

Manpower Planning, Scheduling and Tracking of a Construction Project Using Microsoft Project Software

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Received: August 31, 2015|Revised: September 29, 2015|Accepted: November 30, 2015

Published Online: December 17, 2015

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Abstract Many project suffers time and cost overruns due to improper planning, scheduling and execution works that results in several issues like delay in providing facilities, development, reduction in quality of construction and making the project more expensive. A little consideration shows that the time required to complete the project is inversely proportional to the supply of manpower. As the manpower is increased, the completion time of the project is decreased and on the other hand if the manpower is decreased, the completion time of the project is increased. The present study deals with the manpower planning, scheduling and tracking of “Construction of a Residential Block at Mahadev Parisar, Bhopal”, a six storied (G+6) building project whose construction is in progress at Shivaji Nagar, Bhopal, Madhya Pradesh. A comparison between the baseline duration and cost to actual duration and cost of manpower of project is also determined using project management software tool Microsoft Project 2013.

Keywords: Microsoft Project Software; Task; Critical path; Manpower; Project

1. INTRODUCTION

The management can be defined as the art and the science of preparing, organising and directing human efforts to control the forces and use the materials of nature for the benefit of human race. Project management aims to achieve the specified goals of the project leading to completed facility, by virtue of planning, executing, and controlling time, funds and human and technical resources. The planning essentially consists of setting objective, identifying resources and forming strategy. Execution consists of allocation of resources,

Journal of Today's Ideas –
Tomorrow's Technologies,
Vol. 3, No. 2,
December 2015
pp. 161–169

guiding execution, coordinating efforts and motivating the staff. Controlling consists of measuring achievement goals, reporting, and resolving problems. The planning, executing and controlling are performed on a continuous basis till the goals of the project are realized.

PMBOK Guide (2000), defines that a project is a temporary effort undertaken to create a unique product or service. Temporary means that every project has a definite start and a definite end. Unique means that the every project is different in some way from all other project. Ismail Abdul Rahman et al. (2014) founded significant factors causing cost overrun in construction project are shortage of labour low productivity of labours, lack of experience of contractor and sub-contractor, financial difficulties, unclear and inadequate detail drawing, design change. K.K. Chithkara (1998), defined the project management as a science & art of mobilizing and managing human resources, materials, machineries and money to complete the assigned task within specified duration & pre estimated costs and specified technical performance standards. According to Hamed et al. (2013), every organization, at least, has four types of resources to be allocated in order to achieve organizational aims. These resources are: human resources, physical resources, financial resources, and technology resources. Resources should be allocated in an efficient and appropriate manner since success is achieved when plans, employees, performance, controls and commitments made act to maintain and survive allocated resources.

Workers at the project site are made to execute a specified function and its connected tasks. These workers include engineer, construction workers, supervisors, operators, drivers, and administrative personnel. Construction involves multi skill technology for its wide range of related activities. These skills vary with nature of job, type of project, and corporate policy of the contractor. For ease of estimating, planning, accounting, and controlling; the project workers are classified based on trade wise. Further, these are divided into two groups, namely, direct manpower and indirect manpower.

Building infrastructures in India has now become formidable challenge which can only be met by adopting innovative construction technology. Construction work involves different activities carried out by diverse processes by skilled and unskilled workers, and needs to be completed within planned time schedule. To maintain such time schedule, construction processes need to employ new tools and techniques in project management. So the need for better construction practices, systematised planning and programming of works and effective management in the industry, is therefore the demand of the day.

2. CASE STUDY

The proposed project for case study work is construction of Mahadev Parisar at Shivaji Nagar, Bhopal. Mahadev Parisar is a project of Madhya Pradesh Housing & Infrastructure Development Board, Bhopal.

The construction work of the project is in progress. The Mahadev Parisar project consists of the construction of 92 flats (G+6).

- The construction of proposed structure is taking place under supervision of M.P Housing & Infrastructure Development Board Division-6 Bhopal.
- The contract for the construction of Mahadev Parisar project is awarded to MBL Infrastructures Ltd., New Delhi.
- The Mahadev Parisar is being constructed on an available land of 2.64 acre area at Shivaji Nagar, Bhopal. The contract amount of total project is 2354.29 Lacs with an estimated time period of 24 months (inclusive of rainy seasons).

The project started on 08/02/2012 whose estimated completion date was 07/02/2014. The total number of tasks in the project is 253. The total time period given for completion of entire project is about 24 months (inclusive of rainy season). The activity name, duration, predecessor and manpower are entered in the software which gives a total duration of about 693 working days for the completion of the project.

There are two residential blocks, one commercial block and another community hall which is being constructed.

2.1 Construction of residential block

Both the blocks have same features and configuration. The residential block with configuration of G+6, is having two staircases for entrance in the building and is also provided with two lifts. The ground floor is designed as parking area. The first floor of building consists of two A-type flats, two B-type flats and four C-type flats. Second floor has two A1-type flats, two B-type flats and four C-type flats. Third floor consists of two A2-type flats, two B-type flats and four C-type flats. Fourth floor consists of two A-3 type flats, two B-type flats and four C-type flats. Fifth floor consists of two pent houses (duplex), two B-type flats and four C-type flats. Sixth floor consists of two B-type flats, four C-type flats and two pent houses continued from fifth to sixth floor. The salient features of residential block are each apartment with terrace or balcony, power backup for lift and common area, firefighting system and earthquake resistant structure. Each flat is configured with master bedroom, living room, balcony, kitchen and toilet. The total number of flats in one block is 46 with configuration of 3BHK and 2BHK.

3. METHODOLOGY

The study has been done in two stages. In the first stage, using MSP-2013 software, project schedule for various activities with their sequence for the construction of a residential building was prepared. Then subsequently requirements of human resources were carried out for the activities based on analysis of rates (2012) CPWD. Required manpower is the output quantity i.e., the measured quantity of work which can be done per day per person or unit of work done per person. The requisite data has been collected from detailed drawing, bill of quantities and prevailing site condition. In second stage, consumption of human resource analysis was carried out for the various activities by increasing resource with decreased duration. Based on data obtained, network diagram is prepared and relation are assigned to activities to calculate critical path. Finally the total duration of the project is calculated by MSP-2013.

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

- **Defining Project Calendar**

A working calendar is defined in which the working days in a week and the working hours are specified. In this study, the name given to the project calendar is Mahadev Parisar and the timings are 9:00 AM to 6:00 PM with a lunch break of one hour between 1:00 PM to 2:00 PM. The calendar is 8 hours working per day, 7 working days in a week (i.e. 56 hours in a week), and 30 working days in a month.

- **Selection of Task Mode**

The Task mode gives option whether a task is scheduled manually or automatically.

Manual Schedule Mode

The manually scheduled task placed anywhere in schedule and Project won't move it. This new feature gives greater flexibility and control over planning and managing schedule.

Auto Schedule Mode

Automatic scheduling provides a highly planned, systematic means of managing the project schedule. Project calculates the earliest and latest dates for tasks for the optimal schedule.

- **Entering Task**

The task is individually entered in auto schedule mode in the Microsoft Project software. The tasks are normally entered in the order that they occur. The task duration is entered in terms of days only. Information of milestones in the project is also entered.

• **Creating Work Breakdown Structure**

After the complete planning of a project, the next step is to create work breakdown structure (WBS) to define and organise the project elements at different levels. A WBS represents a hierarchical breakdown of a project into elements. At first level of work break down structure, a project with name Mahadev Parisar is created. Inside this, Block B is created. Then inside this Block B, project break down structure like excavation and earthwork, substructure, superstructure, brick work including door frame, lintel work, internal plaster, waterproofing work, external plaster, finishing work and service work are created.

• **Scheduling the Project**

After all the tasks are entered along with their respective duration, the information of task dependencies is specified by specifying predecessor of each of the task. The information is entered using predecessor column of the software. The four types of task relationships or inter dependency are FS, SS, FF and SF. The default relationship in the software is finish to start with zero lead and lag.

• **Assigning Manpower**

A manpower can be defined as the number of people that is required to complete the task and is assigned to an activity. It is suggested to create and allocate the minimum number of resources to activities. When the project schedule is completed with the activities, duration, start and finish dates for each activity and for the whole project, next step is to define and assign resource to the activities then to find the estimated cost for the activities and for the whole project as shown in Figure 1. This work is done using Analysis of Rate CPWD as shown in Table 1.

Table 1: Analysis of manpower.

Name of Activity	As per Analysis of Rate (CPWD)			
	Unit	Mason	Beldar	Bhisti
PCC	1 Cum	0.10 day	1.63 day	0.70 day
RCC (Footing)	1 Cum	0.17 day	2.00 day	0.90 day
RCC (Plinth Beam)	1 Cum	0.17 day	2.00 day	0.90 day
RCC (Column)	1 Cum	0.17 day	2.00 day	0.90 day

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Task Mode	Task Name	Duration	Start	Finish	Resource Names	Cost
1	MAHADEV PARISAR	693 days	Wed 08/02/12	Fri 07/02/14	PROJECT MANAGER, SENIOR ENGINEER, JUNIOR ENGINEER, SUPERVISORS[2], OFFICE CLERK, STORE OFFICER, ACCOUNTANT, EQUIPMENT MECHANICS, GENERAL HELPER[2], PLANT OPERATOR, DRIVER[2], SECURITY GUARD[2]	Rs. 25,052,861.00
2	BLOCK B	693 days	Wed 08/02/12	Fri 07/02/14		Rs. 15,677,261.00
3	EXCAVATION & EARTHWORK	23 days	Wed 08/02/12	Fri 02/03/12		Rs. 170,430.00
4	COMMENCEMENT OF WORK	0 days	Wed 08/02/12	Wed 08/02/12		Rs. 0.00
5	MOBILISATION OF SITE	7 days	Wed 08/02/12	Tue 14/02/12	BELDAR[10], COOLIE[20]	Rs. 51,870.00
6	SITE CLEARANCE	3 days	Wed 15/02/12	Fri 17/02/12	BELDAR[10], COOLIE[20]	Rs. 22,230.00
7	LAYOUT	3 days	Sat 18/02/12	Tue 21/02/12	BELDAR[10], COOLIE[20]	Rs. 22,230.00
8	EXCAVATION OF SOIL	10 days	Wed 22/02/12	Fri 02/03/12	BELDAR[10], COOLIE[20]	Rs. 74,100.00
9	EXCAVATION & EARTHWORK COMPLETED	0 days	Fri 02/03/12	Fri 02/03/12		Rs. 0.00
10	SUBSTRUCTURE WORK	76 days	Sat 03/03/12	Tue 22/06/12		Rs. 952,782.00
11	FOOTINGS	36 days	Sat 03/03/12	Tue 10/04/12		Rs. 414,616.00
12	PCC BELOW FOOTINGS	8 days	Sat 03/03/12	Sat 10/03/12	MASON (AVG), BELDAR[17], BHISTI[7], FITTER (GRADE-1)	Rs. 52,856.00
13	CENTRE LINE MARKING OF BUILDING	3 days	Sun 11/03/12	Tue 13/03/12	BELDAR[10], COOLIE[20], MASON (AVG)[2]	Rs. 23,952.00
14	REINFORCEMENT FIXING OF FOOTINGS	15 days	Wed 14/03/12	Wed 28/03/12	BLACKSMITH (1st CLASS)[10], BELDAR[10]	Rs. 82,200.00
15	SHUTTERING OF FOOTINGS	10 days	Thu 22/03/12	Sat 31/03/12	BELDAR[6], FITTER (GRADE-1)[3]	Rs. 23,850.00
16	CONCRETING OF FOOTINGS	13 days	Sat 24/03/12	Sun 08/04/12	MASON (AVG)[4], BELDAR[44], BHISTI[20]	Rs. 225,808.00
17	DESHUTTERING OF FOOTINGS	10 days	Thu 29/03/12	Tue 10/04/12	FITTER (GRADE-1), BELDAR[2]	Rs. 7,950.00
18	STUB COLUMN UPTO PLINTH	22 days	Thu 29/03/12	Mon 23/04/12		Rs. 149,804.00
19	REINFORCEMENT FIXING OF PEDESTALS	13 days	Thu 29/03/12	Fri 13/04/12	BLACKSMITH (1st CLASS)[10], BELDAR[10]	Rs. 71,240.00
20	SHUTTERING OF PEDESTALS	14 days	Mon 02/04/12	Wed 18/04/12	BELDAR[8], FITTER (GRADE-1)[4]	Rs. 44,520.00

Figure 1: Manpower Planning and Scheduling.

• Critical Path

The critical path through a scheduled network is the longest time duration path through the network. The word “critical” indicates that these tasks cannot be delayed in the overall project as the project finish date is of great importance in most of the projects. In other words, it is the path of the project where both total and free slack are zero for every critical task. A generalised critical path is represented in Figure 2. The critical path starts from mobilisation of site which ends on de-snagging and handing over.

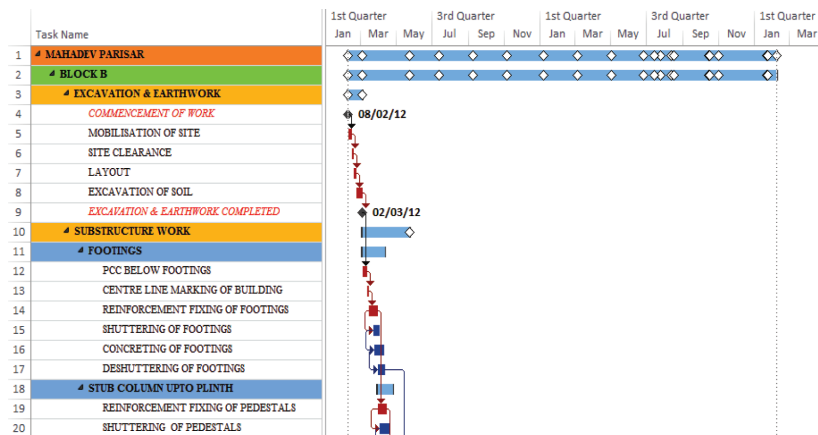


Figure 2: Critical Path.

• Creation of Baseline

A baseline is a complete copy of a project plan that can be used to compare the current schedule to evaluate progress. Target is the initial baseline created after scheduling the project. The critical path network for the project is obtained and the project work proceeds in the planned way. Before updating a schedule for the first time, always create a baseline. As the project progresses, the baselines are used as benchmarks for comparing the target dates, resources and costs to those for the current schedule. The baseline start date is 08/02/12 and finish date is 07/02/14.

• Tracking of Project

The first phase of managing projects is planning. After the planning is completed, the implementation of the project starts. Project is implemented according to the plan. Tracking is the process of collecting, entering and analysing of actual project performance. The main thing to focus on project planning is developing and communicating the details of project plan before actual works starts. When work begins, the next phase of project management is tracking the progress. The tracking of the project was carried out at 27 July 2015. The progress of project is found to be 78% as shown in Figure 3.

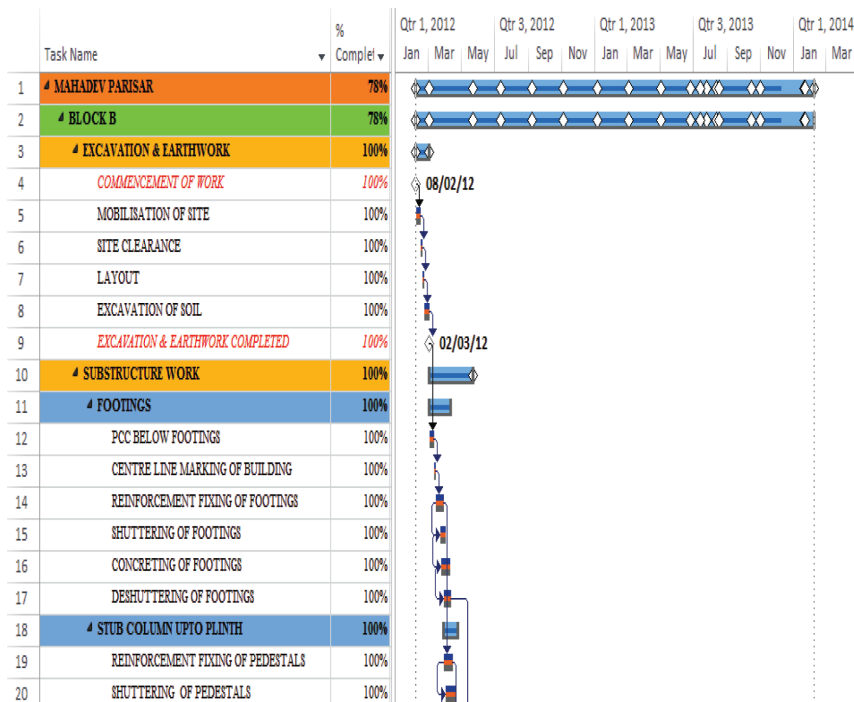


Figure 3: Flow Chart of Project Progress.

4. RESULT & DISCUSSION

In this study, the planned date of starting of project was 08/02/2012 and scheduled completion date was 07/02/2014. The project was suffering from time overrun. It has been found that many activities are delayed from their original schedule. On 27/07/2015, each completed and uncompleted activities were analysed and their percent completion was worked out. On the basis of this analysis it was concluded that the project percent completion on this date was 78%. For remaining work of the project, revised schedule was prepared and the new completion date of the project is found to be 24/02/2016. As the completion time exceeds the estimated time of 693 days to 1424 days, the cost of indirect manpower is exceeded from Rs. 25,052,861 to Rs. 31,778,061 thus cost variance is Rs. 6,725,200 and duration variance of 731 days. The schedule report is examined and causes for delay are analysed. This delay is due to insufficient manpower, contractor not starting the multitasking activities at site, shortage of shuttering material and the work executed by the agency in haphazard manner at site. The baseline and revised estimate of time and cost is shown in Figure 4.

	Task Name	Baseline Duration	Baseline Cost	Duration	Cost	Duration Variance	Cost Variance
1	MAHADEV PARISAR	693 days	Rs. 25,052,861.00	1424 days	Rs. 31,778,061.00	731 days	Rs. 6,725,200.00
2	BLOCK B	693 days	Rs. 18,677,261.00	1424 days	Rs. 18,677,261.00	731 days	Rs. 0.00
3	EXCAVATION & EARTHWORK	23 days	Rs. 170,430.00	23 days	Rs. 170,430.00	0 days	Rs. 0.00
4	COMMENCEMENT OF WORK	0 days	Rs. 0.00	0 days	Rs. 0.00	0 days	Rs. 0.00
5	MOBILISATION OF SITE	7 days	Rs. 51,870.00	7 days	Rs. 51,870.00	0 days	Rs. 0.00
6	SITE CLEARANCE	3 days	Rs. 22,230.00	3 days	Rs. 22,230.00	0 days	Rs. 0.00
7	LAYOUT	3 days	Rs. 22,230.00	3 days	Rs. 22,230.00	0 days	Rs. 0.00
8	EXCAVATION OF SOIL	10 days	Rs. 74,100.00	10 days	Rs. 74,100.00	0 days	Rs. 0.00
9	EXCAVATION & EARTHWORK COMPLETED	0 days	Rs. 0.00	0 days	Rs. 0.00	0 days	Rs. 0.00
10	SUBSTRUCTURE WORK	76 days	Rs. 962,782.00	76 days	Rs. 962,782.00	0 days	Rs. 0.00
11	FOOTINGS	36 days	Rs. 414,616.00	36 days	Rs. 414,616.00	0 days	Rs. 0.00
12	PCC BELOW FOOTINGS	8 days	Rs. 52,856.00	8 days	Rs. 52,856.00	0 days	Rs. 0.00
13	CENTRE LINE MARKING OF BUILDING	3 days	Rs. 23,952.00	3 days	Rs. 23,952.00	0 days	Rs. 0.00
14	REINFORCEMENT FIXING OF FOOTINGS	15 days	Rs. 82,200.00	15 days	Rs. 82,200.00	0 days	Rs. 0.00
15	SHUTTERING OF FOOTINGS	10 days	Rs. 23,850.00	10 days	Rs. 23,850.00	0 days	Rs. 0.00
16	CONCRETING OF FOOTINGS	13 days	Rs. 223,808.00	13 days	Rs. 223,808.00	0 days	Rs. 0.00
17	DESHUTTERING OF FOOTINGS	10 days	Rs. 7,950.00	10 days	Rs. 7,950.00	0 days	Rs. 0.00
18	STUB COLUMN UPTO PLINTH	22 days	Rs. 149,804.00	22 days	Rs. 149,804.00	0 days	Rs. 0.00
19	REINFORCEMENT FIXING OF PEDESTALS	13 days	Rs. 71,240.00	13 days	Rs. 71,240.00	0 days	Rs. 0.00
20	SHUTTERING OF PEDESTALS	14 days	Rs. 44,520.00	14 days	Rs. 44,520.00	0 days	Rs. 0.00

Figure 4: Estimation of Time and Cost Overrun.

CONCLUSION

As explained above, the management of time and manpower is the prime factor that affect greatly to the efficient and timely completion of the project. This is the management that sets up the relations among various activities and helps

the site engineer to fix the priorities of task. Having the information about the availability of the manpower and have those available at right time for the activities plays a vital role in managing the costs and smoothly executing the project activities. The software Microsoft Project 2013 is the popular tool in modern days to manage the project efficiently. The software also helps to enhance project manager's efficient performance towards wastage of resources and its minimization during construction process.

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