

Case Study of Scheduling and Monitoring of Public Building using MSP Software

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Abstract:- Construction Industry is one of the aspects which contributes vastly to the development and growth of a nation. As in this industry each project has its unique and specific characteristics it becomes very important and essential to plan and schedule the various activities of an individual project systematically because time and money plays a very important role in it. Poorly managed projects usually result in a huge amount of financial loss and it consumes a lot of time. In order to eliminate these flaws in construction project, an effective project management tool is required. Project management is the process of leading the work of a team to achieve goals and meet success criteria at a specified time. In order to overcome time and cost overruns due to improper planning, scheduling and execution, using modern project management software is required. One of which is MSP (Microsoft Project 2013) which gives clear planning, scheduling and monitoring for the successful execution of project. Cost, time, and materials of the project are obtained by resource allocation. Budgets in a project are based on the assigned work and the cost of resources. The present study deals with the planning, scheduling and monitoring of “Administrative Building, IGGMC(Mayo) Hospital, Nagpur”, a six storied (G+6) building project. A comparative study between the baseline duration and cost to actual duration and cost of project is also determined using MSP.

Keywords: Microsoft Project, Project Management, Construction, Planning, Scheduling, Resource Allocations, Gantt Charts, Critical Path, Work Breakdown Structure, etc.

1. INTRODUCTION:

Every person is a project manager of their own life. From start to finish on any project, project management process keeps you, as the project manager, on task to measure and track project progress. Project management is the practice of initiating, planning, executing, controlling, and closing the work of a team to achieve specific goals and meet specific criteria at the specified time. The basic challenge of project management is to achieve all of the project goals within the given constraints.

It is the initiation, planning and control of a range of tasks required to deliver the end product. In the construction sector there are two important main factors that need to be considered i.e., time and money for the successful completion of any construction project. In order to keep the pace of the project goes smoothly as specified, an efficient project management is necessarily needed.

Construction project management is the process of planning, coordinating and providing monitoring and controlling of a construction project. Workers which include engineer, architect, project manager, construction workers, supervisors, operators, etc. are made to execute specific functions and tasks. Here for better construction practices, systematic planning, programming with effective management and execution is required.

1.1 Importance of Project Management

- With the right planning, you can ensure that your work is delivered on time and within budget.
- Planning encourages innovation and creativity among the construction managers to execute the project effectively.
- To keep the ongoing project on track, it's important to manage all the functions and tasks in a right way.
- Project management serves as a knowledge asset to a company and helps to build on both experience and knowledge.
- Thus, Project Management is both necessary and essential to the success of the project.

1.2 Microsoft Project

Microsoft Project is a project management software product, developed and sold by Microsoft. Project Management is the application of knowledge, skills, tools and techniques to project activities to meet the project requirements and to execute projects effectively and efficiently. The primary challenge of project management is to achieve all of the project goals and objectives while honouring the preconceived constraints. The primary constraints are scope, time, quality and budget. The secondary and most ambitious challenge is to optimize the allocation of necessary inputs and integrate them to meet pre-defined objectives.

1.3 Benefits of Microsoft Project

- Efficient delivery.
- Faster growth.
- Well organized feature.
- Cost management and control.
- Best remuneration.
- Assigning individuals and different assets to assignment.
- Quality control and management.
- You become a part of the solution rather than part of the problem.
- Real time communication.
- Fantastic Track record, that leads to
 - Money
 - Opportunity
 - Status

2. BRIEF OVERVIEW OF LITERATURE

Rhuta Joshi and Prof. V.Z. Patil analysed the project management technique by scheduling various construction activities, allocation of resources and resource levelling using Microsoft Project 2013 for residential building. The study was carried out in two phases. In first phase data was collected from site and quantities were calculated as per drawing and required manpower was calculated. In second phase of construction activities was defined in MSP 2013. The result was as resource decreases duration increased by 10.38% and cost by 0.94%.

Nikhil R. Mahajan and M. V. Bhogone (2017) The methodology adapted by them was to compare Microsoft Project and Traditional Method. Schedule was prepared for both conventional and prefabrication method. A residential building was taken for comparison. The software used was MSP, the duration required for completion of project was collected from respective company. The comparison was made by comparing the total time required for completion by using critical path method with MSP project. The result shows that the total duration for both the conventional and prefabrication method and prefab construction for individual house and double story the required cost is 13% more than conventional but it reduces the project duration by 63 days.

Wallance Agyei The study was aimed at finding the difference between the cost and minimum expected time that will be required to complete the project. Both CPM and PERT techniques were used for analysis and from the result it was concluded that schedule proposed by bus provides much shorter completion time as compared to the actual time taken by the process.

Rashmi J.V. and Amey A. Kelkar (2017) They analysed the planning and scheduling of multi-storeyed building in two phases by conventional execution approach & again analysis of same building was carried out by applying MSP to compare the result for justification. For their study they considered G+3 with basement and the type of RCC frame structure, to estimate the overall cost and time required to execute a multi-storeyed residential building. The result of their study showed that proper manage of project management skills and technique reduces the time by 23.2% and cost by 3.14%. E.

Suresh Kumar and S. Krishnamoorthy (2015) In their study they focused on the scheduling using MSP and earns value analysis for an apartment building. Thereby time required for the process of cost overrun is avoided. Project schedule is considered as core of the project plan, and the purpose of the project schedule is to show the organization how the work will be performed to uncover the mistakes. After completion of project. it has been observed that there is more difference between budget cost and actual cost, cost increases as the material price increases. Earned value analysis is carried out in order to find the variance cost of the project.

2. OBJECTIVES:

The objective of the research work is to deliver the project efficiently and effectively in given considerate time and keeping all constraints under budget. The various objectives are listed below:

- To develop a module of scheduling using MSP (Microsoft Project)
- To identify the sequence of construction activities followed for the construction of public building.
- To determine the technique of planning and scheduling that has been used by the construction company for the completion of the work
- To provide good and proper quality and quantity of machine, men, materials etc., at right stage of the project.
- To try the project and analyse the reason for delays and increase in estimated budget etc.

➤ To assign resources to project, so can briefly conclude cost and resources variation that's carrying out in the ongoing project.

3. CASE STUDY

The present study deals with the planning, scheduling and monitoring of "Administrative Building, IGGMC(Mayo) Hospital, Nagpur", a six storied (G+6) building project. The construction work of the project is in progress.

- The construction of proposed structure is taking place under supervision of Integrated Unit, PWD (Public Works Department). Nagpur.
- The contract for the construction is awarded to M/S Sadiq and Co. Nagpur.
- The project is being constructed on an available land of 24519.56 sq.

Area –

Basement – 3389.29 sq. m

Ground floor – 3389.29 sq. m

First floor to Sixth floor – 17440.98 sq. m

Total Area – 24519.56 sq. m

- The contract amount of total project is 49420.54 Lacs with an estimated time period of 24 months (inclusive of rainy seasons).
- The project started on 05/03/2019 whose estimated completion date was 04/03/2021.
- The activity name, duration, predecessor and total number of tasks, etc. are entered in the software which gives a total duration of about 24 months working days for the completion of the project.
- The given building has two wings, left wing and right wing respectively which have same features and configurations.
- We worked on two cases: -

Case 1: - Time and cost variation Case 2: - Time and resource variation

3. METHODOLOGY

The methodology follows with collection of all required data and executing the tasks which follows at the certain stage. The site details, plans and drawings etc were utilized for the study. The requisite data has been collected from detailed drawing, bill of quantities and prevailing site condition. consumption of human resource analysis was carried out for the various activities by increasing resource with decreased duration. Finally, the total duration of the project is calculated by MSP-2013.

- **The Gantt Chart** – The Gantt Chart is a combination of the entry table and the bar chart. This is the main working area of projects.
- **Entry Table** – The Entry Table will hold a listing of every task included in the project and will show calculated details for each task. The entry task contains columns like indicator field, task mode, task name, duration, start, finish and etc. There is also an option for insert columns.
- **Bar Chart** – The Bar Chart will show bars drawn to represent the time span of each task against a calendar timescale.

The major steps involved in our work using Microsoft project software are

➤ **Assigning Project Calendar**

Calendar is the primary means by which you control when each task and resource can be scheduled for work in a project. By default, tasks are scheduled based upon the project calendar. For each resource that you enter, project creates individual resource calendars based on the settings in the given standard calendar. A working calendar is defined in which the working days in a week and the working hours are specified.

Calendar used- 24 Hrs Calendar

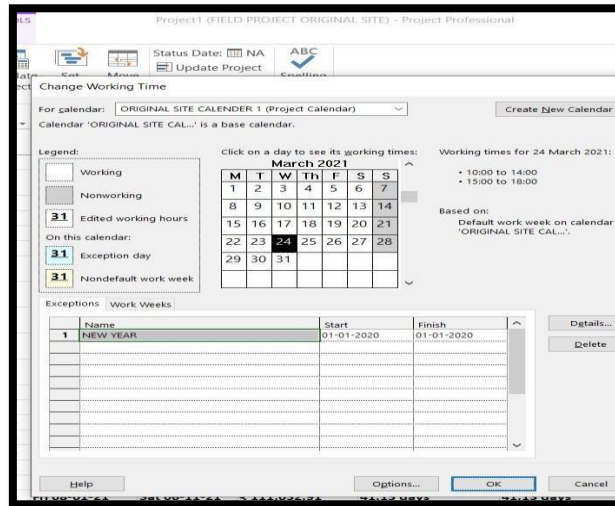


Fig 1. Assigning CalendarTime of work: -10:00-14:00

15:00-18:00
 (Lunch Break: - 14:00-15:00)

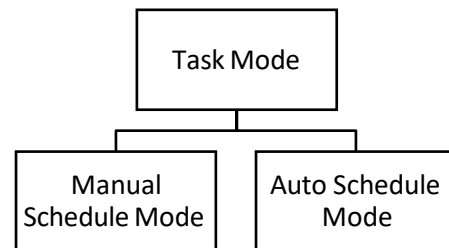
Non-working Days – On every Sunday



Selection of Task Mode

In task mode there are two types of modes.They are-

1. Manual Schedule Mode
2. Auto Schedule Mode



1. **Manual Schedule Mode** – The manually scheduled task placed anywhere in yourschedule, and project won't move it.
2. **Auto Schedule Mode** – Automatically scheduling provides a highly structured,systematic means of managing the project schedule.

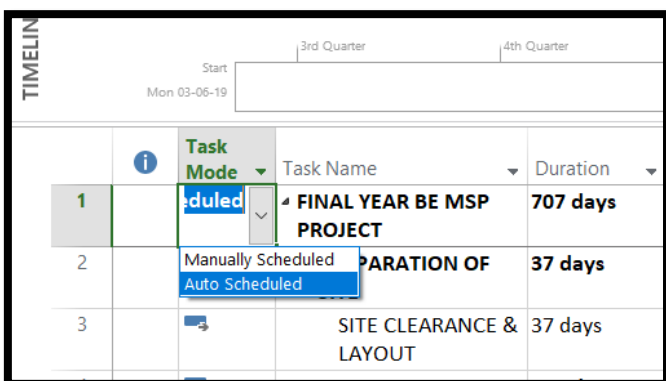


Fig 2.2 Types of Modes

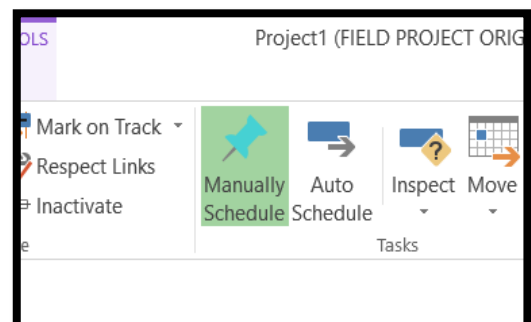


Fig 2.1 Types of Modes

➤ **Entering the Tasks**

The first level of creating a project in Microsoft project is to enter the task name and the duration. If you're not familiar about the sequence of events, projects make it easy to recognize tasks in your schedule at any time. The task duration is the amount of time you expect it will take to complete the task. Milestones are represented as tasks with zero duration.

A relationship establishes the dependency between any two tasks. A task that must occur before another task is a **predecessor task**. The task that occurs later in the relationship is a **successor task**. Tasks with dependency relationships are linked. Gantt Charts show these links as lines running between taskbars, an arrow at one end point to the successor task. **Lead Time** is overlap between tasks that have a dependency. **Lag Time** is a delay between tasks that have a dependency.

➤ **Critical Path**

A Critical Path is the series of tasks that will push out the project's end date if the tasks are delayed. Over the life of a project, the project's critical path is likely to change from time to time as tasks are completed ahead of or behind schedule. Schedule changes, when task change its relationships or durations, it will reflect in the critical path. The term **Slack** is important in the critical path.

Slack – The amount of slack in your schedule indicates how long tasks can be delayed before other tasks or the project finish dates are affected. There are two types of Slack.

1. Free Slack
2. Total Slack

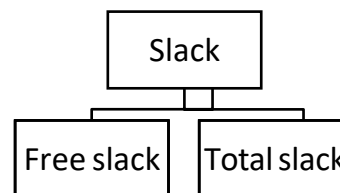


Table No.1 Critical Path

Task Mode	Task Name	Duration	Start	Finish	Cost	Free Slack	Total Slack	Predecessors	Successors	Critical
Auto Scheduled	INTERNAL PAINTING	230.13 days	Mon 01-03-21	Fri 31-12-21	₹ 0.00	0 days	0 days			Yes
Task Mode	Task Name	Duration	Start	Finish	Cost	Free Slack	Total Slack	Predecessors	Successors	Critical
Auto Scheduled	FLOORING / DADO, INT. FINISHING & PLUMBING 6TH FLOOR	193 days	Mon 19-04-21	Fri 31-12-21	₹ 0.00	0 days	0 days			Yes

- The task with 0 slack is considered a critical task. If a critical task is delayed, the project finish date is also delayed.
- In Gantt chart the bar in red colour default indicates the critical task.

➤ **Network Diagram**

A standard project management has various view, tracking from that indicates the detail workflow among the tasks in a project are the network diagram. The network diagram view provides the general flow of work and the relationships between tasks in your project. This view

makes it easy for you to evaluate the flow of your project and to check task dependencies. It is very useful when working on large project, this graphic view helps to focus on one task and the tasks that are linked to it.

➤ **Work Breakdown Structure**

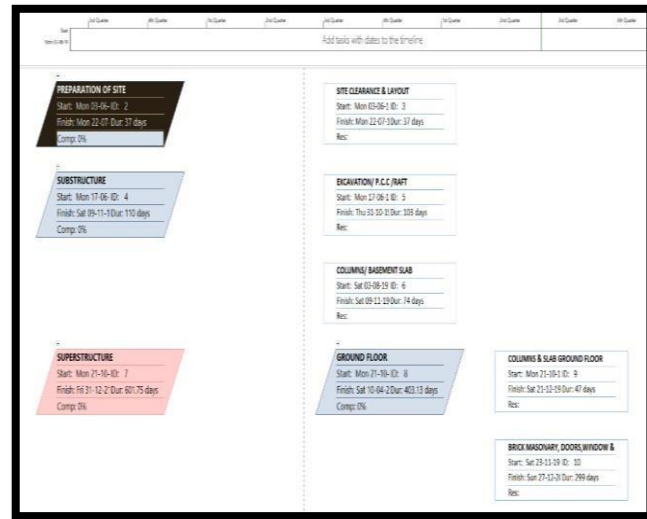


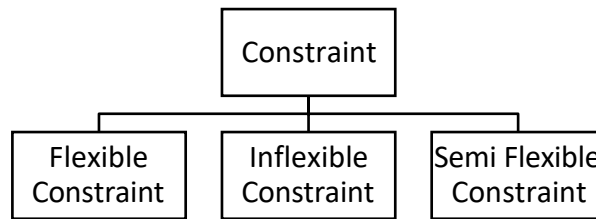
Fig 3. Network Diagram

A work breakdown structure (WBS), in project management is deliverable-oriented decomposition of a project into smaller components. It is also called as an organized method of dividing a product into sub products at lower levels of details. Hierarchical decomposition of work is called work breakdown structure. A work breakdown structure element may be a product, data, service or any other combination thereof.

WBS can be expressed down to a level of interest. Generally, the top three levels are sufficient unless the items identified are high cost or high risk. In that case, be sure to take the WBS to a lower level of definition.

➤ **Constraints and Recurring Tasks**

Restriction is set on the start or finish date of the task. **Constraints** tie tasks to the project start and end or to specific dates. Dependencies tie tasks to the timing of other tasks in the project. Constraints are of three types.



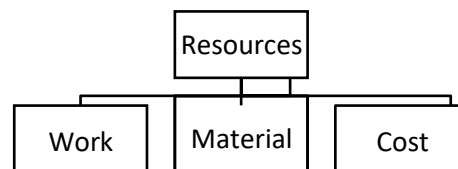
Deadline – Setting a deadline date in project provides you a visual reminder if you don't complete a task by the deadline date.

Recurring Tasks is a task that repeat at certain intervals. You can create a recurring task that repeats for a fixed number of times or that ends by a specific date. Projects often have tasks that occur on a regular basis.

➤ **Designing and Assigning Resources**

Resources are the equipment, people and supplies which enable you to complete the tasks in your project. The resources are defined in the Resource Sheet. They are broadly classified into three groups.

1. Work
2. Material
3. Cost



1. **Work Resource** – When you set up work resources, you define the amount of time that the resources have to spend on a task for a project.
2. **Material Resource** – When a material resource is assigned to a task, appropriate units should be assigned for that material resource.
3. **Cost Resource** – It represents a financial cost associated with a task that you need to account for.

Duration is the length of working time between the start and finish of the task.

Work is the amount of effort, measured in time units that a resource needs to complete the task.

Resource units indicate how much of a resource's available time.

From the Gantt chart view you can easily assign resources to the tasks. There are three types of tasks. They are

1. **Fixed Duration** – In which the duration value is fixed.
2. **Fixed Units** – In which resource assignment unit's value is fixed.
3. **Fixed Work** – In which the work value is fixed.

We can remove the resource from task, replace the resource from task, add notes to a resource, create hyperlink and also modify a resource's working hours using calendar.

Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt. Rate	Cost/Use	Accrue	Base	Code	Number1
Black Smith	Work	B			100%	₹ 484.00/day	484.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Labour	Work	L			100%	₹ 2,784.00/day	464.00/day	₹ 0.00	Prorated	ORIGINAL SITE		6
Bhiшти	Work	B			100%	₹ 484.00/day	484.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Mixer operator	Work	M			100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Mazdoor	Work	M			100%	₹ 1,856.00/day	464.00/day	₹ 0.00	Prorated	ORIGINAL SITE		4
Junior Engineer	Work	J			100%	₹ 1,283.00/day	283.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Supervisor	Work	S			100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Mason I Class Skilled	Work	M			100%	₹ 511.00/day	₹ 511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Mason II class skille	Work	M			100%	₹ 1,022.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		2
Painter I Class Skille	Work	P			100%	₹ 2,044.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		4
Helper Unskilled	Work	H			100%	₹ 484.00/day	484.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Mixer operator	Work	M			100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Vibrator Operator	Work	V			100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Carpenter	Work	C			100%	₹ 1,533.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		3
Bar bandler	Work	B			100%	₹ 928.00/day	464.00/day	₹ 0.00	Prorated	ORIGINAL SITE		2
Tar handler	Work	T			100%	₹ 968.00/day	484.00/day	₹ 0.00	Prorated	ORIGINAL SITE		2
Welder	Work	W			100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated	ORIGINAL SITE		1
Concrete Mixer	Work	C			100%	₹ 600.00/hr	₹ 600.00/hr	₹ 0.00	Prorated	ORIGINAL SITE		1
Generator(b) 63 KVA	Work	G			100%	₹ 1,200.00/hr	1,200.00/hr	₹ 0.00	Prorated	ORIGINAL SITE		1
Belt Conveyer Syste	Work	B			100%	₹ 125.00/hr	₹ 125.00/hr	₹ 0.00	Prorated	ORIGINAL SITE		1
Vibrator (electrical)	Work	V			100%	₹ 157.00/hr	₹ 157.00/hr	₹ 0.00	Prorated	ORIGINAL SITE		1
Welding Maschine	Work	W			100%	₹ 336.00/hr	₹ 336.00/hr	₹ 0.00	Prorated	ORIGINAL SITE		1

Fig 4. Resource Sheet

➤ **Resource Analysis and Allocation**

It is necessary to check whether there are any over allocated resources after assigning resources for each task in a project. We observe that the resources which are over allocated, represented by red colour and highlighted. The over allocation is seen in Gantt table as well as resource sheet, resource graph, etc. They are clearly mentioned below as:

Gantt Chart –

This view makes it easy to create a project and also indicate if there is any difficulty in it. It clearly shows the over allocation in indicator filed, with red mark as shown.

Resource Sheet –

In resource sheet view it gives information about the resources which are assigned in our project as well as standard and overtime rates, availability of overtime work, and fixed costs. It clearly shows when over allocations exists, by showing a warning flag in the indicator field.

Fig No. 5.2 Resource Sheet

WBS	Task Mode	Task Name	Duration	Start	Finish	Cost	Resource Names
1		FINAL YEAR BE MSP PROJECT	707 days	Mon 03-06-19	Fri 31-12-21	₹ 44,779,478.46	
2		SUBSTRUCTURE	115.5 days	Mon 03-06-19	Sat 02-11-19	₹ 18,392,559.00	
3		SITE CLEARANCE & LAYOUT	37 days	Mon 03-06-19	Mon 22-07-19	₹ 1,096,236.00	Helper Unskilled, Labour, Dumper 6 Cu
4		EXCAVATION	10.25 days	Mon 17-06-19	Sat 29-06-19	₹ 2,304,828.00	
5		EXCAVATION 1M-1.5M	5 days	Mon 17-06-19	Sat 22-06-19	₹ 847,944.00	Excavator, Junior Engineer, Lab
6		EXCAVATION 1M-1.5M	5 days	Mon 24-06-19	Sat 29-06-19	₹ 1,456,884.00	Excavator, Junior Engineer, Lab
7		RAFT FOUNDATION	90 days	Mon 01-07-19	Mon 28-10-19	₹ 10,419,676.00	loor, lor, Vibr
10		LAYER REINFORCEMENT STEEL IN RAFT SLAB	33 days	Mon 12-08-19	Wed 25-09-19	₹ 3,756,410.00	Labour, STRUCTURAL

Fig No. 5.1 Gantt Chart

Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt. Rate	Cost/Use	Accrue
Black Smith	Work		B		100%	₹ 484.00/day	484.00/day	₹ 0.00	Prorated
Labour	Work		L		100%	₹ 2,784.00/day	464.00/day	₹ 0.00	Prorated
Bhishiti	Work		B		100%	₹ 484.00/day	484.00/day	₹ 0.00	Prorated
Mixer operator	Work		M		100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated
Mazdoor	Work		M		100%	₹ 1,856.00/day	464.00/day	₹ 0.00	Prorated
Junior Engineer	Work		J		100%	₹ 1,283.00/day	283.00/day	₹ 0.00	Prorated
Supervisor	Work		S		100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated
Mason I Class Skilled	Work		M		100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated
Mason II class skills	Work		M		100%	₹ 1,022.00/day	511.00/day	₹ 0.00	Prorated
Painter I Class Skills	Work		P		100%	₹ 2,044.00/day	511.00/day	₹ 0.00	Prorated
Helper Unskilled	Work		H		100%	₹ 484.00/day	484.00/day	₹ 0.00	Prorated
Mixer operator	Work		M		100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated
Vibrator Operator	Work		V		100%	₹ 511.00/day	511.00/day	₹ 0.00	Prorated
Cementator	Work		C		100%	₹ 1,533.00/day	511.00/day	₹ 0.00	Prorated

Resource Graph –

It gives clear graphical representation to identify the problem. We can spot and correct the resources which are overallocated. The resource graph shows the allocated resource in blue colour where as the over allocated resources are seen in red colour. It can be seen in single or in combination view.

Resource Usage, Task Sheet, Task Usage, Team Planner and Timeline also shows resource allocations in project.

➤ Resource Levelling

Levelling is used to level the over allocated resources and this way it can be fixed efficiently in project. By Automatic Levelling option we can level all the over allocated resources without bringing any change in project time or cost. The levelling can be carried out in other ways as well. They are

1. Delay the task
2. Split the task
3. Resource Levelling Option
4. Overtime
5. Contouring Resources
6. Resource's Availability

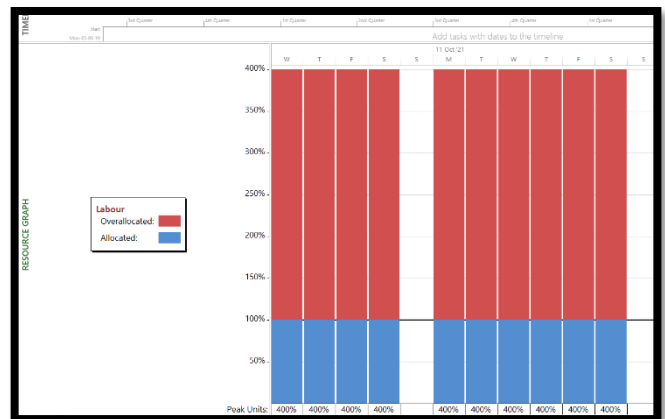


Fig No. 5.3 Resource Graph

Levelling is an efficient option to overcome all the conflicts and difficulties which can affect the project simultaneously.

➤ Tracking of Project

The first phase of project management is planning and the second major phase is considered as tracking. Tracking is keeping the record on project details such as what work done, when the work was done and also the cost analysis as well. Proper tracking of project and by comparing it against the original plan enables to identify variance and adjust the incomplete task of the project. Baseline can show a variety of information of project and it is a set of data saved in the same file where you track actual progress data.

4. RESULT

After getting the brief overview of the project and studying all the cases, the given results are obtained –

- Case 1 is the most convenient and feasible case
- No delay of work and no incrementation in cost is the plus point of Case 1.

- It is beneficial from all perspectives like work, cost, time as well as resource parameters.
- Quality control and management was seen in the given project and it turns out to be successful attempt.

Table 3. Comparison on basis of results obtained

Case 1	Case 2	Case 3
Time For Completion of Project - 707 Days	Time For Completion of Project - 615.25 Days	Time For Completion of Project - 773.25 Days
After Inclusion of Resource Parameter Total Cost: - ₹ 44,779,478.46	After Inclusion of Resource Parameter Total Cost: - ₹ 66,377,484.96	After Inclusion of Resource Parameter Total Cost: - ₹ 68,003,467.71
	Work Is Completed 3 Months Earlier but Results in Cost Incrementation.	Work Is Delayed by 2 Months but Results in Cost Incrementation

5. CONCLUSION

- The most popular and efficient construction management tool which is used nowadays by all construction companies is Microsoft Project (MSP), which is used in our project as well.
- Here, planning, scheduling, resource allocations, levelling, tracking, etc. were carried out in order to make the project work successfully.
- The inappropriate wastage of resources and its minimization during construction project is properly managed and maintained.
- The comparison between the result obtained by the software and on actual site was done and our method is more effective is concluded.

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