iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** IX **Month of publication:** September 2022

DOI: https://doi.org/10.22214/ijraset.2022.46885

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IX Sep 2022- Available at www.ijraset.com

Planning, Scheduling and Cost Estimation Of Villa Project Using Microsoft Project

Prajna Ganesh Gunaga[1], Geena George[2]
[1]*PG Student,* [2]*Associate Professor Department of Civil Engineering, EPCET, Visvesvaraya Technological University, Bengaluru, Karnataka, India*

Abstract: ***Many construction projects experience schedule and expense overruns which results in poor planning, scheduling, and execution, which causes number of problems such as delays in the provision of facilities, development, a decline in construction quality, and an increase in project cost. A little thought reveals that the amount of time needed to accomplish the job is inversely related to the availability of labor. When the number of workers is raised, the project's completion time is shortened; conversely, when the number of workers is reduced, the project's completion time is lengthened. The present study deals with the manpower, planning, scheduling and resource optimization of "Construction of a Villa Project at Chaitanya Sharan, Bengaluru", a two storied (G+2) building of 26 units whose construction is complete at Gunjur, Bengaluru, Karnataka. This study uses Microsoft Project 2013 to schedule various building activities, allocating resources, and level those resources in order to examine project management strategies. In essence, it relates to finding a solution to the project's excessive resource allocation. This project illustrates how resource levelling may be accomplished with Microsoft Project and what impact it might have on overall project duration.***

Keywords: Construction Project, Planning, Scheduling, Execution, Resource Allocation, Leveling, Optimization, Microsoft Project, Activities, etc.

I. INTRODUCTION

The science and art of planning, organising, leading, and controlling the work of organisation members while utilising all organisational resources to achieve specified organisational goals is referred to as management. Construction projects must be finished within the allotted time frame and comprise a variety of tasks carried out by both expert and unskilled labour. Due to poor project planning and poor completion management, the civil engineering industry is currently dealing with a number of problems, the majority of which are time and expense related.

Based on the limitations of the resources, this strategy modifies the start and end dates. When necessary resources are overcrowded or only available at specific times or in specific quantities, it is employed. Resource smoothing is a strategy for modifying the schedule model's activities. It makes sure that the project's resource requirements don't go over or surpass the pre- established resource restrictions. The project is estimated in order to find out the overall cost required to complete it. In order to comprehend the cash flow, it is important to be aware of the financing requirements at each stage of construction.

II. METHODOLOGY

Chaitanya Sharan Projects Pvt. Ltd.'s construction is the case study project. The project's construction is now completed. The Chaitanya Sharan project entails the development of 26 luxurious villas (G+2).

The project's estimated completion date was 12/04/2022, and work on it began on 10/06/2020. The project consists of 97 tasks in total. About 1.5 years have been allotted for the project's completion (inclusive of rainy season). Along with the built-in community hall, there are 26 villas.

The following are the main steps in our work using the Microsoft project software:

Phase I: Planning (data collection, quantity surveying), Scheduling

Phase II: Resource Allocation, Resource Levelling

A. Planning

1) *Data Gathering:* Drawings are gathered as part of the data collection process. It is important to gather all architectural drawings as well as a summary of all the actions involved.
2) *Quantity Surveying:* Calculating quantities from the obtained drawings for each and every item is a part of quantity surveying.

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B. Scheduling

Following the collection of drawings and the creation of an activity list, the quantity for each and every activity has been determined. The next step is to schedule the tasks using the MS-Project software. Following is the scheduling process: Making a new project plan, assigning a calendar, setting project information, entering task, establishing WBS, scheduling activities, resource allocation and leveling in MS-Project are all steps in the process.

C. Developing A Fresh Project Plan

The project schedule for this study is known as Chaitanya Sharan, and it runs from 8:00 AM to 17:00 PM with an hour for lunch between 12:00 PM and 1:00 PM. The calendar has 48 hours of labour each week, or 8 hours of work per day, 6 days per week, and 30 working days per day. Figure 1 shows the Standard Calendar considered for this Villa Project.

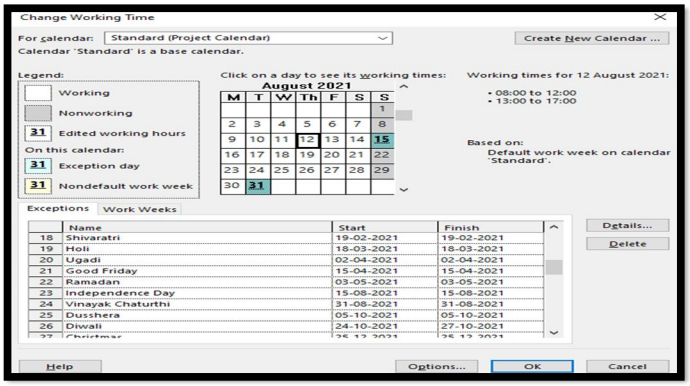


Figure 1: Project Calendar

D. Establishing A Work Breakdown Structure

A WBS shows the hierarchy of a project's component parts. Using the work breakdown structure, a project called home structures is created. This creates various other activities in sequence inside of it. Project breakdown structures such as excavation and earthwork, foundation, superstructure, reinforcement, concreting, brick work including doors and windows frame, lintel work, interior plaster, waterproofing work, external plaster, finishing work, painting and service work are then produced inside this home structures. Figure 2 shows the WBS for the entire project.

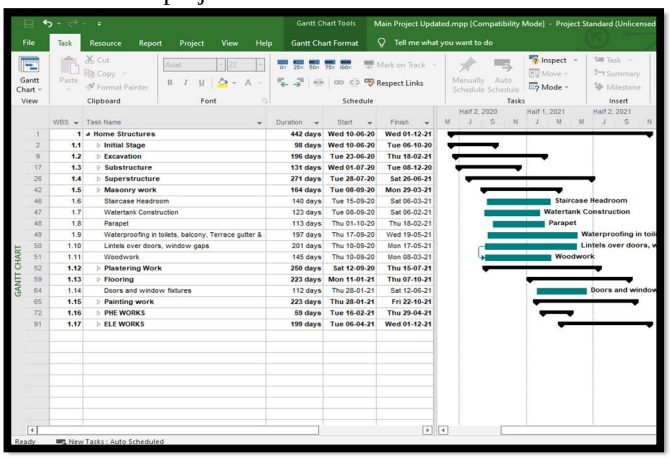


Figure 2: WorkBreakdown Structure

E. Gantt Chart

A Gantt chart is used to create the project schedule for identifying the order of construction. These activities were given resources (manpower). Resource levelling has been done after considering the actual resources that are accessible on the construction site.

F. Resource Optimization

1) *Resource Allocation*: The accuracy of a project's timetable can be improved by adding resources. The Microsoft Project software determines whether resources are over allocated or not when they are assigned, and if they are, it will indicate this in the task sheet and resource sheet.

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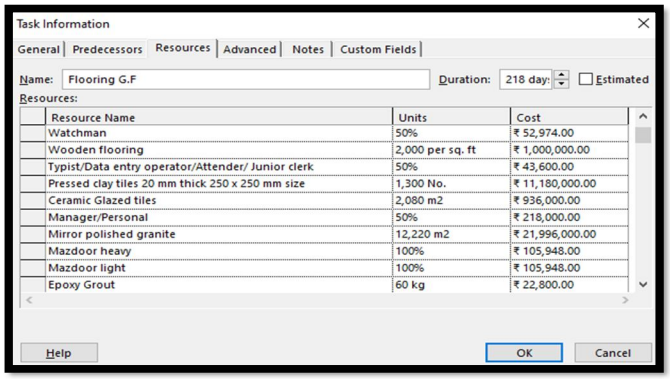


Figure 3: Resource allocation for G.F Flooring

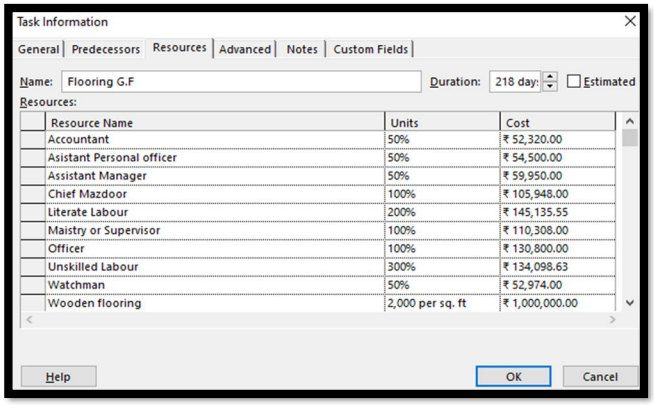


Figure 4: Resource allocation for G.F Flooring

Base calendar is only available for resources of the work type. The estimated cost for all the activities and for the entire project is then determined. This job is completed utilising Analysis of Rate CPWD. Figure 3 and Figure 4 shows the resource allocation for Ground floor flooring. Similiarly, for all the other activities the resources are allocated.

2) *Over Allocation of Resources:* When a resource is assigned to a task and spends more time than allowed by its work schedule on a single task or a group of tasks that are due at the same time. After allocating resources to various tasks, we notice that some of the resources have been overused, which is shown by the colour red. Figure 3.25 and Figure 3.26 shows that the resources that are over allocated are highlighted in red in the resource sheet of MS Project.

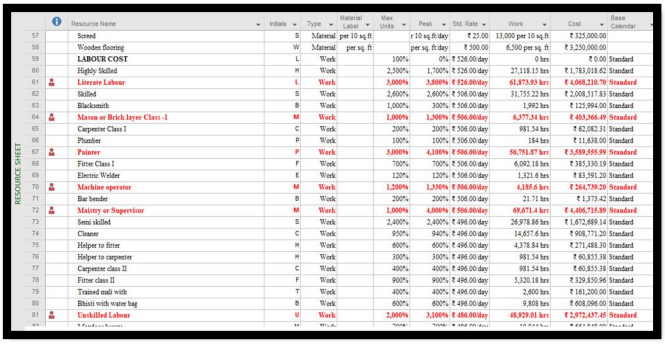


Figure 5: Over-allocated resources

3) *Over-allocated resource Histogram:* The scheduled dates for which resources are over allocated are shown in this histogram. Levelling of resources is crucial for efficient resource use. The over-allocated resources are Assistant Personal Officer, Painter, Tractor Trolley, Supervisor, Machine Operator, Manager Personal, Unskilled labour, Mistry/Supervisor, Mason, Lietrate Labour.

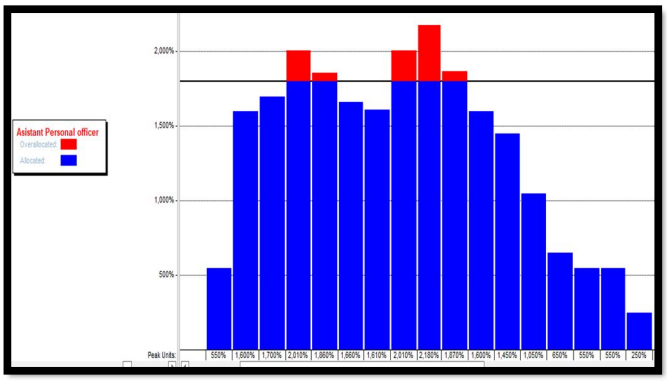


Figure 6: Over allocation for Assistant Personal Officer

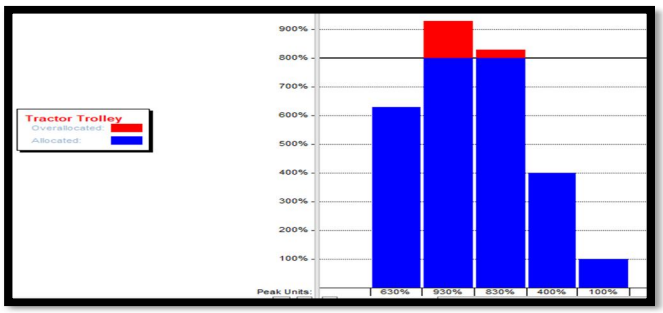


Figure 7: Over allocation for Tractor Trolley

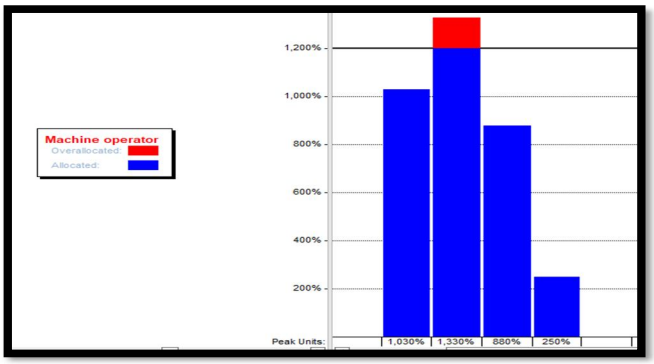


Figure 8: Over allocation for Machine Operator

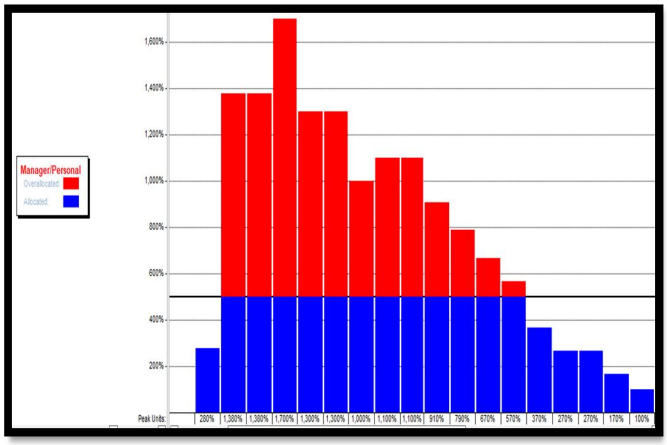


Figure 9: Over allocation for Manager Personal

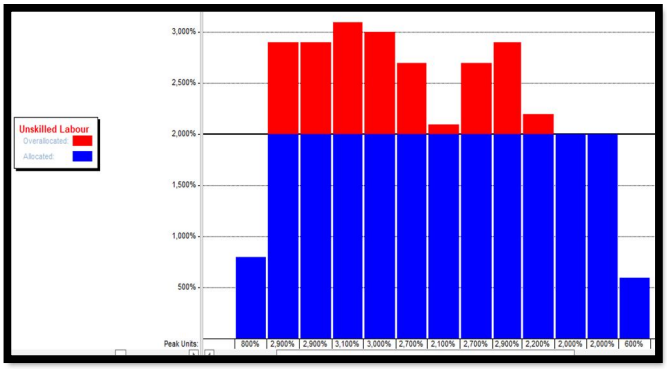


Figure 10: Over allocation for Unskilled Labour

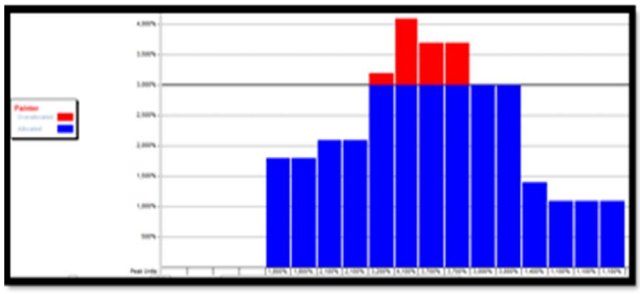


Figure 11: Over allocation for Painter

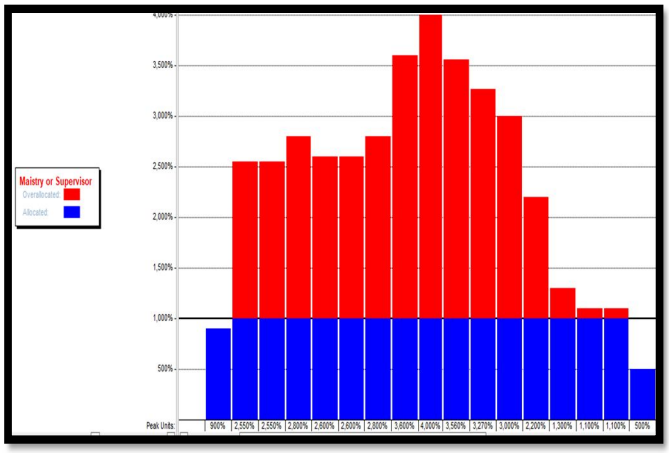


Figure 12: Over allocation for Mistry/Supervisor

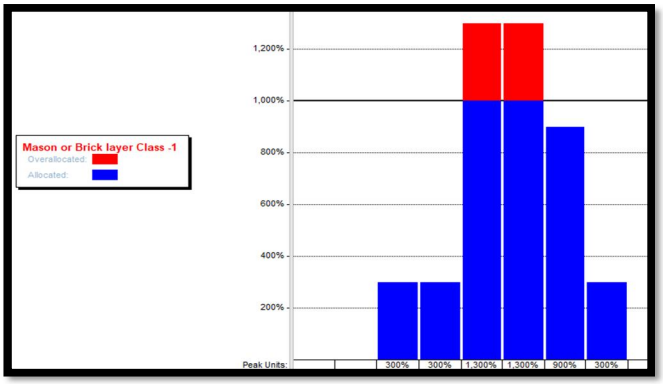


Figure 13: Over allocation for Mason

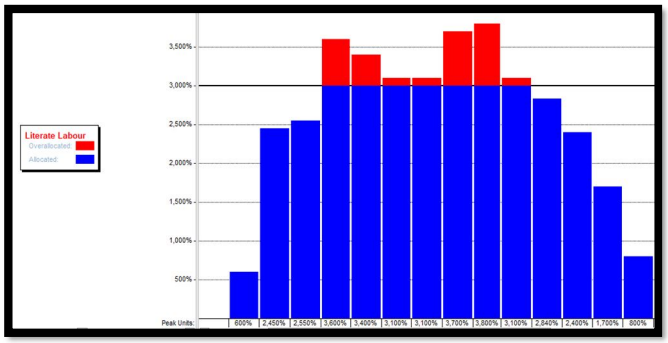


Figure 14: Over allocation for Literate Labour

4) *Resource Levelling:* Levelling is done to balance the activity operation to which the over allocated resources were assigned by levelling the over allocated resources. As demonstrated in the following figures, we introduced the Automatic Levelling option in MSP 2013 which levelled all of the over allocated resources. As a result, after levelling, the price and duration changed. Levelling is carried out with the changes in duration as this there is no time constraint. Figure 3.36 shows how the resource levelling is done.

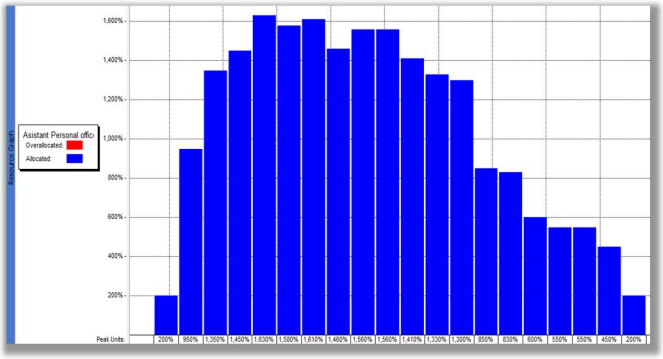


Figure 15: Resource levelling for Assistant Personal Officer

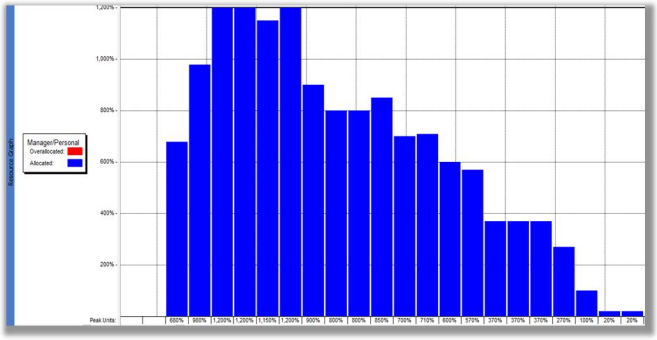


Figure 16: Resource levelling for Manager Personal

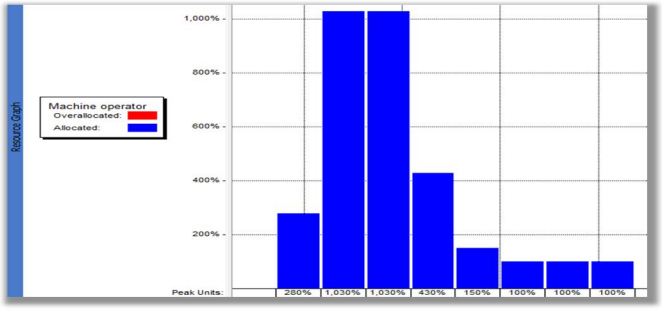


Figure 17: Resource levelling for Machine Operator

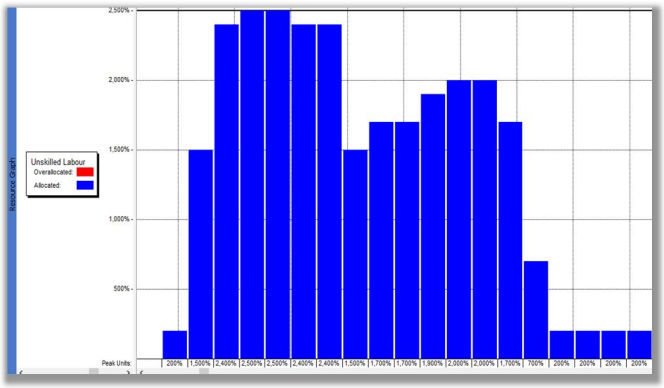


Figure 18: Resource levelling for Unskilled Labour

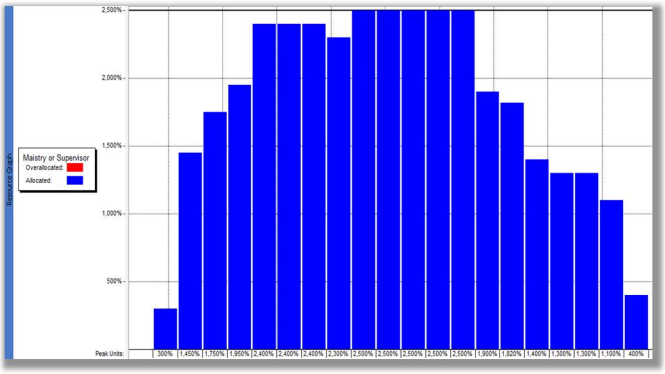


Figure 19: Mistry or Supervisor

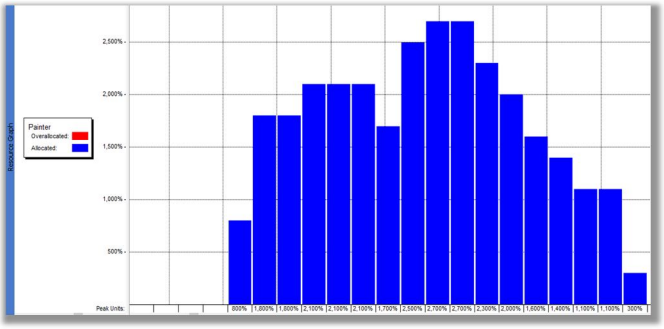


Figure 20: Resource levelling for Painter

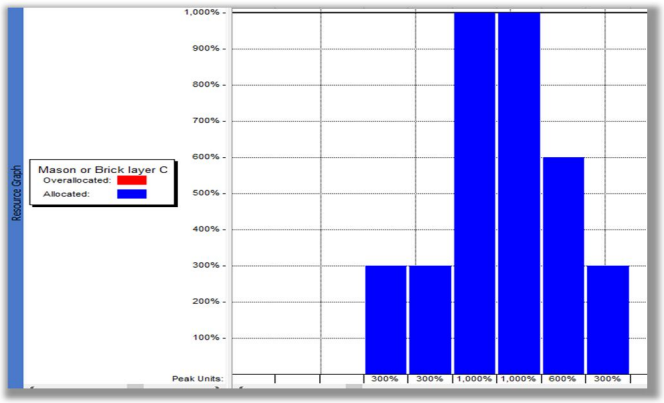


Figure 21: Resource levelling for Mason

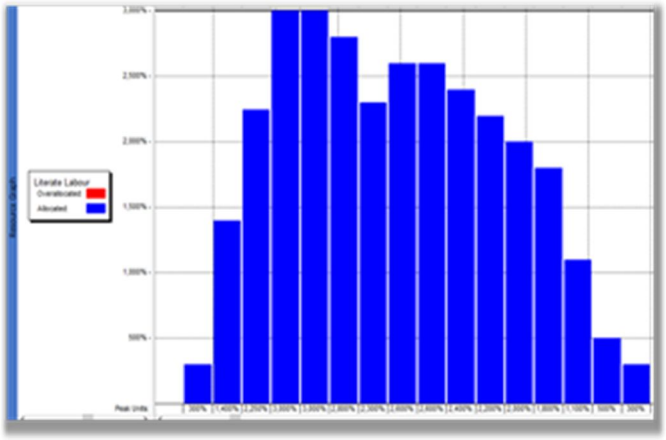


Figure 22: Resource levelling for Literate Labour

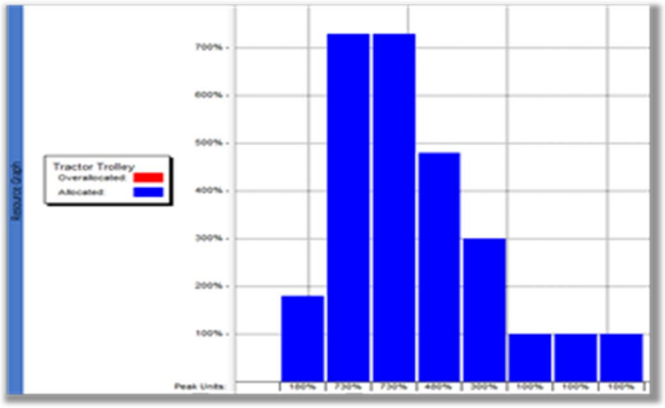


Figure 23: Resource levelling for Tractor Trolley

The process of assigning and managing resources in a way that helps the organisation achieve its planned goals is known as resource allocation. Resources typically refer to labour, money, and material.

5) *Resource Calculation:* Once the levelling is done, the duration of the project is also changed. Earlier the total duration required to complete the whole project was 442 days and after levelling it has been increased to 548 days. The Software automatically calculates the cost of resources for the entire project. The cost is increased after levelling the resources.

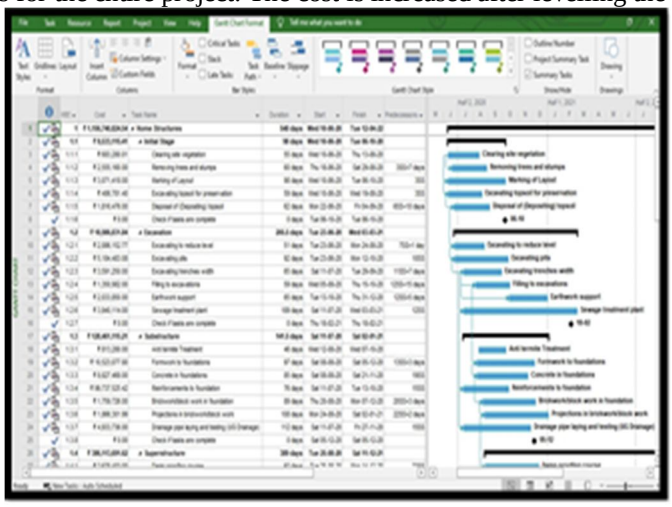


Figure 24: Duration and cost of activities after over-allocation

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III. RESULTS

A. Network Diagram

It is a graphic representation of the many activities and how they relate to one another. The network diagram here displays the project's tasks in the sequential sequence in which they will be completed. The network diagram enables the construction and connection of the tasks and their intended execution visibly. A network diagram may include tasks, deliverables, milestones, or subprojects. Also displayed is the critical path. CPM network will be given by MS Project. Activities that are highlighted in pink are those that are critical; other activities are not.

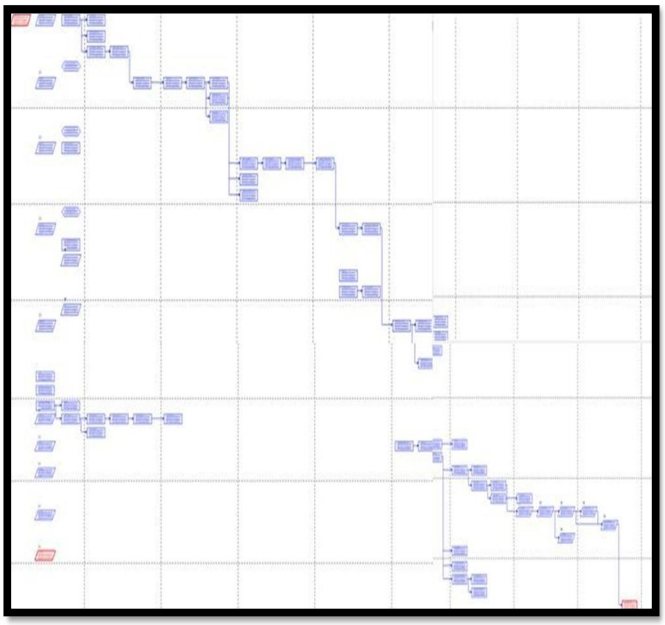


Figure 25: Network Diagram

B. Work Breakdown Structure

By creating the WBS (Work Break down Structure) and allocating the resources the total duration of the project is calculated by planning and scheduling the project. In this study, the planned date of starting of project was 10/06/2022 and scheduled completion date is 12/04/2022.

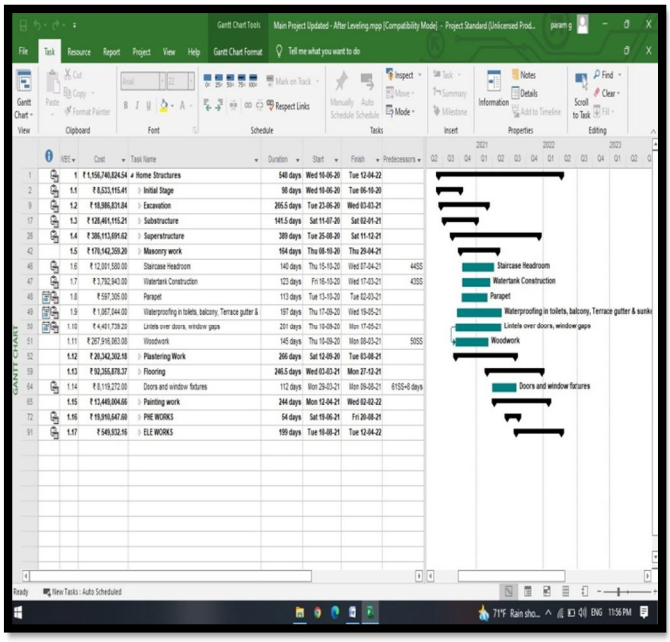


Figure 26: Final Schedule of the Project

C. Resource Sheet After Levelling Resources

Project1

ID	Resource Name	Initials	Type	Material Label	Std. Rate
1	**MATERIAL COST**	M	Material		₹ 0.00
2	Solid Concrete Blocks (200mm thickness)	S	Material	each	₹ 55.00
3	Steel Fe 415	S	Material	t	₹ 65,000.00
4	Superplasticizer as per IS 9103	S	Material	kg	₹ 200.00
5	Damp proofing course	D	Material	per 20l	₹ 5,000.00
6	Acrylic Interior primer	A	Material	per l	₹ 120.00
7	Aluminium Composite panel curved	A	Material	m2	₹ 3,600.00
8	Aluminium sheets for formwork	A	Material	m2	₹ 24,000.00
9	Curing Compund	C	Material	per litre	₹ 690.00
10	Ceramic Glazed tiles	C	Material	m2	₹ 450.00
11	Chicken Mesh	C	Material	m2	₹ 12.00
12	Chromium plated Brass butt hinges	C	Material	10 No.	₹ 805.00
13	Coloured Pedestal type W.C. pan 580x440 mm	C	Material	each	₹ 1,600.00
14	Door spacer Long	D	Material	each	₹ 360.00
15	Dry distemper	D	Material	kg	₹ 38.00
16	Enamel paint	E	Material	per l	₹ 220.00
17	Epoxy Grout	E	Material	kg	₹ 380.00
18	Exterior primer	E	Material	kg	₹ 143.00
19	Italian Marble stone slab	I	Material	m2	₹ 3,600.00
20	Mirror polished granite	M	Material	m2	₹ 1,800.00
21	Oil type wood preservative	O	Material	per litre	₹ 130.00
22	Openable window made out of multi chambered upvc	O	Material	m2	₹ 5,644.00
23	Precast R.C.C. perforated slab	P	Material	each	₹ 740.00
24	Premium Acrylic exterior paint	P	Material	per litre	₹ 210.00
25	Premixed super white gypsum plaster	P	Material	kg	₹ 6.00
26	Pressed clay tiles 20 mm thick 250 x 250 mm size	P	Material	No.	₹ 8,600.00
27	Solid concrete blocks 400x100x200 mm	S	Material	No.	₹ 31.00
28	Solid concrete blocks 400x150x200 mm	S	Material	No.	₹ 38.00
29	Solid concrete blocks 400x200x200 mm	S	Material	No.	₹ 47.00
30	Stainless steel kitchen sink - with drain board	S	Material	each	₹ 3,000.00

Figure 27: Resource Sheet after leveling

31	Stainless steel SS 304 grade adjustable friction window stay	S	Material	each	₹ 925.00
32	Teak wood	T	Material	m3	₹ 175,000.00
33	Teak wood planks for panels 20 mm thick	T	Material	m3	₹ 150,000.00
34	Teak wood scantling for styles and rails 35 mm thick	T	Material	m3	₹ 150,000.00
35	Textured exterior paint	T	Material	per litre	₹ 280.00
36	Thermal insulation of roofing	T	Material	m3	₹ 358.00
37	Vitrous china pedestal for wash basin	V	Material	each	₹ 950.00
38	Water proofing cement paint	W	Material	kg	₹ 38.00
39	White Vitreous china flat back wash basin 630x450 mm	W	Material	each	₹ 725.00
40	15 mm C.P.brass tap	1	Material	each	₹ 270.00
41	2 Point spider fittings of SS-316 grade	2	Material	each	₹ 1,659.00
42	Panel sliding windows	P	Material	m2	₹ 5,339.00
43	20 mm dia holding down bolts	2	Material	No.	₹ 6,100.00
44	20 mm dia. PTMT stop cock	2	Material	each	₹ 68.00
45	Clear toughened Laminated glass for fins with holes	C	Material	m2	₹ 6,000.00
46	Anti-Termite treatment	A	Work		₹ 80.00/hr
47	High performance glass	H	Material	m2	₹ 1,000.00
48	Staircase headroom	S	Material	per unit	₹ 150,000.00
49	Cement for watertank	C	Material	per bag	₹ 400.00
50	Sand for watertank	S	Material	per m3	₹ 500.00
51	Coarse aggregate for watertank	C	Material	per m3	₹ 650.00
52	Steel for watertank	S	Material	per kg	₹ 75.00
53	Parapetwall Construction	P	Material	per sq.ft.	₹ 10,000.00
54	Earthworkk Support	E	Work		₹ 1,250.00/hr
55	External plaster	E	Material	per sq. ft	₹ 40.00
56	Self compacting concrete	S	Material	per m3	₹ 350,000.00
57	Screed	S	Material	per 10 sq.ft	₹ 25.00
58	Wooden flooring	W	Material	per sq. ft	₹ 500.00

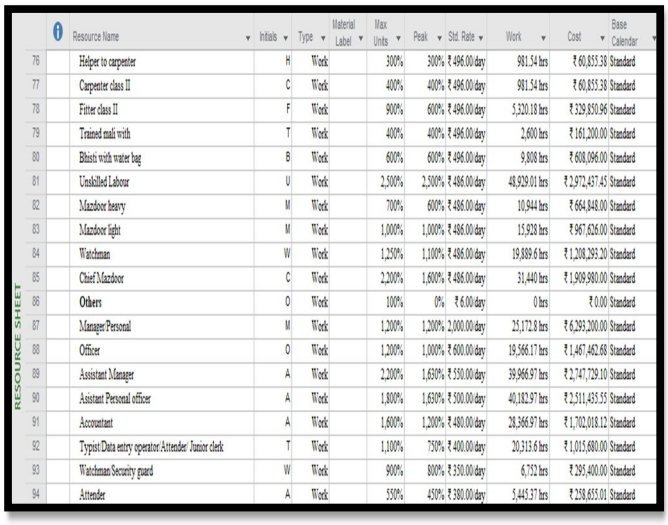
Figure 28: Resource Sheet after leveling

RESOURCE SHEET

59	**LABOUR COST**	L	Work	100%	0%	₹ 526.00/day	0 hrs	₹ 0.00 Standard
60	Highly Skilled	H	Work	2,500%	1,400%	₹ 526.00/day	27,118.15 hrs	₹ 1,783,018.62 Standard
61	Literate Labour	L	Work	3,000%	3,000%	₹ 526.00/day	61,873.93 hrs	₹ 4,068,210.70 Standard
62	Skilled	S	Work	2,600%	2,200%	₹ 506.00/day	31,755.22 hrs	₹ 2,008,517.83 Standard
63	Blacksmith	B	Work	1,000%	300%	₹ 506.00/day	1,992 hrs	₹ 125,994.00 Standard
64	Mason or Brick layer Class -1	M	Work	1,000%	1,000%	₹ 506.00/day	6,377.34 hrs	₹ 403,366.49 Standard
65	Carpenter Class I	C	Work	200%	200%	₹ 506.00/day	981.54 hrs	₹ 62,082.31 Standard
66	Plumber	P	Work	100%	100%	₹ 506.00/day	184 hrs	₹ 11,638.00 Standard
67	Painter	P	Work	3,000%	2,700%	₹ 506.00/day	56,751.87 hrs	₹ 3,589,555.99 Standard
68	Fitter Class I	F	Work	700%	600%	₹ 506.00/day	6,092.18 hrs	₹ 385,330.19 Standard
69	Electric Welder	E	Work	120%	120%	₹ 506.00/day	1,321.6 hrs	₹ 83,591.20 Standard
70	Machine operator	M	Work	1,200%	1,030%	₹ 506.00/day	4,185.6 hrs	₹ 264,739.20 Standard
71	Bar bender	B	Work	200%	200%	₹ 506.00/day	21.71 hrs	₹ 1,373.42 Standard
72	Maistry or Supervisor	M	Work	2,500%	2,500%	₹ 506.00/day	69,671.4 hrs	₹ 4,406,715.89 Standard
73	Semi skilled	S	Work	2,400%	2,100%	₹ 496.00/day	26,978.86 hrs	₹ 1,672,689.14 Standard
74	Cleaner	C	Work	950%	900%	₹ 496.00/day	14,657.6 hrs	₹ 908,771.20 Standard
75	Helper to fitter	H	Work	600%	600%	₹ 496.00/day	4,378.84 hrs	₹ 271,488.30 Standard

Figure 29: Resource Sheet after levelling

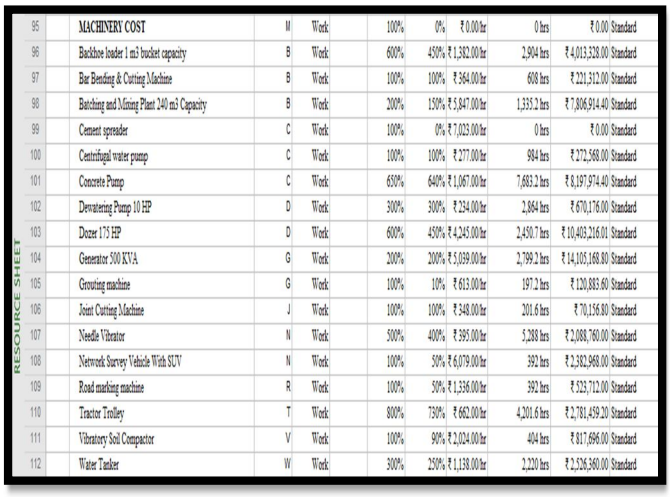
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RESOURCE SHEET

	Resource Name	Initials	Type	Material Label	Max Units	Peak	Std. Rate	Work	Cost	Base Calendar
76	Helper to carpenter	H	Work		300%	300%	₹ 496.00/day	981.54 hrs	₹ 60,855.38	Standard
77	Carpenter class II	C	Work		400%	400%	₹ 496.00/day	981.54 hrs	₹ 60,855.38	Standard
78	Fitter class II	F	Work		900%	600%	₹ 496.00/day	5,320.18 hrs	₹ 329,850.96	Standard
79	Trained mali with	T	Work		400%	400%	₹ 496.00/day	2,600 hrs	₹ 161,200.00	Standard
80	Bhisti with water bag	B	Work		600%	600%	₹ 496.00/day	9,808 hrs	₹ 608,096.00	Standard
81	Unskilled Laborar	U	Work		2,500%	2,500%	₹ 486.00/day	48,929.01 hrs	₹ 2,972,457.45	Standard
82	Mazdoor heavy	M	Work		700%	600%	₹ 486.00/day	10,944 hrs	₹ 664,848.00	Standard
83	Mazdoor light	M	Work		1,000%	1,000%	₹ 486.00/day	15,928 hrs	₹ 967,626.00	Standard
84	Watchman	W	Work		1,250%	1,100%	₹ 486.00/day	19,889.6 hrs	₹ 1,208,293.20	Standard
85	Chief Mazdoor	C	Work		2,200%	1,600%	₹ 486.00/day	31,440 hrs	₹ 1,909,980.00	Standard
86	Others	O	Work		100%	0%	₹ 6.00/day	0 hrs	₹ 0.00	Standard
87	Manager Personal	M	Work		1,200%	1,200%	₹ 2,000.00/day	25,172.8 hrs	₹ 6,293,200.00	Standard
88	Officer	O	Work		1,200%	1,000%	₹ 600.00/day	19,566.17 hrs	₹ 1,467,462.68	Standard
89	Assistant Manager	A	Work		2,200%	1,630%	₹ 550.00/day	39,966.97 hrs	₹ 2,747,729.10	Standard
90	Assistant Personal officer	A	Work		1,800%	1,630%	₹ 500.00/day	40,182.97 hrs	₹ 2,511,435.55	Standard
91	Accountant	A	Work		1,600%	1,200%	₹ 480.00/day	28,366.97 hrs	₹ 1,702,018.12	Standard
92	Typist Data entry operator Attender Junior clerk	T	Work		1,100%	750%	₹ 400.00/day	20,313.6 hrs	₹ 1,015,680.00	Standard
93	Watchman Security guard	W	Work		900%	800%	₹ 350.00/day	6,752 hrs	₹ 295,400.00	Standard
94	Attender	A	Work		550%	450%	₹ 380.00/day	5,445.37 hrs	₹ 238,655.01	Standard

Figure 30: Resource Sheet after leveling



RESOURCE SHEET

	MACHINERY COST	M	Work		100%	0%	₹ 0.00/hr	0 hrs	₹ 0.00	Standard
96	Backhoe loader 1 m3 bucket capacity	B	Work		600%	450%	₹ 1,382.00/hr	2,904 hrs	₹ 4,013,328.00	Standard
97	Bar Bending & Cutting Machine	B	Work		100%	100%	₹ 364.00/hr	608 hrs	₹ 221,312.00	Standard
98	Batching and Mixing Plant 240 m3 Capacity	B	Work		200%	150%	₹ 5,847.00/hr	1,335.2 hrs	₹ 7,806,914.40	Standard
99	Cement spreader	C	Work		100%	0%	₹ 7,023.00/hr	0 hrs	₹ 0.00	Standard
100	Centrifugal water pump	C	Work		100%	100%	₹ 277.00/hr	984 hrs	₹ 272,568.00	Standard
101	Concrete Pump	C	Work		650%	640%	₹ 1,067.00/hr	7,683.2 hrs	₹ 8,197,974.40	Standard
102	Dewatering Pump 10 HP	D	Work		300%	300%	₹ 254.00/hr	2,864 hrs	₹ 670,176.00	Standard
103	Dozer 175 HP	D	Work		600%	450%	₹ 4,245.00/hr	2,450.7 hrs	₹ 10,402,216.01	Standard
104	Generator 500 KVA	G	Work		200%	200%	₹ 5,039.00/hr	2,799.2 hrs	₹ 14,105,168.80	Standard
105	Grouting machine	G	Work		100%	10%	₹ 613.00/hr	197.2 hrs	₹ 120,883.60	Standard
106	Joint Cutting Machine	J	Work		100%	100%	₹ 348.00/hr	201.6 hrs	₹ 70,156.80	Standard
107	Needle Vibrator	N	Work		500%	400%	₹ 395.00/hr	5,288 hrs	₹ 2,088,760.00	Standard
108	Network Survey Vehicle With SUV	N	Work		100%	50%	₹ 6,079.00/hr	392 hrs	₹ 2,382,968.00	Standard
109	Road marking machine	R	Work		100%	50%	₹ 1,336.00/hr	392 hrs	₹ 523,712.00	Standard
110	Tractor Trolley	T	Work		800%	730%	₹ 662.00/hr	4,201.6 hrs	₹ 2,781,459.20	Standard
111	Vibratory Soil Compactor	V	Work		100%	90%	₹ 2,024.00/hr	404 hrs	₹ 817,696.00	Standard
112	Water Tanker	W	Work		300%	250%	₹ 1,138.00/hr	2,220 hrs	₹ 2,526,360.00	Standard

Figure 31: Resource Sheet after leveling

D. Gantt Chart

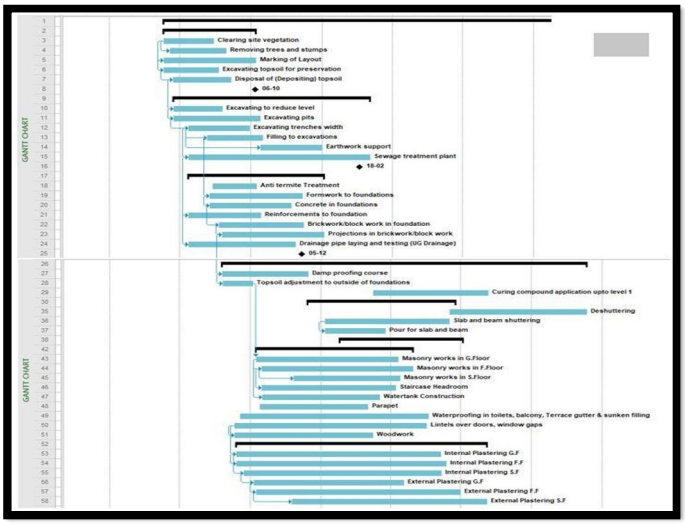


Figure 32: Gantt Chart

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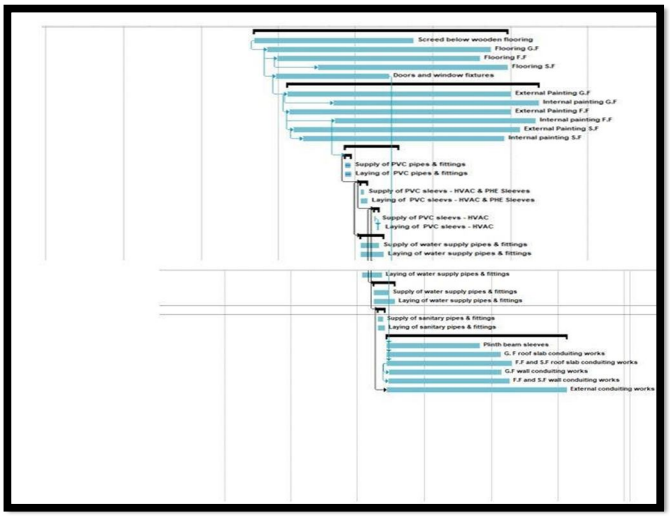


Figure 33: Gantt Chart

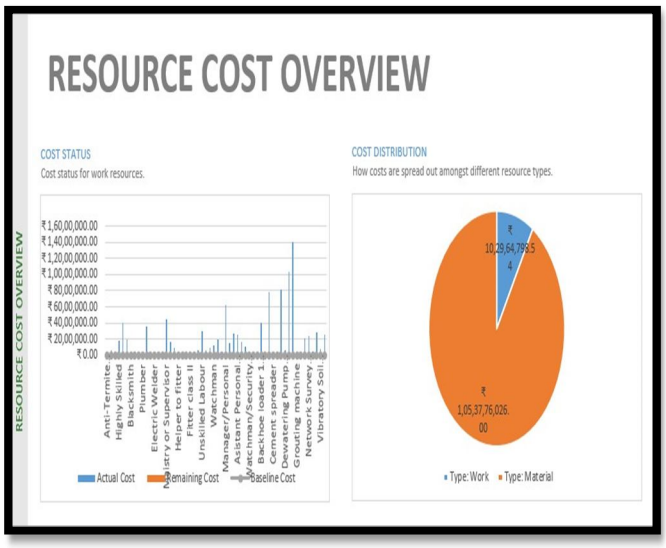


Figure 34: Resource Cost Overview

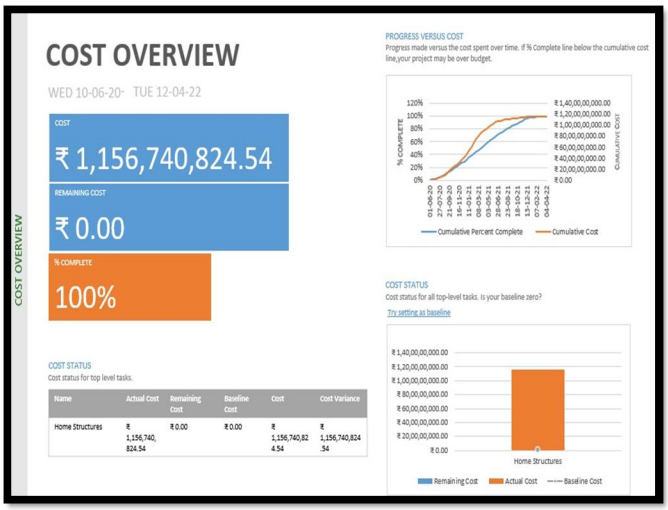


Figure 35: Cost Overview

The cost of each action is calculated by Microsoft Project, which also provides the project's overall cost. The cost is calculated by Microsoft Project in the same way as we manually calculate it. The client can learn his project's final budget from this. It supports the budget of the client, the owner, or the contractor. The price of any item can be helpful as well.

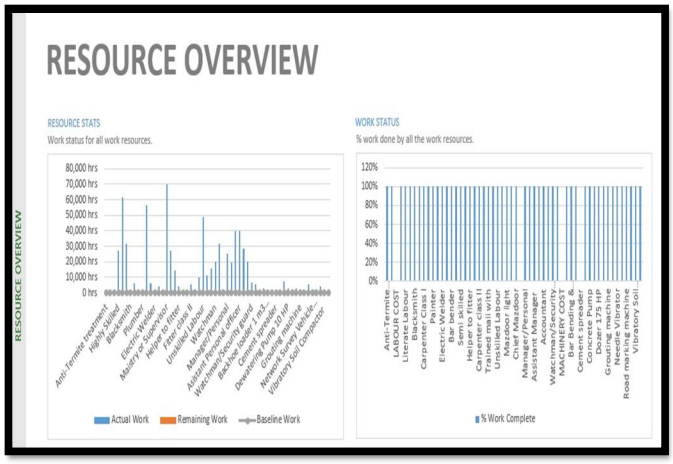


Figure 36: Resource Overview

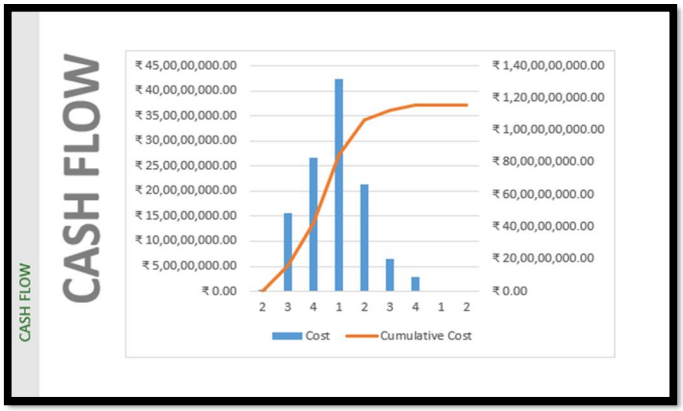


Figure 37: Cash Flow

Cash flow shows the Cost of the Project for every Quarter year coming within the schedule. This Graph is automatically generated in MS Project Software.

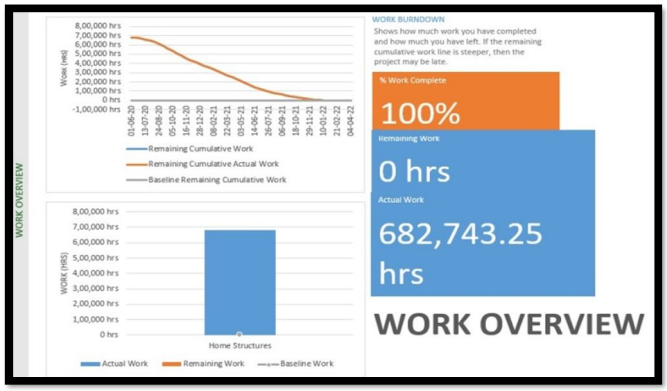


Figure 38: Work Overview

Actual required duration to complete the project is 442 days. After resource levelling duration of project is increased to 548 days. Thus the project duration increased by 19%. Increase in project duration causes increase in the project cost. Project cost is increased to Rs.136, 850,237. Thus, project cost increases by 0.94%

IV. CONCLUSION

1) Construction management application, Microsoft Project 2013 is utilised in this project for planning, scheduling, resource allocation, levelling, and tracking.

2) Resources such as manpower, material and machinery are allocated for each and every activity according to the requirement. The overallocated resources are Assisstant Personal Officer, Painter, Tractor Trolley, Supervisor, Machine Operator, Manager Personal, Unskilled labour, Maistry/Supervisor, Mason, Lietrate Labour

3) Resource levelling is done for resource constrained analysis. Only labour and machinery are considered resources for this project. In exchange for lessening resource restrictions, duration is extended.

4) Actual required duration to complete the project is 442 days. After resource levelling duration of project is increased to 548 days. Thus the project duration increased by 19.3%.

5) Increase in project duration causes increase in the project cost. Project cost is increased to Rs.136, 850,237. Thus, the project cost increases by 0.001% without slack. Since there are 26 Villas, the cost of each villa would be around 4.5Cr.

6) Different graphical representations like charts, views are used to analyze the project as they are easy to understand.

7) This system of analysis can be used by a company with numerous projects that are comparable to update the best options accor ding to the requirements.

8) This comprehensive study is conducted to develop a project timetable and identify the best way to employ all available resources. Additionally, it will support the funding needed for it as well as the procurement of materials.

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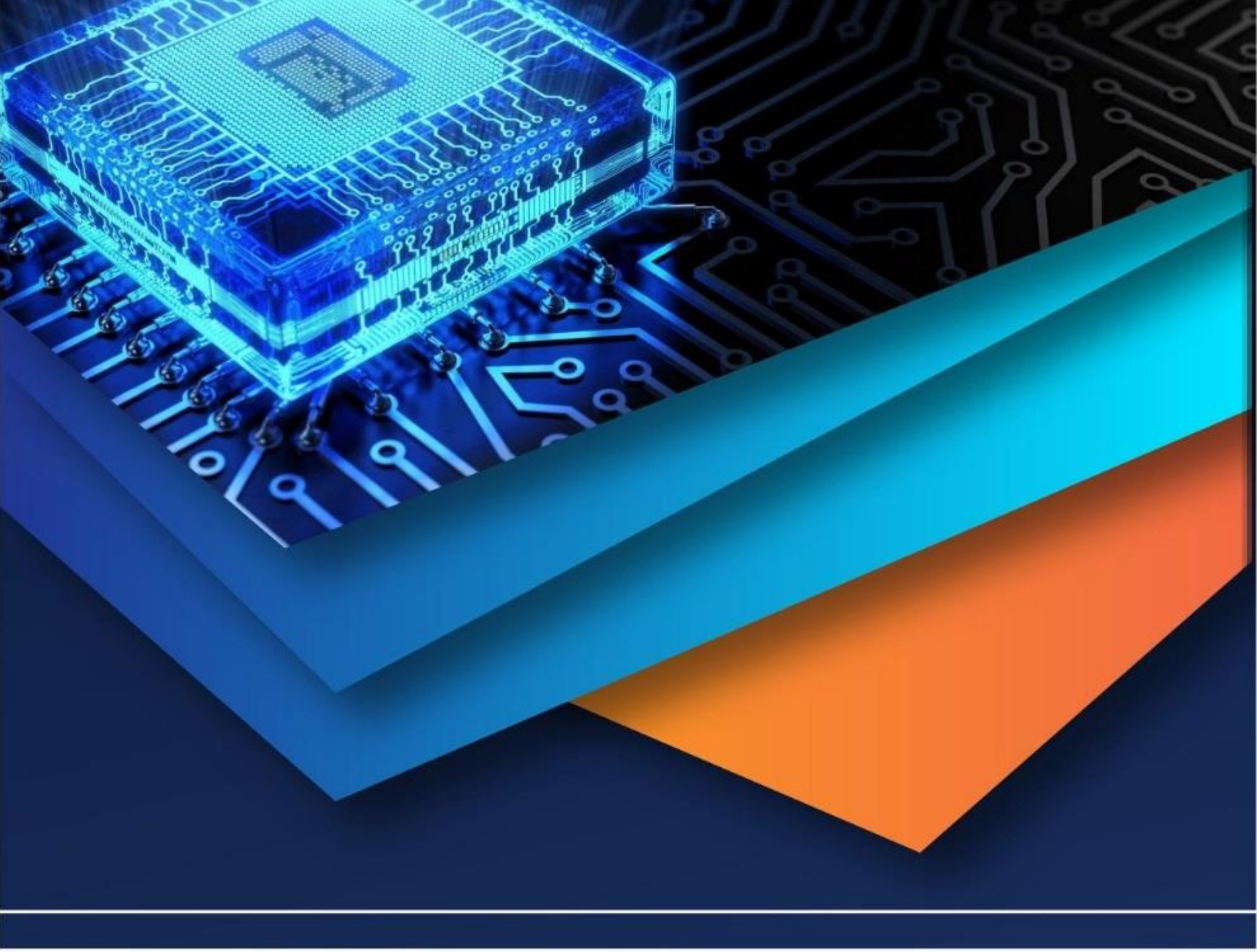
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