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RESEARCH ARTICLE

A STUDY ON RESOURCE MANAGEMENT IN CONSTRUCTION PROJECTS

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ABSTRACT

Repetitive construction projects are common in India. Several approaches and models have been presented for modelling repetitive construction projects for optimizing scheduling and resource allocation for these types of projects in spite of the above most of the promoters do improper scheduling and not well systematic utilization of man power planning. This paper presents a model that uses PERTMASTER& spread sheet to prepare optimum scheduling for effective utilization of man power resources to repetitive activities in order to minimize the overall project duration in construction projects. The data presented in this paper has been collected from southern region of India, the culture and method of construction being considered in this model. The model presented in this paper is a formulation that can be easily modified and implemented for any type of repetitive project problem, which reduces the modelling time for typical problems extensively. The outcome of the model result will reduce the overall duration of project and fine tune effective utilization of manpower.

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1. INTRODUCTION

In recent years, Mass Housing Projects (MHP) ismore common in most of the construction projects. Since Mass Housing Projects have highly repetitive activities will face more problems in the allocation of the resources in scheduling. More over most of the contractors are forced schedule the project with the deadline as per the client bases. However, in the repetitive project Manpower, Materials and Machineries are the major resource to finalise the project. We know that Critical Path Method (CPM) and Program Evaluation Review Technique (PERT) fails to seamlessly integrate activity and resource planning as it assume limitless availability of resource. To overcome this drawback of unrealistic CPM schedule deliveries, number of levelling techniques has been developed over the years. Delay in completion of the project is mainly due to improper scheduling. This paper mainly focuseson allocating the resource in the repetitive construction projects. Schedule for the smooth moment of resource will minimize the idle time and the total project cost. A model has been developed using PERT and SPREADSHEET for simulation. The model provides an optimum duration for the repetitive construction projects while applying the minimum resource to the construction activities. Proposed model is created in the Pert-master & Spreadsheet software to find the optimum solution.

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2. BACKGROUND OF STUDY

Resource constrained scheduling models can be categorized into two areas: (1) Deterministic scheduling; and (2) non-deterministic scheduling. Currently, resource-constrained scheduling models mostly focus on deterministic situations. The most popular techniques of deterministic resource-constrained scheduling models are analytical and heuristic methods. Early attempts to solve deterministic resource-constrained scheduling problems used mathematical models to obtain an optimal solution. Integer linear programming, dynamic programming, as well as branch and bound were generally used (David 1973). Johnson (1967) and Stinson (1976) separately presented branch-and-bound solutions for deterministic resource-constrained scheduling problems. However, resource-constrained scheduling problems belong to one type of NP-hard problem. Each heuristic model has its own philosophy, and they all try to increase the possibility of obtaining the best solution. Construction management has recently begun to pay attention to non-deterministic scheduling and models are categorized according to the presence or absence of resource constraints and the uncertainty theories used. Traditionally, uncertainties associated with project duration are modelled using probability theory. They can be classified into two sub-fields, depending on whether resources are constrained or not. Classical resource-unconstrained scheduling models under uncertainty are PERT and Monte Carlo simulation, and they are the most widely used in practice (Diaz and Hadipriono 1993). Ang (1975), Gong (1993), and several others also developed probabilistic resource-unconstrained scheduling models. When resource constraints are taken into consideration, only a few probabilistic models have been developed. The model proposed by Ahuja and Arunachalam (1984), and the DYNASTRAT by Padilla and Carr (1991) are some examples of probabilistic resource-constrained scheduling models in SPREAD SHEET.

2.1. Nature of resource allocation problems

Reviewing the literatures, it is evident that previous researches have implemented different methods of finding the optimum solution, rather than discussing the resource allocation problems in construction projects. Before proposing the model formulation, it is necessary to note the topics that inspire this study, and to distinguish the proposed model from prior researches.

2.1.1. Repetitive project

In similar projects, the repetitive activities are iterated throughout the project. These activities represent the work to be performed and by performing, the labour learns the project activities day to day. By this way we can speed up the project performance and minimise the project duration.

2.1.2. Unlimited resource leveling

Similar to resource-constrained allocation problems, attempts to solve unlimited resource levelling problems generally used mathematical models or heuristic models (Harris 1978). These models do not give the guarantee for the optimal solution and moreover these models have to take care by the project engineers to get the optimal result. Judging from the state of past research, it is necessary todevelop a more efficient algorithm to obtain good and near optimal solutions for practical construction projects in which computational efficiency and multiple objective issues are of concern. The model integrates concepts from the unlimited resource levelling model into a seamless architecture.

2.1.3. Resource limitation

For construction projects, effective resource management is always crucial for planners. Comparing the characteristics of resource management issues in highly-automated industry, the complexity of resource management in labour-intense construction projects arises from the diversity of resource acquirement. For limited resource we can consider machine times for productivity. The project planner's needs to be realized the project and outsourcing action should consider maintaining the project performance. The proposed model defines two general types of resources, namely INTERNAL and EXTERNAL resources, depending on procurement behaviour and holding period.

2.1.3.1. Internal Resources Usage: Here contractors own or hire for the entire project cycle, while external resources refer to temporary resources hired for specific time frame when resource consumption is heavy, and such resources are dismissed upon completion of the designated activities, on a short-term basis.

2.1.3.2. External Resource Usage: According to the above statements, one of the main focuses of this study is investigating the significance of external resources and the corresponding influence on project duration and cost, from the optimization perspective. In addition to setting the upper limits of internal resources, contractors have the option of considering external resources for resolving resource deficiency issues, depending on the assessment of their availability throughout the project.

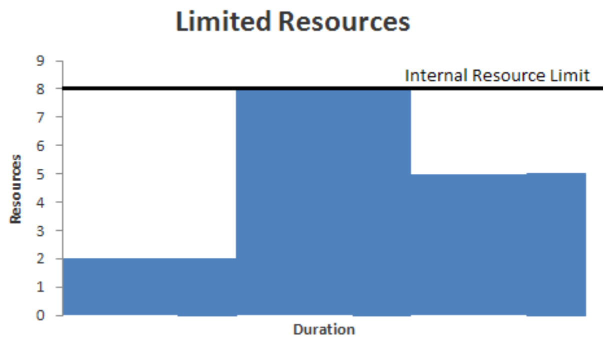

Fig. 1. Planned Resource Usage

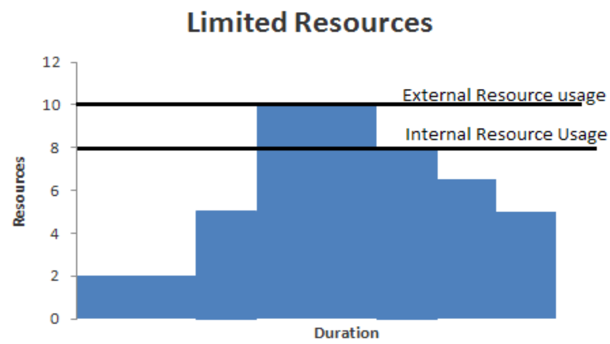

Fig. 2. Modified External Usage

Fig.1 and Fig.2 shows the resource usage in the project and how the duration in optimize the by using the external resource. More over the contractor mistake is that they do not know the exact quantity of the project. By using the external resource it may lead to high cost.

3. MODEL DEVELOPMENT

Considering the various factors on this paper, the model is highly focused on the usage of limited resource to the construction project which in turn gives high productivity. When we consider the productivity then here comes the problem again how to schedule the resource according to the productivity. This can be solved by this model by giving the high productivity with the limited resource in less budgeted cost. A software tool was developed to generate automated man hour used for the productivities. The main intended for getting the information from the user, combining the Pert and Monte Carlo to fine the optimum duration for the project. It was developed by Spreadsheet and commercial Simulation base tool for the optimization. Table 1 present the calculation for the sample problem described above. The calculations are divided into three main parts:

- Firstly, part one calculates the total man hour required for each of the activities.
- Secondly, part two calculates the total man power required for 8hours and 9hours duration for the total man hours.

Table 1. Total Man Hour & Cost Difference

Methods	Over All Cost	Days	Man Hours Required	8 hours/ day	Direct cost	9 hours/ day	Direct cost	Over Head charges 1 hour		Labour Difference Charges	
Pessimistic	305	509	56	6	2100	5	1750	88	438	1	350
			0	0	0	0	0	0	0	0	0
			108	13	20548	10	1900	48	475	3	1050
Optimistic	207	356	79	9	3150	7	2450	88	613	2	700
			0	0	0	0	0	0	0	0	0
			155	19	29379	15	2850	48	713	4	1400
Most Likely	238	407	70	8	2800	6	2100	88	525	2	700
			0	0	0	0	0	0	0	0	0
			135	16	25698	13	2470	48	618	3	1050
Mean	243	417	68	8	2800	6	2100	88	525	2	700
			0	0	0	0	0	0	0	0	0
			132	16	25082	13	2470	48	618	3	1050
Monti Carlo Simulation	227	392	72	9	3150	7	2450	88	613	2	700
			0	0	0	0	0	0	0	0	0
			140	17	26681	14	2660	48	665	3	1050

Table 2. Total Man Hour for the Complete Project

S. No	Component	Unit	Quantity	Skilled Hour	Semi Hour	Unskilled Hour	Skilled No	Semi No	Unskilled No	Skilled No	Semi No	Unskilled No
2	Site Cleaning - Entire Land area (Manual)	sft	2525			48			6			5
14	Pcc 1:4:8 laying for footings in Foundation	cft	545	16		235	2		29	2		23
15	Pcc 1:4:8 Levelling for footings in Foundation	cft	545	16		235	2		29	2		23
16	Pcc 1:4:8 laying for Lift well raft in foundation	cft	44	1		19	0		2	0		2
17	Pcc 1:4:8 levelling for Lift well raft in foundation	cft	44	1		19	0		2	0		2
18	Reinforcement works for footings mat 8mm	Kgs	28	2		2	0		0	0		0
19	Reinforcement works for footings mat 10mm	Kgs	787	47		47	6		6	5		5
20	Reinforcement works for footings mat 12mm	Kgs	311	19		19	2		2	2		2
21	Reinforcement works for footings mat 16mm	Kgs	195	12		12	1		1	1		1
22	Reinforcement works (25mm steel) for footings	Kgs	273	16		16	2		2	2		2
23	Reinforcement works for Columns upto Stilt floor	Kgs	240	14		14	2		2	1		1
24	Reinforcement works for Columns upto Stilt floor	Kgs	868	52		52	7		7	5		5
25	Reinforcement works for Columns upto Stilt floor	Kgs	1566	94		94	12		12	9		9
26	Reinforcement works for lift R.c.c walls in founda	Kgs	380	23		23	3		3	2		2
27	Shuttering for footing sides in foundation	sft	560	50		55	6		7	5		6
29	RCC M20 Laying for Footings in Foundation	cft	761	43		377	5		47	4		38
30	RCC M20 Levelling for Footings in Foundation	cft	761	43		377	5		47	4		38
31	RCC M20 Laying for Footings in Foundation	cft	553	31		274	4		34	3		27
32	RCC M20 Levelling for Footings in Foundation	cft	553	31		274	4		34	3		27
893	Main Door frame (3.5 ft x 7ft) making Charges i	sft	49	288	77		36	10	0	29	8	0
1102	Grill painting with Enamel Paint (Black)) for windo	sft	160	3		1	0		0	0		0
1103	Joinery painting for wooden Doors with frames pr	sft	610	13		4	2		1	1		0
1104	Joinery painting for wooden Doors (Enamel paint)	sft	610	13		4	2		1	1		0
1105	Joinery painting for wooden Doors (Enamel paint)	sft	610	13		4	2		1	1		0
				28295	77	55048	3534	10	6869	2827	8	5495
						Cost	1236786	2013	1305055	989429	1610	1044044

- Finally, the third part is used to determine the total cost (direct and indirect cost) of each man power for the 8 hours and 9 hours duration, which may reduce the total duration and cost.

3.1. Model Explanation

Part One of the Model: In part one first column 4 says about the total man hour required for the complete project duration. Columns 5 & 7 indicate the man power required for the 8 hours and 9 hours for the project. While calculating the man hour to man powers we could find the resource difference which in cost base analysis. While comparing to the cost there is much difference in the total project cost as shown in Table 2.

Quantity of Man Power = Constant x Quantity of Activity.

Part Two of the Model: In the part two we calculate the total duration of the project by pert and simulation analysis. Taking the valves in the pert by optimistic (a) 70%, most likely (m) 10% and pessimistic (b) 20% did the calculation for the overall project duration. This gave an optimal result.

$$\mu(i,j) = \frac{1}{6}\left(a_{ij} + 4m_{ij} + b_{ij}\right)$$

$$\sigma^2(i,j) = \frac{1}{36}\left(b_{ij} - a_{ij}\right)^2$$

Where $\mu(i,j)$ and $\sigma^2(i,j)$ are the mean duration and its variance, respectively, of an activity (i,j). Monti Carlo technique valve is much higher than the optimistic but which give an optimal schedule and overall cost of the project as shown in Table 3 & 4.

Table 4. Duration Calculation

Methods	Duration	Delay
Pessimistic	509	153
Optimistic	356	0
Most likely	407	51
Monti Carlo Simulation	392	36
Mean	417	61

Table 3. Percentage valve

Optimistic	0-69
Most likely	70-79
Pessimistic	80-99

Part Three of the Model: Cost plays the major role in the project. Here we calculate the direct and indirect cost of the combining DC and IC gives the much variance in the project. From table.1 the Column 2 show the overall DC and IC cost difference of the over project and it also shows the total duration cost of the project by Pert and Monti Carlo simulation.

Total cost = Direct cost + Indirect cost + Bonus - Penalty.

By comparing the total man hour, man power, DC, IC of the project the Monti Carlo gives us the best result.

4. CONCLUSION

In this paper the resource allocation for the repetitive project was described. Using the proposed spreadsheet Monte Carlo simulation implementation, user can minimize the overall project duration while increasing the total Man hour. While most optimizer keeps only the limited resource for the overall project schedule, the model presented here can easily be implemented for similar problemsas been found to outperform similar models in terms of increasing the total man hours in the project. From the author, concludes that by increasing the man hour instead of increasing the man power will have a much difference in the cost in the projects and thereby performing the man hour will give the best in cost and duration.

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