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Planning Scheduling and Delay Analysis- Case Study

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Abstract: Planning and scheduling and delay analysis have become an essential part of any project for the timely and economical completion of the project. A proper construction schedule can be used for different purposes. By using construction schedule to predict project completion, contractors can adjust crew size, shifts or equipment to speed or slow the progress. All the construction projects will vary from each other in size. All the projects have time constraint. Delay in completion of project will increase the overall cost of the project. Small projects can be managed efficiently manually; whereas large projects are not so large projects can be better handled by the use of computers. Many types of software are available with the help of which project management can be done easily. Large quantities of different kinds of resources are also required for execution and the risk is more in the case of projects. So planning and scheduling of activities for construction of big projects is essential. In this study, an effort is made in planning, scheduling and delay analysis updating of various activities, which is done by using MS Project and MS Excel software, manpower of each activity is determined and allocation is done using the software. Labor requirement for each activity is calculated from standards obtained from site. An updated schedule, which helps to finish the project well in time with optimum resources and update helps in delay analysis, is under the scope of this study.

Keywords: Planning, Scheduling, Delay analysis, MS Project.

I. INTRODUCTION

In India, construction is the second largest economic activity next to agriculture. Being a capital goods industry, construction plays an vital role in economic growth through the multiple effects on the other sectors of the economy. But, due to the secretive nature of construction business, knowledge gained in planning, scheduling and delay of construction process is rarely disseminated. Consequently, the cost of inefficiency is being incurred in recurring cost.

If proper planning of work is done the company could be saved from making loss. In construction there was a time when all the projects were labor intensive and planning of those days meant proper utilization of labor to make optimum progress in construction in the most effective manner. But now a day's technological advancement and scientific inventions have added in new research in the construction industry. Construction is considered as a group of activities, having inter-relations, which may include the role of to worker those are specialized and specialized work using the latest knowledge and technology available(i.e. use of software, machineries, chemicals etc), to be undertaken in most effective way, failing which construction will be stop, leads to delay.

The "most effective way" involves adoption of techniques such as Critical Path Method "(CPM) or Program Evaluation and Review Technique (PERT) are being applied for planning of construction. Scheduling and monitoring of construction process is rarely disseminated. Consequently, the cost of inefficiency is being incurred as a recurring cost. To overcome from the making loss in construction, effective planning should be done.

The use of CPM and PERT techniques in construction, plant, machinery and specialized workers, finding alternative solutions and selecting the best possible solution with the aid of computer, have made the whole process so scientific that it is now difficult to think of going for large constructional activities without these exercises.

II. OBJECTIVE OF THE STUDY

The primary goal of construction unit is to finish the work as specified, on schedule and within the budget with proper utilization of all the resources like man power, materials, money and machinery.

To achieve the above goal, planning is to execute main objective of planning is to execute the project most economically better in terms of money and time. For updating construction, there should be actual progress report of the works and the original work schedule. The actual progress of work may be behind or ahead the original work schedule. The updating can be done using software such as MSP (Microsoft Project) or Primavera. The main objective of this study is to do the Planning, Scheduling, and delay analysis for 'construction of apartment'.

III. LITERATURE SURVEY

Many authors have concentrated their work on an effective utilization of resources for construction, and importance of planning, scheduling, and delay. A work by **Olusegun O et al[1]**, suggested that optimum allocation of resources

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for construction have not been taken seriously till now, they havealso given some case studies where they had shown how resources are not used in an optimal way. They have shown that, if resources are wasted, then in one day we will have to pay more to acquire the same thing. The importance of proper resource scheduling and proper implementation of it in actual construction is given more importance.

Another study by **M. G. Sayal et al[2]**, the importance of time with respect to planning is being stressed. Construction planning models has been created for different time estimate and use of those schedule reports is made. In their work they found that the models were theoretically very good but practical application is difficult. In the models they created, they divided the project into four well-defined stages, which included two major stages of project planning and project controlling and the two transmission stages of control format development and feedback.

According to another study by **Abd El-Razek et al[3]**,The causes of construction delays are numerous, including strikes, adverse weather, late decisions by the owner, engineer. Unforeseen changes affecting construction duration and so on. He asserts that delays affect unfavorably all the contracting parties, for example- owners get their Funding later than planned, contractors are affected adversely due to increased construction costs.

In field observation by Mubarak[4],groups the causes of construction delays in six categories regardless of who is at fault are Differing Site Conditions, Design Errors or Omissions, Changes in Owner's Requirements, Unusually Adverse Weather, Miscellaneous Factors, Force Majeure.

IV. PLANNING

A. Introduction

Planning involves listing of all the work packages, activities, tasks that are involved in the construction. Requirement of materials, manpower, machineries and money are determined in this phase. Estimates of costs and duration for the various activities are made. The objective of construction planning is to operations require to be performed for the completion of the work and to produce a time table or proper sequential relationship between the activities, with each activity allocated a start date and finish date and with the assurance that the things necessary to do each activity will be available when required. The steps required to accomplish such a planning include logic (planning), timing, analysis and scheduling. Input for planning comes from the estimating departments, project managers, field engineers, foremen, contractors. Planning is the base of the whole project and must be based on clearly defined objectives. With proper planning, adequate resources are available at the right moment and adequate time is allowed for each stage in the process and all the various component activities start at appropriate times. planning includes, Estimate, Budget, Time schedule, sequence for completion of each part of work, Cash flow budget, Manpower, Plant and equipment planning, Material planning.

B. Steps in Planning

The following are the step by step procedure for project planning. They are, make a detailed list of activities. prepare a network diagram, identify the critical path, allocate the resources or juggle the schedule, consider the tradeoff of time and money, organize the project information, record the status of every activity, compare reported original plan.

C. Planning Methods

Due to the need for planning many methods were developed in order to assist management in the construction field.

The most widely used techniques are Bar chart or Gantt chart Method, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT).

V. SCHEDULING

A. Introduction

A construction schedule may mean different things to the designers, contractors, sub-contractors, suppliers and the owners involved in the construction process. The schedule may mean the completion date required for phase of the work. The schedule may mean the schedule values the contractors submit against which monthly progress payments will be made.

The schedule may also refer to the process of sequencing and phasing individual activities required to complete the project. In this report construction schedule means a graphical presentation, which shows the phasing rate of construction activities with the starting and completion dates are sequential relationship among the various activities in a project so that the work can be carried out in an orderly and effective manner.

B. Scheduling Steps

Construction schedule is a projected timetable/calendaring of construction operations. Steps are, estimation of time required to carry out each network activity. using these time estimates, compute the time period required for overall project completion, estimate time intervals within which each activity must start and finish satisfying the completion date requirement, estimation of quantities of work for each of the component activity involved, identify these activities whose expedient execution is crucial to timely project completion, if the project completion date is not constant with contract or other requirements, shorten the project duration at least possible cost.

Utilizing the surplus of float times that most activities possess, adjust the start and finish times of selected activities to minimize resource conflicts and smooth out demands on manpower and equipments, makeup a working project schedule that shows anticipated calendar dates for the start and finish of each activity.

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C. Scheduling method

Construction scheduling methods are Bar chat method and Ghant chart method generally used.

VI. CASE STUDY

A. Introduction

Case study is residential apartment by name Sangam. Sangam is residential building located near Sai Baba Ashram, Whitefield Bangalore, location provides convenient access to anywhere in Bangalore. Airport, school, colleges, offices, entrainment, and shopping malls are just minute away. It has two blocks and consists of silt floor, ground floor, and 4 floors accommodating 60 flats in total. Each block in each floor has 12 flats. The flats here are 3BHK four in number and 2BHK eight in number other amenities provided within the building area. Here 3BHK flat consists of 1091Sft and that of 2BHK flat consists of 1415Sft. Estimated cost of the project was Rs. 4,93,12,027/-. For the proposed building approval has been taken from BBMP (Bhruhat Bangalore Mahanagar Palike) and BDA (Bangalore Development Board), and for the same official's permission drawings has been submitted and got permission.

FIGURE.1. ORGANIZATION CHART

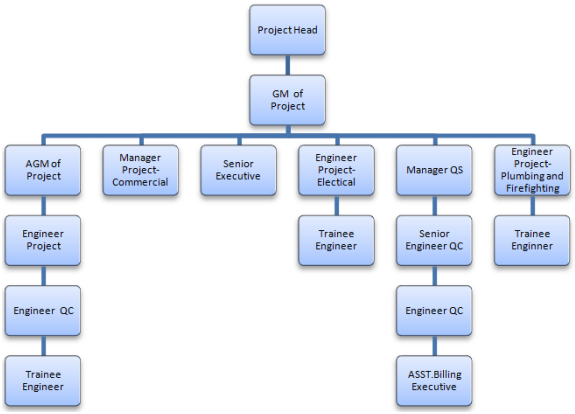

Figure.1 shows the hierarchy of project head to trainee engineer.

TABLE I: MANPOWER PRODUCTIVITY

Sl No	Description of work	Quantity	Unit	Manpower per day	
1	Column	1	cum		
	Barbending			1B	1BH
	Shuttering			1.2C	1.2H
	Concrete			1MS	5H
2	Slab work	1	m^3		
	Barbending			0.8B	0.8BH
	Shuttering			1C	1H
	Concrete			2MS	5H
3	Blockwork	75	sft	1MS	1H
4	Plastering				
	Ceiling	100	sft	1Ms	1H
	Wall	150	sft	1MS	1H
5	Bath wall tiling	100	sft	1MS	1H
6	Vitrified Flooring	150	sft	1MS	1H
7	Plumbing (B4 water proofing)				
	Chasing & pipe fixing	1	flat	1P	1H
	Levelling & Testing	3	flat	1P	1H
	After Water proofing				
	Pipe laying	2	flats	1P	1H
	Vertical lines (1Month)			4P	4H
	Basement line (15 Days)			4P	4H
	Commissioning & CP Fixtures			1P	1H
8	Electrical				
	Slab conduiting (2 Days)	10	flats	5E	
	Wall Conduits - chasing	1	flat	1E	1H
	Conduit laying	½	Day	1E	1H
	Wiring	2	flats	3E	1H
	Switch Plates	2	flats	1E	

B. Duration Of Activities

In this project determination of duration of activities is done below by using the table.1 man power productivity, it has two blocks and consists of silt floor, ground floor, and 4 floors accommodating 60 flats in total. Each block in each floor has 12 flats.

The flats here are 3BHK four in number and 2BHK 8 in number other amenities provided within the building area. Each floor has floor area of 12596Sft. Total floor area 75576Sft (6 × 12596 = 75576). For example considering first floor data for calculation of duration and man power for same data is done below,

1) Concrete in columns = 30 Cum
2) Concrete in slabs =210 Cum
3) Steel quantity = 30.91MT
4) Slab Shuttering area = 1170.2 Sqm
5) Concrete block =1407.1 Sqm
6) Internal plastering =3592.3 Sqm
7) Tiles flooring =756.23 Sqm
8) Toilet tiles and dadoing = 224.45 Sqm

Explanation for Duration Taken To Complete First Floor by using equation (1) given below,

$$\textbf{REQUIRED MANPOWER}=\frac{\textbf{TOTAL QUANTITY}}{\textbf{PRODUCTIVITY X DURATION}} \quad (1)$$

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a) Concrete in Columns
A mason and 5 helpers can execute a volume of 10 cum per day for column concreting, so by allotting 3 concrete masons per day will execute 30 Cum within 1 days.

b) Concrete in Slabs
Two mason and 5 helpers can execute a volume of 30 cum per day for slab concreting, so by allotting 3 concrete masons and 10 helpers per day will execute 210 Cum within 6 days.

c) Steel
A Barbender can handle/execute 400 kg per day, so
Quantity = 30910 kg
Productivity = 400 kg/day
Duration = 7 days

Therefore duration is
$30910/(400 \text{ X } 7) = 12$ Nos.
So 12 Nos. of bar benders should be allotted for a day.

d) Slab Shuttering/ Form Work
A Carpenter can execute 10 Sqm per day, so
Quantity = 1170.2 Sqm
Productivity = 12Sqm/day
Duration = 10 days
Therefore duration is
$1170.2/(12 \text{ X } 10) = 10$ Nos.
So 10 Nos. of Carpenters should be allotted for a day.

e) Concrete Blocks
A block mason can execute 10 Sqm per day, so
Quantity = 1407.1 Sqm
Productivity = 10 Sqm/day
Duration = 10 days
Therefore duration is
$1407.1/(10 \text{ X } 10) = 14$ Nos.
So 14 Nos. of block masons should be allotted for a day.

f) Internal Plastering
A Plastering mason can execute 15 Sqm per day, so
Quantity = 3592.3 Sqm
Productivity = 15 Sqm/day
Duration = 20 days
Therefore duration is
$3592.3/(15 \text{ X } 20) = 12$ Nos.
So 12 Nos. of plastering masons should be allotted for a day.

g) Tiles Flooring
A tiles flooring mason can execute 20 Sqm per day, so
Quantity = 756.23 Sqm
Productivity = 20 Sqm/day
Duration = 12 days
Therefore duration is
$756.23/(20 \text{ X } 12) = 3$ Nos.
So 3 Nos. of tiles flooring mason should be allotted for a day.

h) Toilet Tiles and Dadoing
A tiles flooring mason can execute 10 Sqm per day, so
Quantity = 224.45 Sqm
Productivity = 10 Sqm/day
Duration = 6 days
Therefore duration is
$224.45/(10 \text{ X } 6) = 4$ Nos.

So 4 Nos. of tiles flooring mason should be allotted for a day.
Similarly duration calculation for all floors.

VII. DELAY ANALYSIS

A. Introduction
Delay in construction can be defined as an event or a condition that results in finishing the project later than stipulated in the construction or delay in construction claims as the time during which some part of the construction has been extended or not executed owing to an unexpected event.

Delays are common due more complex task and activities till the finish of project. There are many reasons for delay in construction project. Reasons for delay have been given below.

1) Unskilled labors
Due to unskilled labors work efficiency decreases, it results into delay in activity and also reduces the product quality.

2) Shortage of workers
Manpower is an important and unavoidable resource in the construction industry. Delay occurs due to shortage of manpower. There is always delay in the work due to lack of skilled labors. It includes electrician and labors.

3) Shortage of materials
Material is an important and unavoidable resource in the construction industry. Delay occurs due to non availability of material on time. It includes RMC and steel bars.
Improper management

4) Improper management
The allocation of labors and resources is bad and lacks time management which causes delay. There is lack of supervision throughout the line of hierarchy which is the result of project unfinished. It includes structural engineer visit, structural drawings and architectural drawings.
Improper planning.

5) Improper planning
Planning is the essential and initial step of a construction project. It is a process in which slight mistake and misconception lead to great losses to the company. Hence greater care needs to be taken during planning, but in this it has been revised thrice due to the lack of allocation of resources.

6) Weather problems
For smooth flow of any construction activity a favorable weather is needed. In India the construction work gets a delay due to unfavorable monsoons.

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FIGURE.2. REPRESENTATION OF DELAYS IN BAR CHART

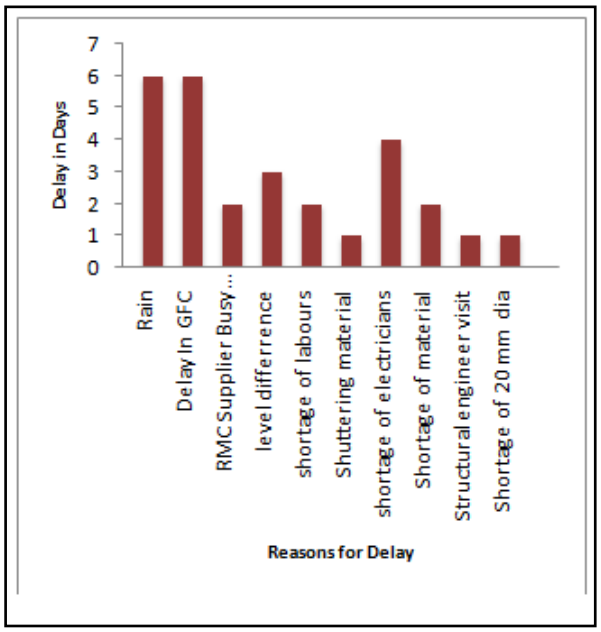

TABLE.2. COST INCURRED DUE TO DELAYS IN ACTIVITIES

Reason For Delay	Delay In Days	Cost Due To Delay (Rupees)
Rain	6	46750
Delay In GFC	6	39000
RMC Supplier Busy schedule	2	7250
level difference	3	6500
shortage of labors	2	59250
Shuttering material	1	13500
shortage of electricians	4	16000
Shortage of material	2	168600
Structural engineer visit	1	7250
Shortage of 20 mm dia	1	7000
	28	**371100**

VIII. CONCLUSION

Construction of Sangam residential building was planned for 743 days but it was extended to 761 days because of delay in activities as shown in table.2,that incurred extra cost as as shown in table.2.The initial estimated cost of the project was Rs. 4,93,12,027/- but due to delay of activities of Rupees 3,71,100/- is added to the estimated as a cost of delay. Delay costs can be minimized if proper control in planning, scheduling and execution takes place in construction.

If the experience or well skilled team of employee can reduce or minimize the delay cost but delay cannot be avoidable because of heterogeneous weather, unavailability of labors, approval and many more reasons. Therefore effective planning, tracking/monitoring of construction leads to lesser or minimal extra cost of delay.

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