Resource Optimization in Mivan Construction Project

Mr. Shreyas Revannath Papal¹, Prof. Pratima V. Kalokhe²

¹*P.G Student (Construction Management), Department of Civil Engineering, Pimpri Chinchwad College of Engineering, Pune, India.*

² *Assistant Professor, Department of Civil Engineering, Pimpri Chinchwad College of Engineering, Pune, India.*
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Abstract - *In any construction project resources plays important role in successful completion of project. Resources are main constituents in any construction project. In Mivan construction main resources are men, material and money. By process of optimization, we can save so many natural resources and cost. So, main purpose of this project work is to understand this concept of optimization clearly and apply optimization techniques to optimized various resources on site. To achieve the said target of project-work, a site interaction is essential. So, for the project work a site of "Rohan Builders" was taken for the study and by finding some problem of resource utilization optimization techniques such Assignment model, Resource levelling and EOQ Analysis are implemented.*

Key Words: **Optimization, Material, Resources, Construction Industry, Resource Levelling, Assignment Model**

1. INTRODUCTION

Optimization is nothing but provide something which is just required only and it should be in such an amount that it is neither available in short amount nor it is going to waste. In simple way optimization is the procedure of getting the solution under given circumstances. During any construction engineer need to take many constructions related decisions at various stages of project. The Final goal of all these such decision is either to reduce effort for performing task or to increase the benefits from tasks. Now the effort required or the benefit desired in any practical situation can be expressed as a function of a certain decision variables, optimization can be defined as the process of finding the conditions that give the value of maximum or minimum function.

Human resource optimization is tools for giving positive impacts on efficiency, productivity and finally profitability of firm of construction. Any projects success and profitability of a construction organization is counted by the work performed by the human resource and by the cost required to allocate human resources on project.

For any construction project the resources play an important role. The resources are the thing which mostly influences in cost on any construction project. So, by optimizing them we can easily save the wastage of money and applied appropriately where they are needed.

In construction sector there are 3 types of resources. They are as follows,

1) Men,

2) Materials,

3) Machinery.

1) Men

Manpower is one most critical resource to handle on site. The changes in that are unexpected. So, to tackle such problem one must firstly optimize the way to use them. Human resource optimization consists following points,

A) To allocate human resource for a particular project in such a way that it gives maximum benefits in minimum cost with very low risk and with environmental consideration.

B) To find out different ways to allocation of human resources and select best of them for execution of project work.

2) Material

For the human resources the manager only thinks about the best allocation of them for a particular project work. But for material the manager has to think about its quality, usability period, price escalation etc. Concrete, Steel, Bricks, Formwork, Other miscellaneous material, etc.

3) Equipment's

Equipment's are of various sizes and used for many purposes. To manage them optimally the manager has to think about many aspects like their maintenance, profit generation from them, operating costs, efficiency to carry work, appropriate way to allocate them etc. Depending on mechanization used in any construction project its cost varies from 11% to 30 % of total project cost. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in optimization of the project.

1.1 Aim

'To study resource optimization techniques and manage resources effectively in mivan construction'

1.2 Objectives

1. To study process of resource optimization.

2. To select construction site related to mivan construction and get details about resource management thoroughly.

3. To increase resource usability by optimal allocation of resources using construction management techniques.

2. Literature Findings

1. Using Software programs for managing resources for construction project having positive impact.

2. Resource optimization is also achieved through proper control on wastage of resources.

3. Well established working procedure plays important role in resource optimization.

4. Projects with proper scheduling helps for managing resources effectively
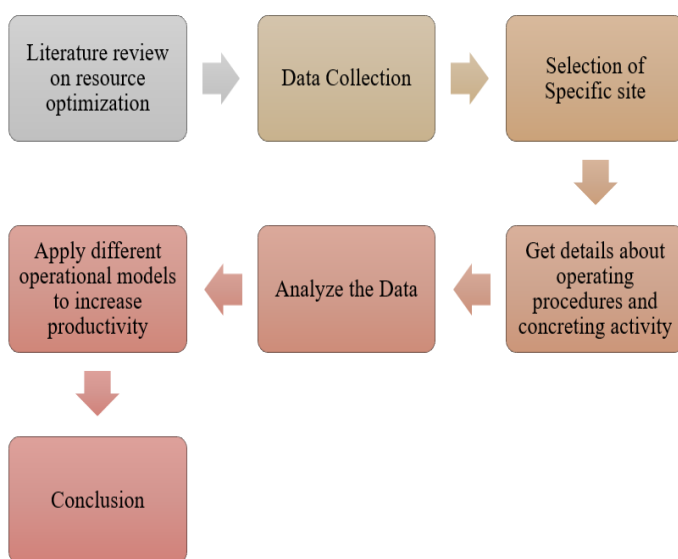
3. Methodology Adopted

Fig 1: Methodology Adopted

4. Approach for Optimization

Approach is developed for the shuttering work and casting of aluform flats and accordingly factors are considered which are affecting directly or indirectly to optimization of resources. Necessary resources required are categorized in three parts as follows.

1. Materials,
2. Manpower,
3. Equipment

4.1 Materials

Price of material is mainly depended on the market and its inflation. Consumption process of any material is also affecting its usage on construction site. Optimization material is depending on following factors

a) Costing of Material
b) Management of material on site
c) Taxes of Material
d) Carrying cost of material,
e) Stacking Cost,
f) Testing Cost,
g) Discount from suppliers,
h) Market Price Inflation,
i) Onsite Material Consumption Practice.

Now in the above-mentioned factors some factors are not avoidable. So, process of optimization is not applicable for such certain factors. There is no control on such factors they are unable to optimize by manager. In above factors like material cost, Onsite material management, discount on purchase, Material consumption practices can be optimized by optimization techniques.

4.2 Manpower

Optimization of manpower is mostly depending on following various factors this may affect
.

a) Workers Skill Level,
b) Labor Allocation to work,
c) Workers' Wages,
d) Inflation,
e) Workers expenses towards medical,
f) Onsite Accidents,
g) Amenities provided to workers.

First two factors can be control by proper management and its study. Optimal allocation of labor for particular tasks also plays important role in optimization. Assignment model is used for allocation of proper labors.

4.3 Equipment

Following factors are mostly plays important role in optimization in case of equipment.

a) Equipment Cost,
b) Cost of Fuel,
c) Equipment Selection
d) Cost of Logistic

5. Case Study/ Data Collection

To complete this project a particular construction site in which main focus is mivan work is considered. The site is Rohan Builders Rohan Anand project. The project consists of 5 building. Total estimated cost of project is about Rs.85 crores. So, for such project proper management of resources is very necessary

Table -1: Project Details

Sr. No.	Content	Description
1.	Name of Project	Rohan Anand
2.	No. of Storey	G+11
3.	Name of Work	Mivan Aluform work
4.	No. of Flats	620
5.	Built up area	4,90,182 Sq.ft.

Data collection is carried out based upon the drawing, specifications, schedule rates, etc. For this project in the major components are as follows:

    a) Concrete,
    b) Steel,
    c) Manpower,
    d) Equipment,
    e) Shuttering Work

For this project concrete of grade M40 & M50 is used for concreting work. Ready Mix Concrete is used in this project There is total five building in project but currently 3 buildings are in progress. Out of which D building is taken for our project work. Description about building are as follows.

Table -2: D Building Description

Content	Description
Building	D
Built Area (One Floor)	10588 Sq.Ft.
Material (Shuttering)	Aluform (Mivan)
Approximately Quantity	
1. Reinforcement	33 MT
2. Concrete	318 Cum.

5.1. Working Procedure

Sequence of activity in mivan construction is as follows.

1. Levelling and marking on surface.
2. Vertical Wall and Column Steel Binding.
3. Transferring shuttering material above level.
4. Formwork coating with oil.
5. Wall Panel Fixing (Installation of internal panel formwork – Install flat wall tie – Install external wall formworks – Install wedge and Pin).
6. Electrical Wall Conduiting.
7. Plumbing Groove Fixing.
8. Beam and Slab Formwork Fixing.
9. Inspection and Acceptance
10. Slab and Beam Reinforcement Binding.
11. Slab Electrical Pipe Conduiting.
12. Clearing material and object out of pouring floor.
13. Concreting
14. Dismantling. (Dismantle steel accessories – Dismantle Wall Formworks- Dismantle Beam Formwork – Dismantle Deck Formwork).

Fig-1: D Building 1st Floor Shuttering

5.2. Estimation of Resources

1. Labors-

For Mivan work, labor is one of most volatile resource. Labor required for shuttering, reinforcement, concreting, electrical, plumbing, etc work. Proper utilization of labor is most important for optimization of resources.

Table -3: Estimate of Labors

Content	Quantity	Approx. work/day	Description
Carpenters (Shuttering Work)	3888 SQM	20-25 SQM	Skilled-60, Unskilled - 35
Fitters (Reinforcement	36 MT	0.25-0.3 MT	Skilled-40,

Work)			Unskilled - 25
Helpers (Concreting Work)	-	Lumpsum	10
Curing Work	-	Lumpsum	4
Electrician	12 Flats	1 for 2 Flats	6
Plumber	12 Flats	1 for 2 Flats	6

5.2. Time required for shuttering

Time calculations for shuttering activity of different gangs

Table -4: Labor Gang for Sukumar Mandal

Flat Type	Date of Casting Ready	Transfer of Shuttering	Wall Shuttering	Deck Shuttering	Concreting	De-shuttering	Total
1BHK	12/2/22	0.5	1	1.5	0.5	0.5	4
2BHK	17/2/22	1	1.5	1	0.5	1	5
1RK	22/2/22	1	1	1.5	0.5	1	5.25

Table -5: Labor Gang for Nirpen Mandal

Flat Type	Date of Casting Ready	Transfer of Shuttering	Wall Shuttering	Deck Shuttering	Concreting	De-shuttering	Total
1BHK	14/2/22	1	1.5	1.25	0.5	1	5.25
2BHK	21/2/22	1.25	2	1.5	0.75	1.5	7
1RK	25/2/22	0.5	1	1.5	0.5	0.75	4.25

Table -6: Labor Gang for Chanchal Dutta

Flat Type	Date of Casting Ready	Transfer of Shuttering	Wall Shuttering	Deck Shuttering	Concreting	De-shuttering	Total
1BHK	15/2/22	0.75	1	1.25	5.25	0.75	5
2BHK	21/2/22	0.75	1.5	1.25	0.75	1	5.25
1RK	25/2/22	0.5	1.25	1.25	0.5	0.5	4

Table -6: Flatwise Time required for different Gangs

Sr. No.	Gang Name	1 BHK	2 BHK	1 RK
1	Sukumar Mandal	4	6.5	4.25
2	Nirpen Mandal	5.25	5	4.25
3	Chanchal Dutta	4.25	5.25	4

From the value obtained from table the assignment model is work out to calculate minimum days requires to complete casting of Flats.

5.3 Task Scheduled in MSP

Microsoft Project software is used for scheduled tasks of mivan construction. After scheduling of tasks various resources assigned to them so as to check overallocated tasks. Gantt Chart view in MSP helps for showing scheduled tasks and its over allocation.

Formwork Fixing	1.13 days	Sat 26-02-22	Sat 26-02-22		
Levelling and Marking on Surface	1 day	Mon 28-02-22	Mon 28-02-22		Reinforcement Labour, Reinforcement
Vertical Wall and Column Reinforcement Binding	3 days	Mon 28-02-22	Thu 03-03-22	2SS+0.5 days	Reinforcement Foreman Reinforcement Labour
Shuttering Transfer	2 days	Tue 01-03-22	Thu 03-03-22	3SS+1 day	Carpenter Labour
Formwork Oil Coating	2 days	Tue 01-03-22	Thu 03-03-22	3SS+1 day	Carpenter Labour
Wall Panel Fixing	4 days	Tue 01-03-22	Sat 05-03-22	4SS+0.3 days	Carpenter Labour,Carpe
Electrical Counduiting	2 days	Wed 02-03-22	Fri 04-03-22	6SS+1 day	Elecrician,Unskilled
Plumbing Groove Fixing	2 days	Wed 02-03-22	Fri 04-03-22	6SS+1 day	Elecrician,Unskilled
Beam and Slab Formwork	4 days	Thu 03-03-22	Mon 07-03-22	8SS+1 day	Carpenter Labour, Carpenters Foreman
Inspection and Acceptance	1 day	Sat 05-03-22	Sun 06-03-22	9SS+2 days	Carpenters Foreman, Reinforcement
Slab reinforcement binding	3 days	Sun 06-03-22	Wed 09-03-22	10	Reinforcement Foreman
Slab conduiting	2 days	Mon 07-03-22	Wed 09-03-22	11SS+1 day	Elecrician
Clearing Floor	1 day	Wed 09-03-22	Thu 10-03-22	12	Unskilled
Concreting	1 day	Wed 09-03-22	Thu 10-03-22	12	Unskilled
Dismantling	2 days	Thu 10-03-22	Sat 12-03-22	14	Carpenter Labour,Carpe

Chart -1: Task Scheduled in MSP

4			Shuttering Transfer	2 days	Tue 01-03-22	Thu 03-03-22	3SS+1 day	Carpenter Labour
5			Formwork Oil Coating	2 days	Tue 01-03-22	Thu 03-03-22	3SS+1 day	Carpenter Labour
6			Wall Panel Fixing	4 days	Tue 01-03-22	Sat 05-03-22	4SS+0.3 days	Carpenter Labour,Carpe
7			Electrical Counduiting	2 days	Wed 02-03-22	Fri 04-03-22	6SS+1 day	Electrician,Unskilled
8			Plumbing Groove Fixing	2 days	Wed 02-03-22	Fri 04-03-22	6SS+1 day	Elecrician,Unskilled
9			Beam and Slab Formwork	4 days	Thu 03-03-22	Mon 07-03-22	8SS+1 day	Carpenter Labour, Carpenters Foreman
10			Inspection and Acceptance	1 day	Sat 05-03-22	Sun 06-03-22	9SS+2 days	Carpenters Foreman, Reinforcement
11			Slab reinforcement binding	3 days	Sat 12-03-22	Wed 16-03-22	9FS-2 days,10	Reinforcement Foreman
12			Slab conduiting	2 days	Mon 14-03-22	Wed 16-03-22	11FS-2 days	Elecrician
13			Clearing Floor	1 day	Wed 16-03-22	Thu 17-03-22	12	Unskilled
14			Concreting	1 day	Wed 16-03-22	Thu 17-03-22	12	Unskilled
15			Dismantling	2 days	Fri 18-03-22	Sun 20-03-22	14FS+1 day	Carpenter Labour,Carpe

Chart -2: Overallocated Tasks

Above chart showing overallocated tasks. Task 4,5,6,7,8,9,10,13,14 is overallocated. Red marking on left side of chart shows for overallocated tasks. More manpower is required to overcome this overallocation. These increases the cost of manpower

Table -7: Increase in Cost to overcome overallocation

Type of Manpower	Present Manpower	Required Manpower	Increase in Cost
Carpenters Foreman	60	120	100%
Carpenter Labor	35	105	200%
Reinforcement Foreman	40	40	0%
Reinforcement Labor	25	25	0%
Unskilled Labor	10	20	100%
Electrician	06	12	100%

6. Data Analysis

As per content given in the approach to optimization on site, the data analysis is carried out resource wise for different factors which are likely to affect cost and time requires for the work.

6.1 Assignment Model for Manpower

On Rohan Anand site different gangs are used for performing the different works. On site there are three gangs

which are doing all shuttering activity. In the data given in the data collection the time required for the different gangs to complete shuttering activity is calculated.

Table -8: Flatwise Time required for different Gangs

Gang Name	1 BHK	2 BHK	1 RK
Sukumar Mandal	4	6.5	4.25
Nirpen Mandal	5.25	5	4.25
Chanchal Dutta	4.25	5.25	4

Solving Steps

Step 1:- Subtract row minimum value from each row element

Step 2:- Subtract column minimum value from each column element.

Step 3:- Draw such lines that min. no. of lines covers all zero .

Step 4:- Check , No. of rows = No. of Column = No. of Lines

Step 5:- Now if check satisfies then stop iteration and the table obtained is the answer and if not then repeat step 1 and 2 again to reach final answer. This method also called as Hungarian method to solve assignment model. So, by solving with above steps the final result came as below.

Table -9: Final result of Assignment Model

Gang Name	1 BHK	2 BHK	1 RK
Sukumar Mandal	0*	1.5	0.25
Nirpen Mandal	1.25	0*	0
Chanchal Dutta	0.25	0.25	0*

So, by above table it is clear that if we allotted work as 1 BHK flat to gang Sukumar Mandal, 2BHK Flat to gang Nirpen Mandal and 1 RK Flat to gang Chanchal Dutta then the minimum time for completion for respective flat construction work which is shown as below.

Table -10: Minimum Days required for shuttering of flats

Gang Name	Flat Allotted	Minimum Time in Days
Sukumar Mandal	1 BHK	4
Nirpen Mandal	2 BHK	5
Chanchal Dutta	1 RK	4
	Total	13 Days

6.1 Resource Levelling for Manpower

In Microsoft Project Software Resource Levelling is carried out. This reduces demands of labor required. It levels the resource usage in a way that we require approximately constant number of resources on site. Resource levelling enables the contractor to utilize the available resources at optimum levels without any wastage by avoiding over-allocation and under-allocation of resources to project tasks.
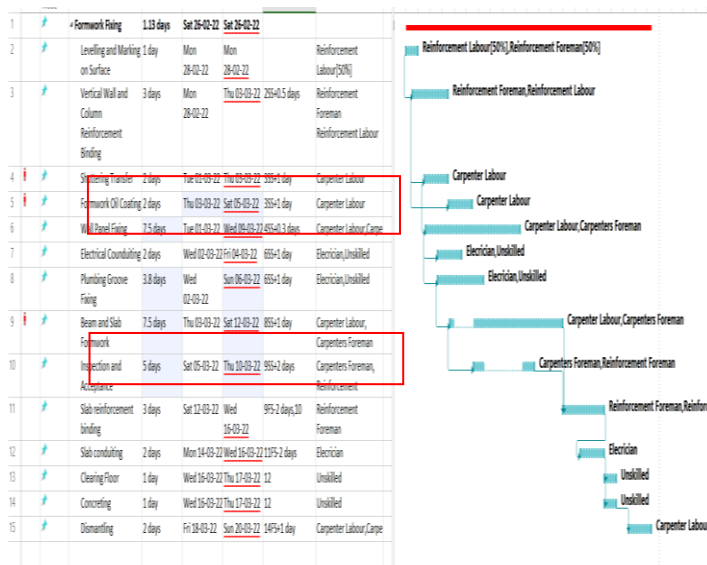
Following chart showing tasks after resource levelling

Chart- 3: Gantt Chart after Resource Levelling

In above chart only three tasks are remained overallocated after resource levelling

Table-11: Increase in cost to overcome overallocation after   resource levelling

Type of Manpower	Present Manpower	Required Manpower	Increase in Cost
Carpenters Foreman	60	60	0%
Carpenter Labor	35	53	50%
Reinforcement Foreman	40	40	0%
Reinforcement Labor	25	25	0%
Unskilled Labor	10	10	0%
Electrician	06	6	0%

Above table showing that there is significant reduction in overallocated tasks. These reduces extra demand of manpower. So, it decreases cost for manpower

3. CONCLUSION

From the study we come on conclusion that the construction management techniques are much effective for optimization of resources on construction project. As stated in literature it is shown that much more cost is saved by implementing these methods. On the project case study work it is seen that if proper model used on site, then it may possible to save much amount of money. Assignment model is helpful so as to select most efficient team to perform particular tasks. Resource Levelling overcomes the overallocation of resources which reduces the cost for manpower.

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