are massive and come with lots of complications. Thus, general schedule control techniques are useful in optimizing resource scheduling and project duration. Primavera P6 is one such software that is used for planning, managing, and executing project work. It is designed to handle large and small projects in several diverse industries such as construction, manufacturing, energy, and IT. Compared to conventional methods, this tool has been highly effective for project managers. Practically, work delays occur due to various uncertainties. Hence by software techniques, one can apply resource dependencies, reschedule the project, and fast-tracking critical activities which delay the duration. The main aim of the study is to optimize the time and cost of a residential building through planning and scheduling, allocation of needed resources, budgeting and tracking by using the Primavera P6 tool. In conclusion, it is important to realize that through crashing and resource leveling the time and cost will be optimized and hence in this paper there will be changes to the schedule between the expected and optimized progress. Based on that, the schedule needs to be changed to complete the paper.

Keywords: Planning, Scheduling, Optimization, Tracking, Primavera P6, Crashing, Resource leveling.

1. Introduction

Today construction and infrastructure industries are the second largest industries in India. Although being the second largest industry many projects are still carried out by conventional methods and approaches leading to improper planning and management. Due to this inadequate project formulation, the industry faces problems like cost overruns and time overruns. Many organizations use tools like labor wage cards, Excel, handling many files and papers, and many other traditional methods which makes it a tedious job for engineers and project managers to execute the project.

Project management and formulation seem to offer what is needed in terms of tools and techniques to solve this problem to make this job easier and more effective. In India, there is a lack of project management practices prior to the start of the project. Various complex phases are involved in large building construction projects. The pressure to complete such projects on time and within budget is making project developers

implement the project management process.

In the absence of Managerial competence, projects which are otherwise feasible may fail. On the contrary, even a poor project may become a successful one with good managerial ability. Project management on the other hand seems to offer what is needed in terms of tools and techniques to solve this problem and to make the job easier and more effective. Hence to meet such perfect conditions there are tools in the form of software such as Primavera P6, MS Project, etc. So, to overcome this, in this analysis, we are using technology and software like Primavera P6 which can be used for effective and efficient management of projects. In this present study, we are planning and scheduling a residential building using Primavera P6 and performing a feasibility study on this project and finding the life cycle cost of the project.

The objectives of this study are:

- 1) To collect the data from the site and import it on Primavera P6.
- 2) To prepare a schedule of G+24 residential buildings and allocate resources using Primavera P6.
- 3) To reschedule and reallocate the resources which will give us the optimized cost.
- 4) Crashing schedule and finding the optimized duration.
- 5) To conduct a financial feasibility study.
- 6) To find the Life Cycle cost of the building.

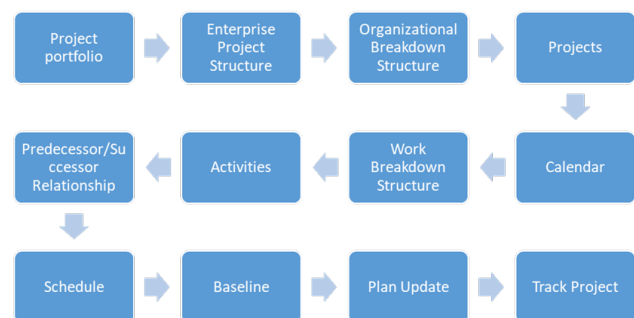


Fig. 1. Primavera phases cycle

A. Problem Statement

Optimization of time and cost of a Residential (G+24) building using Primavera P6 along with its feasibility study and

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life cycle costing analysis.

B. Scope

Feasibility study: The study involves the analysis basis on three different parameters of economical aspect, technical aspect, and schedule aspect.

Planning: The planning stage is the preliminary stage of project management where there will be data collection along with the specifications that are stated to carry out the smooth execution of the project.

Scheduling: The project is arranged in a proper work order which is drafted in Work Breakdown Structure (WBS) in Primavera P6. The list of activities is prepared and ordered properly with interrelationships. The duration of the project is determined along with the estimated cost of the project.

Tracking: After the start of the project track record of the project is taken with the help of Primavera P6 which helps in tracking the actual completion of the project with the drafted timeline.

Life cycle costing: Costing of the life cycle is calculated with the cost of construction from day 1 till the completion of the project along with the maintenance and sinking fund.

C. Objectives

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2. Data Collection and Optimization

A. Planning

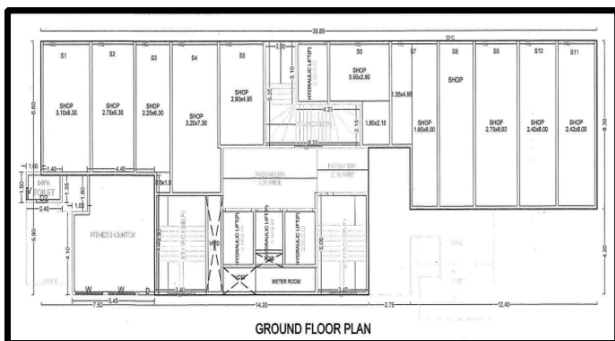


Fig. 2. Ground floor plan

Construction planning is a fundamental and challenging activity in project management and execution of construction projects. It includes the selection of construction techniques, the definition of work tasks, the estimation of required durations and resources of individual tasks, and identify the interdependency between different work tasks. For this project, the Actual planning process starts with the collection of data like layout (Floor plan, section and elevation), project, start

date, and activities involved in the construction of a G+24 Residential building at Anand Nagar, Thane; equipped with modern technologies. The activity sequences, duration taken, resources needed and the amount and cost spent for each and every activity.

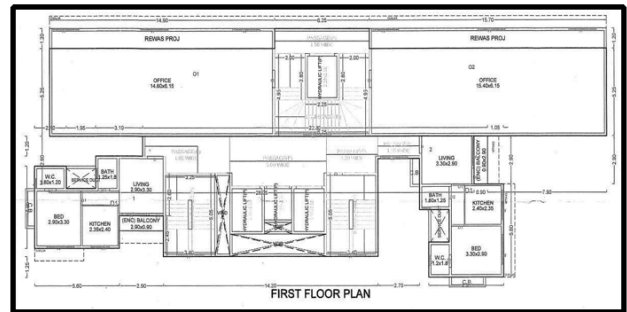


Fig. 3. First floor plan

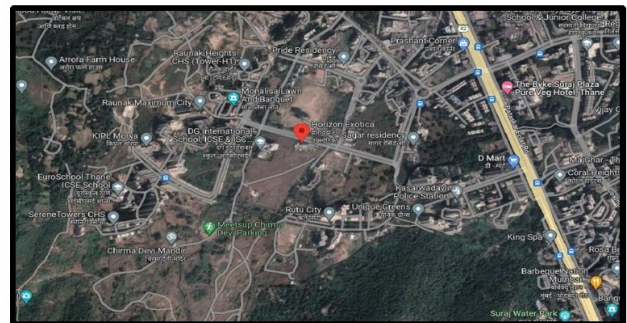


Fig. 4. Site location

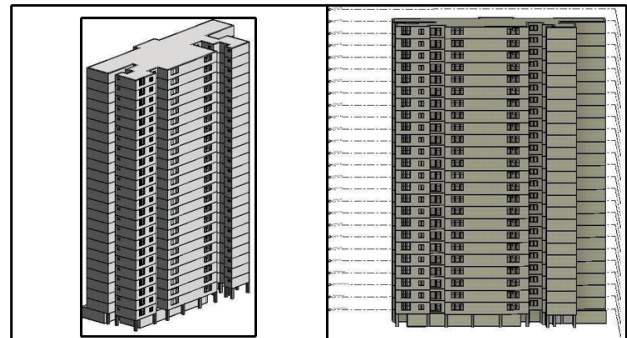


Fig. 5. 3-D model

B. Scheduling of (G+24) Residential Building

Projects			
Projects	Activities	Tracking	WBS Resources
Layout: Projects			
Project ID	Project Name	Total Activities	Strategic Priority
Total		313	
Enterprise	All Initiatives	313	
EAC	Engineering & Construct	313	500
LEARN	Learning portfolio	313	500
RES BUILD	Residential building	313	500

Fig. 6. Project

Project is a series of activities, which are performed to create a product, service, or a measurable business result in any organization. An ideal project will have a definite beginning and end. A project is concluded in the hierarchy, when its objectives have been reached or when the project is terminated.

A *project portfolio* is a collection of projects where you can easily view data from more than one project at a time. It facilitates effective new product development and management of the projects by grouping the projects and programs together to optimize the organization or a project's success. It also allows for reviewing the summary data and status information of an organization or a project.

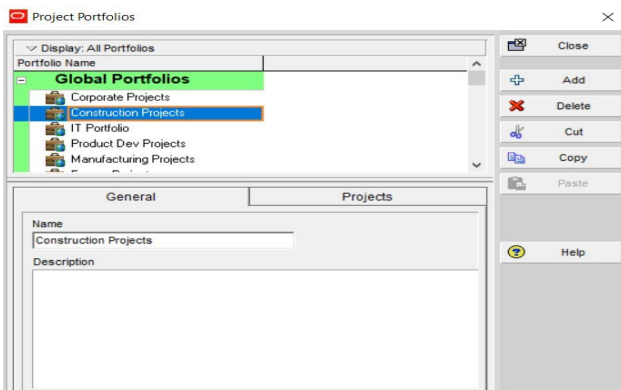


Fig.7. Project portfolio

Enterprise Project structure (EPS) represents the hierarchical structure of all projects in an organization. EPS will always occupy the highest level of the project management hierarchy. It can be subdivided into as many levels as needed to represent the entire work of an organization. The number of EPS levels or subsidiaries depends on the scope of the projects.

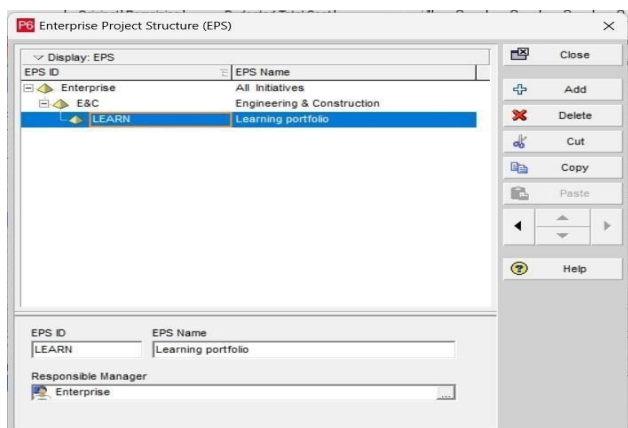


Fig. 8. Enterprise Project Structure

Organizational Breakdown Structure is part of the CPM hierarchy which is used to identify or assign the responsible employees for a project. Example: Project Manager, Sales Manager, HR manager, etc. This is a very important phase in the project management hierarchy because the efficiency of a project will always depend on the right or skilled project manager.

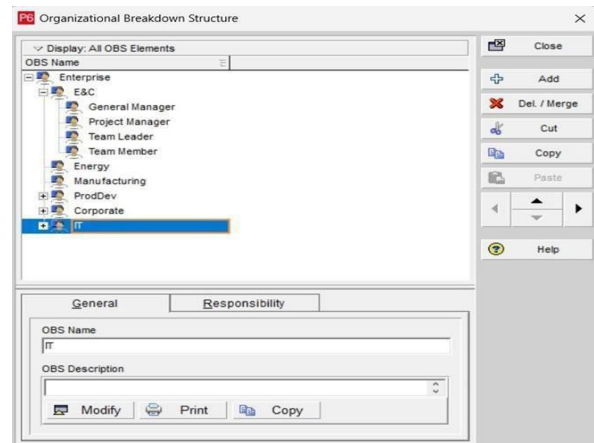


Fig. 9. Organizational Breakdown Structure

Calendar is assigned to activities and resources where they are used for scheduling activities and leveling resources. The Primavera P6 supports three types of calendars namely the Global calendar, Project Calendar, and Resource Calendar. In this project, we have used 6 Days X 8 Hours Global Calendar.

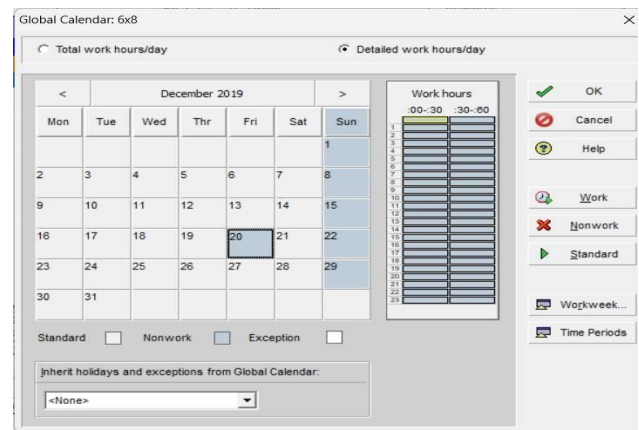


Fig. 10. Calendar

Work Breakdown Structure (WBS) is a hierarchical arrangement of work or activities that divides a project into discrete levels, phases or layers. Developing WBS is the foremost step done by a project manager while creating a project. WBS is a key project deliverable that organizes the project's total work into manageable sections. For this project, WBS is created for different stages involved in the construction of multistoried residential building.

Activities are the basic work elements of a project. An activity is also known as a task, item or event. These are the lowest level of manageable work elements in a project. The activities that are required for the project with their original duration are added under respective WBS. The total number of activities involved in this project are 313. Successors and predecessor are assigned for all the activities. Interdependencies of various activities for simultaneous independent work are assigned.

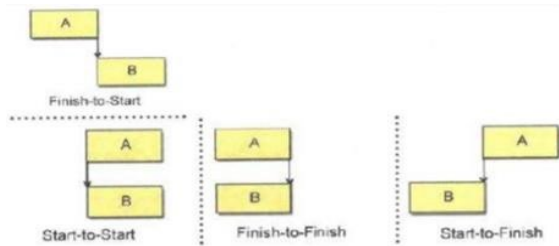


Fig. 13. Interdependency

Schedule Chart is a type of bar chart that illustrates a project schedule. This chart lists the tasks to be performed on the vertical axis and time on horizontal axis. The width of the horizontal bars in the graph shows the duration of each activity. It shows the start and finish date of the activities.

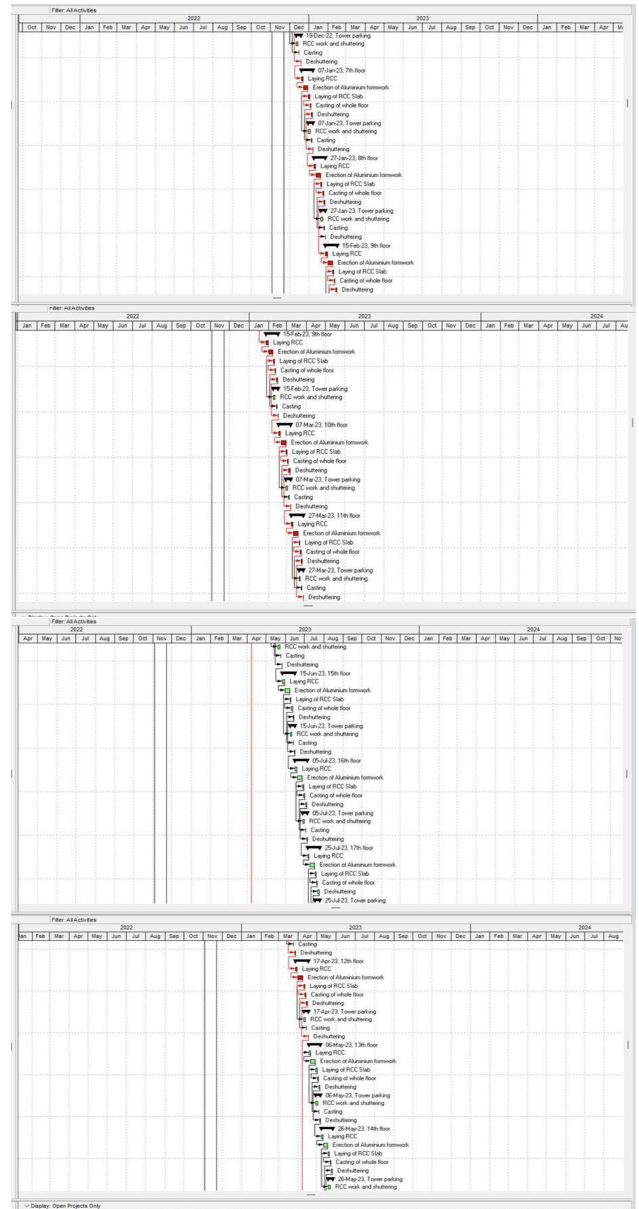
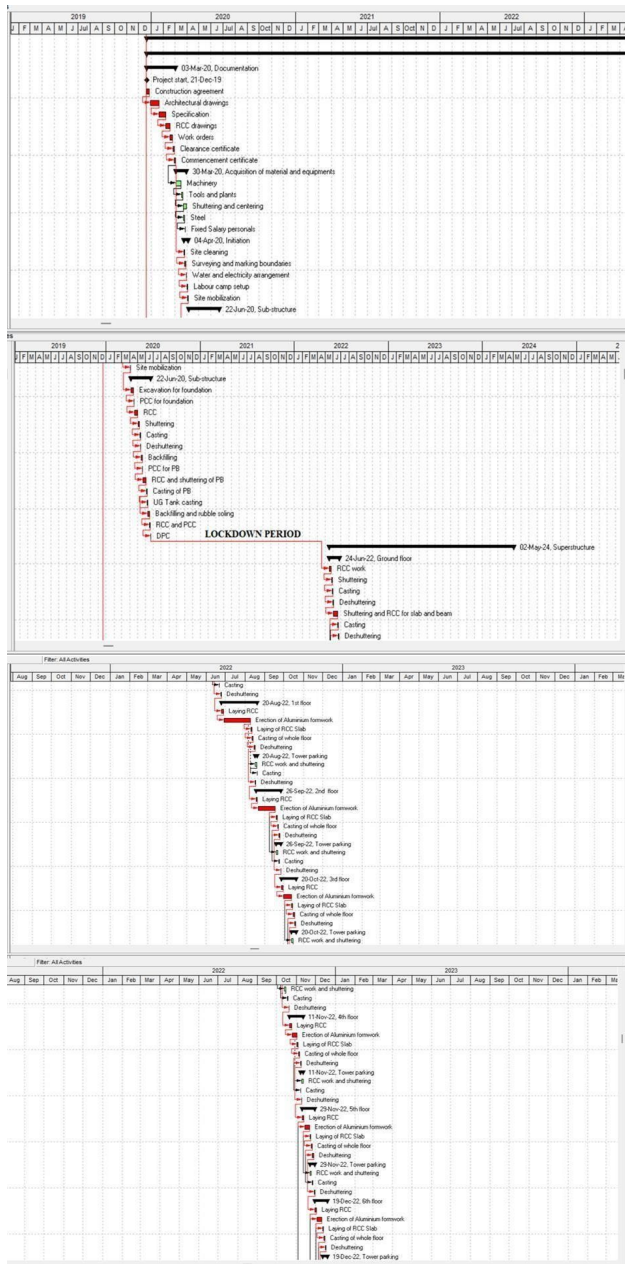


Fig. 14. Schedule chart

Resource creation to complete the activity there are requirements of various resources such as labor, equipment's, materials and machinery. So, we need to create different categories of resources with unit cost and hours of working.

Resource ID	Resource Name	Resource Type	Unit of Measure	Primary Role	Default Unit/Time
SR	Surveyor	Labor		Foreman	0.5hr
PTOWER	Parking tower mechanism	Material	Each		0.5hr
FE	Field engineer	Labor		Engineer	0.5hr
DE	Design engineer	Labor		Engineer	0.5hr
CP	Concrete pump	Material	Each		0.5hr
PR	Partner	Labor		Construction	0.5hr
MZ	Mason	Labor		Construction	0.5hr
HM	Helper mason	Labor		Construction	0.5hr
FTT	Fiber	Labor		Construction	0.5hr
CRP	Carpenter	Labor		Construction	0.5hr
MAS	Mason	Labor		Construction	0.5hr
PH	Passenger & material host	Material	Each		0.5hr
ST	Steel	Material	Tonne		0.5hr
BEED	Blair bending and cutting machine	Material	Each		0.5hr
FRNS	Concrete fins	Material	sqm		0.5hr
DP	Door frame	Material	sqm		0.5hr
WF	Window frame	Material	sqm		0.5hr
SKRT	Skirting	Material	sqm		0.5hr
BLK	Slope blocks	Material	per cubic meter		0.5hr
SB	Sold block	Material	per cubic meter		0.5hr

Fig. 15. Resources

Resource Allocation for Activities: The created resources are then assigned to each and every activity with their respective

need. After the resources are allocated the cost for the activity is calculated and the total cost is found out.

Schedule: Critical path methodology scheduling assigns dates to project activities, calculates project's finish date and also reveals the project's critical path.

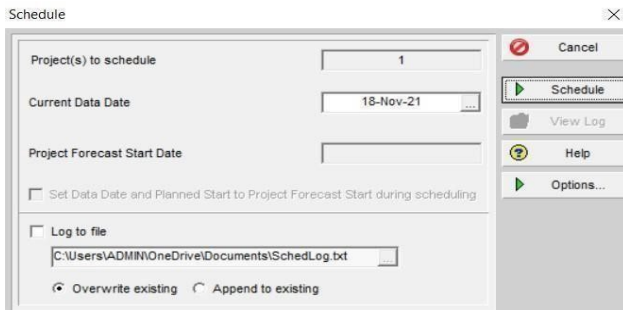


Fig. 16. Schedule box

D. Resource Curve

Resource/cost distribution curves enable you to specify how you want resource units or costs spread over the duration of an activity. Resource units and costs are distributed evenly from the assignment start to the assignment finish unless you specify a nonlinear distribution by assigning a curve. You can assign a resource distribution curve to any resource or role assignment on activities with a duration type of Fixed Duration and Units/Time or Fixed Duration & Units. Assign the appropriate curve to a resource or role assignment by selecting a curve in the Curve column in the Resource Assignments window. You can also assign a resource curve in the Resources tab in the Activity details.

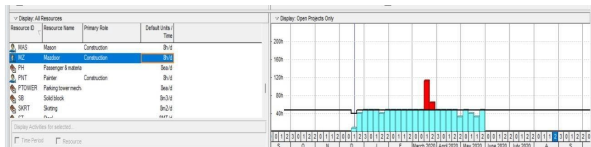


Fig. 17. Resource curve

E. Stacked Histogram

Stacked Histogram are a common sight in project environments. Primavera P6's stacked histogram stacks each bar on top of each other to give you a full view of your resourcing over time. The stacked histogram can be graph either at Completion Units or at Completion Costs.

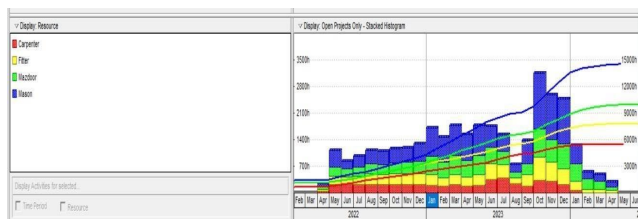


Fig. 18. Stacked histogram

F. Tracking

Project tracking is a project management method used to track the progress of tasks in a project. By tracking your project, you can compare actual to planned progress, and identify issues

that may prevent the project from staying on schedule and within budget. Project tracking helps project managers and stakeholders know what work has been done, the resources that have been used to execute those tasks, and helps them create an earned value analysis by measuring project variance and tracking milestones.

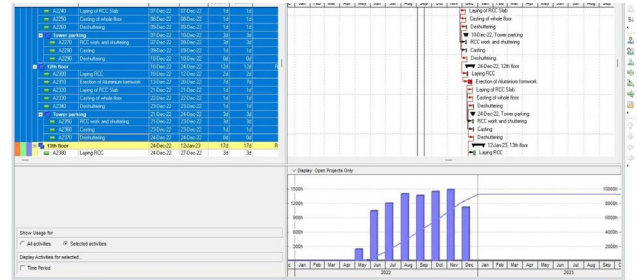


Fig. 19. Tracking

The purple bar represents the tracking of selected activities from 1st floor to 12th floor as an example. We can see a clear difference between the month of Nov 22 to Dec 22. This way we can easily track the progress of any selected activities or all activities from the project which will really beneficial till the end.

G. Resource Levelling

Resource levelling is a project management technique used to balance the demand for resources with the availability of those resources. It involves adjusting the project schedule to ensure that the resources required for each task are available when needed, without overloading or underutilizing them. The goal of resource levelling is to optimize resource utilization while maintaining the project schedule and budget. It is especially important for projects with limited resources or those that require specialized skills or equipment. By balancing resource demand and availability, resource levelling can help prevent delays, reduce costs and improve project outcomes.

H. Rescheduling

Rescheduling in Primavera P6 is a process of updating the project schedule to reflect changes in the project scope, timeline, or resource availability. It involves adjusting the project schedule to ensure that it reflects the most up-to-date information and accurately reflects the status of the project.

To reschedule a project in Primavera P6, follow these steps:

- 1) Update the project schedule: Update the project schedule to reflect any changes in the project scope, timeline, or resource availability. This may involve adding, deleting, or modifying activities, as well as adjusting durations and dependencies.
- 2) Review the critical path: Review the critical path to ensure that it reflects the most up- to date information. The critical path is the longest sequence of activities that determines the earliest possible completion date of the project. It is important to ensure that the critical path is accurate, as it will drive the project timeline.
- 3) Analyze resource usage: Analyze resource usage to ensure that resources are being utilized efficiently and

effectively. This may involve adjusting resource assignments or re-allocating resources to different activities.

Overall cost after Rescheduling:

Table 1
Comparison of cost between two schedules

S.No.	Type	Cost (including additional investments=Rs.3,22,82,500)
1	Budgeted total cost	Rs. 24,52,21,990
2	Optimized cost	Rs. 20,84,65,750

I. Schedule Crashing

Schedule crashing is a project management technique that is used to accelerate the completion of a project by shortening the project schedule. In Primavera P6, schedule crashing involves reducing the duration of critical activities in order to achieve the desired project completion date.

To perform schedule crashing in Primavera P6, follow these steps:

- 1) Identify critical activities: Identify the critical activities in the project schedule that are on the critical path and have the biggest impact on the overall project duration.
- 2) Determine the crashing options: Determine the options available to shorten the duration of these critical activities. This may include adding additional resources, increasing work hours, or reducing the scope of the activity.
- 3) Analyze costs: Analyze the costs associated with each option, including the cost of additional resources, overtime pay, and other expenses. Determine the most cost-effective option for each critical activity.
- 4) Update the schedule: Once the most cost-effective option has been determined, update the project schedule to reflect the new duration of the critical activities.

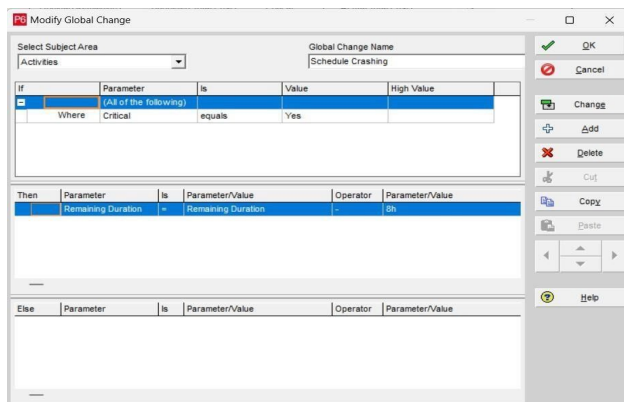


Fig. 21. Schedule crashing

J. Optimized Crashing

Activity ID	Activity Name	Start	Finish	Original Duration	Remaining Duration
Total		21-Dec-19	11-Apr-24	1348d	1348d
Res build		21-Dec-19	11-Apr-24	1348d	1348d

Fig. 22. Optimized crashing

Table 2
Crashed duration

Type	Duration
Original duration	1461 Days
After Crashing	1348 Days

3. Result

- 1) The project completion date according to the planned schedule is 11 Apr -2024.
- 2) Total duration of the project is 1348 Days.
- 3) Total of 313 activities are involved with this project from its initiation to delivery.
- 4) It shows the critical activities and path which helps to keep more focus on them to avoid schedule and cost overrun.
- 5) It provides an idea of arranging the required resources for the upcoming activity.
- 6) Total Construction Cost is ₹20,84,65,750.
- 7) After Life Cycle Cost Analysis (LCCA) the cost we have calculated is ₹57,95,46,811. The feasibility of the project is good in terms of its long-term investment

4. Conclusion

The main goal and mission of the study were to learn and optimize the residential building with the timely accomplishment of any construction project. This helps to forecast the total duration of the project which was expected to be 1461 days. After rescheduling and reallocating the resources we found out the optimized cost of the project is less than the budgeted cost. The difference was about 3 crores from the budgeted total cost. After the schedule crashing, we found a new critical path and a new optimized duration is about 1348 days. The usage in this study proved as an interpreting the progress of Horizon Exotica Building, which helps to recognize the various problems aroused during or prior the execution process. The output results of the current case study define the usefulness of efficient planning, Scheduling, Monitoring and Controlling. Primavera helps Project Manager to help him aware about the schedule with respect to the activities which are to be started or finished according to the schedule.

Thus, with this study it could be concluded that:

- 1) For the current project the planned schedule activities are productive.
- 2) The implementation of immense monitoring policies could be well observed.
- 3) On the various tasks of schedule completion, the very high and systematic priority is been provided.
- 4) The usages of various resources throughout the project would be optimum.
- 5) The software Primavera P6 proved like a perfect and efficient tool for the purpose of monitoring and controlling of the various construction project. The time for updating effort will be highly decreased by the help of it.

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