RESEARCH ARTICLE OPEN ACCESS

Efficient Planning Scheduling and Delay Analysis of Residential Project

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ABSTRACT
Planning and scheduling 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: Delay analysis, MS Project, Project management, Planning, Scheduling.

I. INTRODUCTION

In India, construction is the second largest economic activity next to agriculture. Being a capital goods industry, construction plays an important role in economic growth through the multiple effects on the other sectors of the economy. Unfortunately, due to the secretive nature of construction business, knowledge gained in planning, scheduling and controlling construction process is rarely disseminated. Consequently, the cost of inefficiency is being incurred as a recurring cost. If proper management of work is done the company could be saved from making loss. In construction industry there was a time when all the projects were labor intensive and management in those days meant proper utilization of labor to make optimum progress in construction in the most economical manner. But now-a-days technological advancement and new scientific inventions have added in new dimensions to the construction industry. A project is now considered as a group of activities, having inter-relations, which may include the role of specialists and specialized work using the latest knowledge and skill available, to be undertaken in most systematic manner, failing which the project may be stalled or progress may be hampered. The "most systematic manner" involves adoption of techniques commonly known as Critical Path Method "(CPM) or Program Evaluation and Review Technique (PERT) are being applied for the management of the project.

The application of these construction management techniques, the use of 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. STATEMENT OF THE PROBLEM

Proper planning and scheduling of construction projects with proper technique is a must, because there has been incidents in the past where, due to lack of proper planning, projects have cost more than what they should have cost and also delayed to a great extent. The concept of scientific planning and scheduling was totally neglected in the construction industry until the late 50's when the concept of Critical Path Method and Programme Evaluation and Review Technique made an impact.

So meticulous care has to be taken in manpower planning in order to identify areas of surplus manpower and areas where there is a shortage of manpower. If there is a surplus, it can be re-deployed, and if there is a shortage it may be

made good. Our main concern, naturally, is to plan, schedule and allocate manpower in an optimum manner so as to complete the project in stipulated time.

III. OBJECTIVES OF THE STUDY

The primary goal of construction team is to finish the projects as specified, on schedule and within the budget with proper utilization of all the resources like man power, materials, money and equipments. 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 scheduling of a project, a scheduling system has to be selected. The various project activities can easily be scheduled by using computer running scheduling software programmers' readily available in the market.

For updating a project, there should be actual progress report of the works involved in the project 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 same software.

Therefore, the main objective of this study is to complete the project on schedule and within the estimated budget and delay take place in construction than delay analysis. And if any uncertain or unforeseen problems arise, the project schedule must be updated and a new updated schedule should be formed by software.

The main objective of this study is to do the Planning, Scheduling, and delay analysis for 'construction of apartment' project.

IV. REVIEW OF LECTURES

Many authors have concentrated their work on an optimum allocation of resources for construction works, and importance dealt detail. A work by **Olusegun O et al, (1999)**, suggested that optimum allocation of resources for construction jobs have not been taken seriously till now, they have also given some case studies where they had shown how resources are not used in an optimal way. They have also shown in their work 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 prime importance.

In another study done by **Donald et al (2004)**, a concept of optimum crew for each activity and its costing techniques were researched. Using different simulation techniques, they were able to find out a best crew for an activity and to see that the cost is within the range. The entire study was done using algorithm and flow chart techniques. The goal of this research was to develop and illustrate a technique for finding the optimum crew configuration, from a range of possible configurations, assigned to complete a defined quantity of work in a timely and cost effective manner. The concept of activity- based costing was used to define the scope of work in terms of the activities to be accomplished and their associated productivity rates and cost performance.

In another study done by **M. G. Sayal et al, (2002)** the importance of time with respect to planning is being stressed. Construction Project planning models has been created for different time estimate and using those schedule reports is made. In their work they found that the models were theoretically very good but practical implementation would be 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. In another study by sayal, he separated project planning and project scheduling and focused mainly on the latter aspects.

Another classical work done by author's viz., **Michael et al (2006)**, introduces techniques for planning and control, and which concentrates on recommending appropriate practice for the practical problems which readers may come across when using both computerized and non-computerized planning methods. They discuss the whole of planning and control cycle as a function of management. In another research, conducted a study on the major causes of delays in construction projects in the Florida Construction Industry through a survey. According to the authors, there are two groups of causes for delays in construction projects: external and internal causes. Internal causes of delays cover the causes, which come from four parties involved in that project. These parties are the owner, designers, contractors, and consultants. Other delays, which do not come from these four parties, are based on external causes for example from the government, material suppliers, or weather.

According to **Abd El-Razek et al,(2008)** The causes of construction delays are numerous, including strikes, adverse weather, late decisions by the owner, unforeseen changes affecting construction duration and so on. He asserts that delays affect unfavorably all the contracting parties, for example; owners get their buildings later than planned, contractors are affected adversely due to increased construction costs.

V. PLANNING AND SCHEDULING

A. Introduction of Planning

Planning involves listing of all the activities/tasks that are involved in the project. 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 project planning is to identify the various activities and operations require to be performed for the completion of the job 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. A plan includes the following-

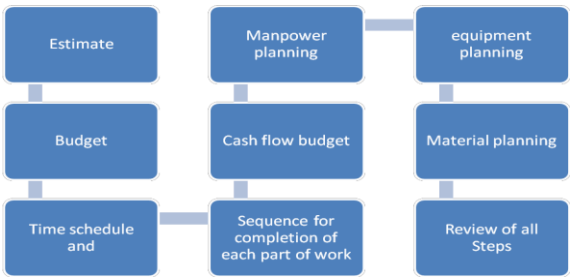
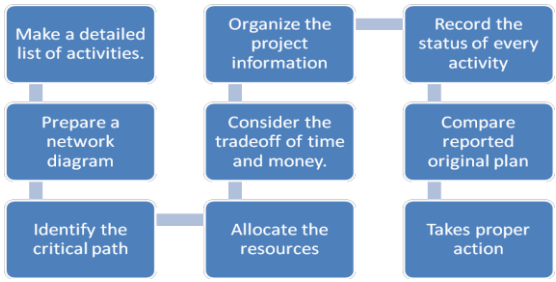


Fig. 1: General things included in planning

B. Steps in Project planning

The following are the step by step procedure for project planning.



C. Introduction of Scheduling

A construction project 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.

D. Project Scheduling Steps

A project schedule is simply a projected timetable of construction operations. There are several steps involved in the devising of an efficient and workable job schedule. The following list is offered as a procedural guide in this regard -

1. Estimation of time required to carry out each network activity.
2. 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.
3. Estimation of quantities of work for each of the component activity involved.
4. Identify these activities whose expedient execution is crucial to timely project completion.
5. If the project completion date is not constant with contract or other requirements, shorten the project duration at least possible cost.
6. 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.
7. Makeup a working project schedule that shows anticipated calendar dates for the start and finish of each activity.

E. Manpower Management

Manpower management is most important in construction industry. This is because:

1. Manpower is non-pool type of resource, i.e.; if manpower is not used in time, they are lost and they have to be paid for it. But, other resources like money, materials, and equipments are not lost when they are not used in time.
2. Manpower is an active resource where as other resources is passive. Other resources are to be utilized by manpower. So, if the manpower is utilized in a better way other resources can be used effectively and economically.

3. Unskilled manpower is available in a large number, but skilled manpower is not available large numbers. Thus, proper management of manpower will help in balancing this problem.

F. Manpower Planning

This has to be done while doing planning. The number of workers required for each activity has to be calculated from the standard data or from the past experience so that on that basis the number of days required for completing the respective activity can be calculated. As it involves a large amount of computations, computers are normally used to estimate the total requirement of manpower. Most of the commercial software has the features to estimate the resource demands. The summary of the manpower requirements is normally presented in tables and graphs.

VI. CASE STUDY

A. Introduction

Case study on the residential apartment, 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. Here 3BHK flat consists of 1155Sft and that of 2BHK flat consists of 915Sft. Total area of open duck, common space, lift consist of 656 Sft. Estimated cost of the project was Rs. 4,93,12,027/-
Amenities: Gym, Swimming pool, Park, Security, DTH TV Facility, Power backup

B. Duration of Activities

In this project determination of duration of activities is done below by, 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. Each floor has floor area of 12596Sft. Total floor area 75576Sft (6 × 12596 = 75576).

Example: First Floor (DATA of first floor)

a. Concrete volume: Concrete in columns = 30 Cum & Concrete in slabs =210 Cum
b. Steel quantity = 30.91MT
c. Slab Shuttering area = 1170.2 Sqm
d. Concrete block =1407.1 Sqm
e. Internal plastering =3592.3 Sqm
f. Tiles flooring =756.23 Sqm
g. Toilet tiles and dadoing = 224.45 Sqm

Calculation of Duration Taken To Complete First Floor

Required Resources = {Total Quantity/ (Productivity X Duration)}

I. Concrete For 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.

II. For 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.

III. Steel

A Bar bender can handle/execute 400 kg per day,
Quantity = 30910 kg
Productivity = 400 kg/day
Duration = 7 days
Therefore Bar Bender required
30910/ (400 x 7) = 12
So 12 Nos. of bar benders should be allotted for a day.

IV. Slab Shuttering/ Form Work

A Carpenter can execute 10 Sqm per day,
Quantity = 1170.2 Sqm
Productivity = 12Sqm/day
Duration = 10 days
Therefore Carpenter requires
1120.2/ (12 x 10) = 10
So 10 Nos. of Carpenters should be allotted for a day.

V. Concrete Blocks

A block mason can execute 10 Sqm per day,
Quantity = 1407.1 Sqm
Productivity = 10 Sqm/day
Duration = 10 days
Therefore Mason required
1407.1/ (10 x 10) = 14
So 14 Nos. of block masons should be allotted for a day.

VI. Internal Plastering

A Plastering mason can execute 15 Sqm per day,
Quantity = 3592.3 Sqm
Productivity = 15 Sqm/day
Duration = 20 days
Therefore Mason required
3592.3/ (15 x 20) = 12
So 12 Nos. of plastering masons should be allotted for a day.

VII. Tiles Flooring

A tiles flooring mason can execute 20 Sqm per day,
Quantity = 756.23 Sqm

Productivity = 20 Sqm/day
Duration = 12 days
Therefore Mason required
756.23/ (20 x 12) = 3
So 3 Nos. of tiles flooring mason should be allotted for a day.

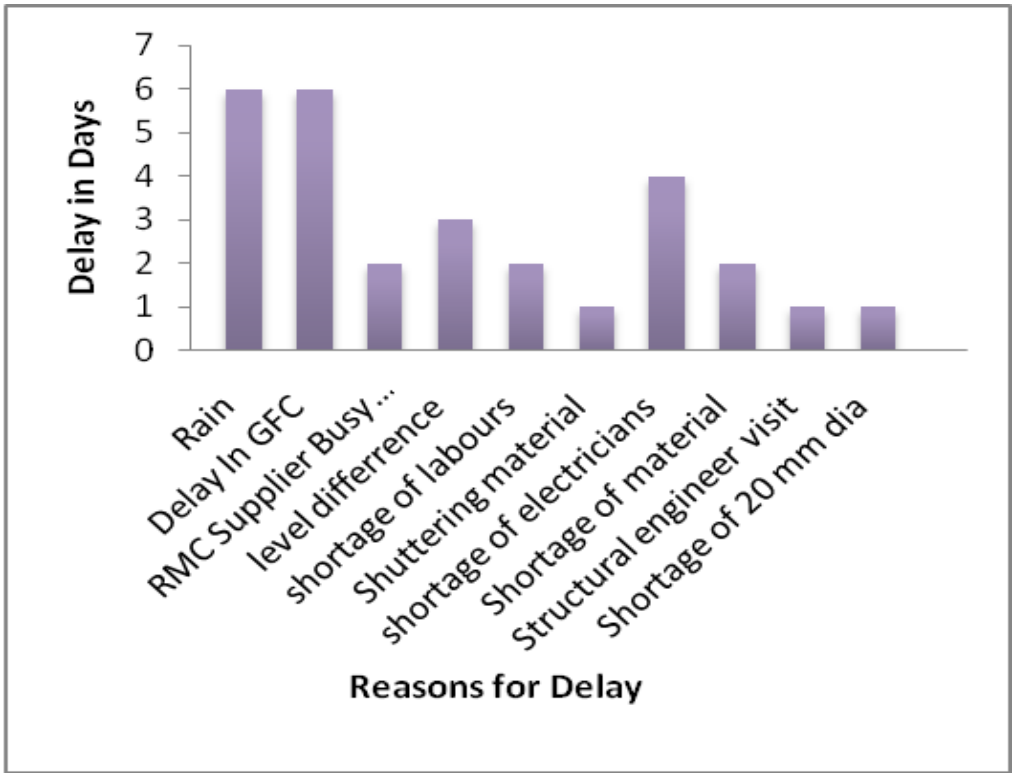
VIII. Toilet Tiles and Dadoing

A tiles flooring mason can execute 10 Sqm per day,
Quantity = 224.45 Sqm
Productivity = 10 Sqm/day
Duration = 6 days
Therefore Mason required
224.45/ (10 x 6) = 4
So 4 Nos. of tiles flooring mason should be allotted for a day.

C. Delay Analysis

Delay in construction can be defined as an event or a condition that results in finishing the project later than stipulated in the contract or delay in construction claims as the time during which some part of the construction project 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 in delay analysis.



Graph 1 Representation of delays in bar chart

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 labours	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**

Table 2 Cost Incurred due to delays in activities

VII. RESULTS AND DISCUSSION

A. Master Schedule

The contract of construction was awarded to a construction company. On 15th June 2012 initial actives such as drawing, design, architectural drawing and mobilization work take place. Construction started on 5th July 2012 day. In the baseline schedule the duration of construction is 743 days. The duration of each activity was estimated from various data gathered from the project and from the knowledge of experienced personnel of the project.

B. Activities

The work breakdown structure of apartment is mainly divided into 3 parts. The WBS is Site clearance and excavation, structural works and finishes. This is a construction of a residential building and has repetitive schedule followed. 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.

Site clearance and mobilization had taken place on 5th July 2012 and excavation with anti termite treatment is carried out. Next part is the major activity i.e. structural work which incorporates tasks like raft foundation, basement columns and shear wall, first floor slab and columns and continues till the 4th floor. The third activity is named as finishes as it includes the left over work like masonry works, electrical conduiting, internal plastering, and water proofing works, painting works, floor finishes, landscaping works, elevators, fire fighting.

The main critical activities in structural work are raft foundation, construction, columns and shear walls of basement and the slabs of each floor. The critical activities for finishes are masonry works, electrical conduiting and internal plastering.

In addition to the critical activities which cannot be delayed at any cause, there are some other additional activities where the project really experienced difficulties in execution and delay in completion. It has been observed that 28days delay due to which, extra cost of Rs. 3,71,100/- took place. Some of the difficulties faced in the individual activities listed below.

C. Unskilled labours

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

D. 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.

E. 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.

F. 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.

G. 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.

H. 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.

VIII. CONCLUSTIONS AND RECOMMENDATION

1. The schedule which was prepared here involves periodical as well as day to day observation in scheduling, tracking and delay analysis of the project.
2. The schedule were lacking along with the delay in process due to problems in excavation, lack of manpower and materials, shortage of labor and weather etc.
3. Scheduling using computer as a tool was found to be easy and accurate. Software used here i.e., MS project. The project schedule and project track generation was its main highlight. The schedule report helps in identifying start date, finish date, total float, also the duration of the project as a whole. The schedule tracking report helps in delay calculation.
4. To conclude, if a big project like this is not planned, schedule and updated properly then

delays cannot be minimize and amount of money wasted would be enormous so at least in the future one can hope that proper planning will take place in all departments of the company. Due to poor manpower allocation, construction organizations are finding it difficult to use available manpower. The result of poor manpower

5. The initial estimated cost of the project was Rs. 4,93,12,027/- but due to delay of activities as described in the previous chapter an extra cost of Rs. 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 any project.
6. The study has provided immense knowledge in identifying deficiencies, ability to reschedule and delay calculation by tracking the same through observational facts, skills, analytical evaluation system and framing schedule for expansion of project.

ACKNOWLEDGMENT

We are very grateful to all authors in reference section. Their methods, conceptual techniques are very helpful for our research. AGM of planning department, site engineer, everyone at project shared information and knowledge helped us to complete our proposed work, and we are very grateful to them.

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