PLANNING, SCHEDULING AND DELAY ANALYSIS OF A BUILDING

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ABSTRACT
Planning and scheduling has become an inevitable concept to be taken into consideration for the smooth functioning of construction works. The primary objective of planning is to enable the execution of the project to be right on schedule, along with being better in terms of economy and time. The purpose of the schedule is to determine the duration across which the project spans, so that the general conditions of work and requirements can be determined. The objective of this project was to plan and schedule the construction process of a building in Manipal and to identify the causes of delays. Since many unforeseen circumstances arose during the construction, the prior schedule was updated and the newer schedule was followed. Oracle’s Primavera P6 has been used for the scheduling of this project. Planning and scheduling of the building was achieved through the following steps: creating an EPS (Enterprise Project Structure), creating a WBS (Work Breakdown Structure), linking of activities according to their interdependencies as well as relations and delay analysis. The final updated schedule was compared with the original schedule to perform a thorough delay analysis. Using the results of delay analysis, the causes and mitigation measures of delays are identified. Based on the results, alternative practices are recommended, which could have compensated for the delay in the original schedule.

Keywords: Planning, Scheduling, Delay analysis, Enterprise project structure, Work breakdown structure

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1. INTRODUCTION
In India, due to an increasingly local and international competition, construction companies are always striving for maximum efficiency and a competitive operational advantage. Companies are always looking for improvements in equipment features, communication tools, efficient management techniques, and training human resources. They are also narrowing their focus to specialize in certain projects instead of taking up all forms of it. This specialization requires a very streamlined approach for controlling techniques and extremely good planning for the best services. The benefits of effective planning, scheduling and control of construction projects are: reduced construction time, reduced cost overruns.

Project planning is a part of project management, which relates to the use of schedules such as Gantt Charts to plan and subsequently report progress within the project environment.

Scheduling is the process of determining the sequential order of the planned activities, assigning realistic durations to each activity and determining the start and finish dates of each activity.

It can also be defined as the process of converting a general or outline plan for a project into a time-based graphical representation with the necessarily provided information on the available resources and time constraints. Construction Planning is the necessary forerunner to scheduling and it includes:

- Defining work tasks,
- Determining a general sequence to the defined tasks, and
- Assigning responsibility

2. LITERATURE REVIEW
Assaf, S.A. and Al-Heiji (2006), [1] conducted a survey on time performance of different types of construction projects in Saudi Arabia. They found that, the most common cause of delay is “change order” for all the three project participants, i.e., the owner, consultant and the contractor. Surveys concluded that 70% of projects experienced time overrun and found that 45 out of 76 projects considered were delayed. G. Bilgin, Irem Dikmen (2017), [2] University of Istanbul have found that dependencies between projects within a portfolio need to be taken into consideration since they may significantly affect the portfolio success with their combined effects. There are limited studies in the area of construction project portfolio management that investigate how the dependencies between projects can be handled. A method is presented to calculate and visualize project dependencies to support decision making process within a portfolio management tool for construction projects. Hamid, M.A. and Torrance, J.V. (2006), [3] adopted a quantitative approach to determine the current level of construction time performance of public sector projects. They identified variables related to project characteristics and variables associated with excusable delay that have significant effects on the construction time performance of public sector civil engineering projects in Malaysia. They found that construction time performance of the public projects in Malaysia was affected more by variables related to excusable delays than project characteristic variables. Samad M E Sepasgozar et. al.(2015), [6] presented key sources of construction projects delay in Iran. Seventy-three delay causes were identified in the sample projects, in which 25 factors were related to the new technology restriction. They found the relationship between new technology and time overrun in those projects. Their study revealed that one of the main causes of delay in many projects is the usage of old generation of construction technologies. The study also focused on technology attributes that may affect the project scheduling and time. Long L.H., Lee Y.D. and Lee J.Y (2008), [4] conducted a questionnaire survey to elicit the causes of projects delays and cost overruns In Vietnam. Twenty one causes
of delay and cost overruns appropriate with building and industrial construction project were inferred and ranked with respect to frequency, severity and importance indices. A comparison of causes of time and cost overruns was done with various selected construction industries in Asia and Africa. Factor analysis technique was applied to categorize the causes, which yielded 7 factors: Slowness and Lack of constraint; Incompetence; Design; Market and Estimate; Financial capability; Government; and Worker. S. Collyer, Clive MJ Warren (2009) [5] investigated the properties of projects conducted in rapidly changing environments. These projects were challenged by the rapid introduction of new unknowns as they progress. The difficulties posed by these projects are identified and the literature is reviewed for suitable approaches.

3. METHODOLOGY

Collection of information – A detailed analysis of the material, man power, machinery, other resources used, and sequence of activities (dependent or independent) executed from the commencement of the construction to its completion.

The methodology adopted is as follows:

- Collection of ideas.
- Literature review
- Site Visit
- Collection of raw information from site engineer and contractor.
- Data Collection, which is the basis to prepare manual schedule.
- Preparation of WBS and corresponding activities.
- Preparation of the plan and schedule by using the different elements of primavera.
- Comparing the updated schedule with original schedule to perform delay analysis.

A schedule is a preplanned format to do any work/project which contains lists of intended activities and times. It is a primary time management method that arranges all the activities of a project in chronological order. The development of a relation between activities, deciding the sequence of different tasks, distributing resources for different tasks, allotting the tasks times depending on availability of work force is called scheduling.

A schedule is a vital part of a project because a schedule systematizes the work force working on a project and minimizes chaos which in turn reduces the delays caused by human error. An appropriate schedule requires a lot of organization and planning resulting in the elimination of cost surges and waste of time. Scheduling is done taking into account all available manpower, resources and time. Tasks are arranged in a way which employs all the manpower and resources at any specific time, without rendering any resource useless. A good schedule also includes contingency plans for unforeseen delays ranging from natural weather conditions to the malfunction of equipment.

To produce the updated schedule, a site visit was conducted to collect the required data. Activities that were delayed the most due to various reasons were interpreted from the data. Various possible counter measures were proposed to compensate for the delays. The delays were ideally categorized on the basis of their degree of impact to the project’s total duration.
4. UPDATED SCHEDULE FOR THE STUDENT PLAZA

Figure 4.1, 4.2, 4.3, 4.4, and 4.5 show the updated schedule
5. METHODS TO MINIMISE DELAYS

- Use of better suitable construction methods.
- Efficiently calculated planning.
- Suitable and timely material procurement.
- Frequent coordination between the parties involved.
- Proper project organization and scheduling.
- Completed drawings and design layouts delivered at the right time.
- Better site organization and supervision.
- Additional resources of manpower, plant and materials directly employed or subcontracted.
- Revised practices including off-site prefabrication, extra scaffolding, and temporary weatherproofing and so on.
- Proposals for phased completion.
- Increasing working hours on and off site, counting weekends, holidays, night working and shift working.

To compensate for the above stated delays, overtime work and night shifts were assigned to the laborers. A better plan of action should have been mapped out. Keeping the monsoons in mind, the planning phase should have been thoroughly improvised to start the affected activities early, or with the necessary precautions. Fixtures and other materials that were imported should have been ordered with the calculation of delays in mind. Better communication should have been established between the foreign and local engineers. Most delays are caused by poorly skilled laborers and the coordination between contractors should have been better. Contractors showed the need of rework on their managerial skills.

6. DELAY ANALYSIS

Numerous factors lead to the causes of delays in construction projects which range from issues in the technology and its management, to those emanating from the social, physical and financial environment. These delays are grouped into the following categories

- Causes of delay by owner
- Causes of delay by contractor
- Causes of delay by Consultant
- Causes of delay by equipment
• Causes of delay by labors
• Causes of delay by external factors
Tables 6.1 and 6.2 show the details of various delays occurred in the Project

### Table 6.1 Details of Various Delays Occurred in the Project

<table>
<thead>
<tr>
<th>Activity</th>
<th>Delayed by (Day(s))</th>
<th>Reason for Delay</th>
<th>Responsible for delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Clearance</td>
<td>1</td>
<td>Unavailability of labor; Traffic</td>
<td>Contractor</td>
</tr>
<tr>
<td>Supply of Cement &amp; Fly Ash</td>
<td>3</td>
<td>Late Payment</td>
<td>Owner</td>
</tr>
<tr>
<td>Supply of Reinforcement Steel &amp; Site</td>
<td>2</td>
<td>Late Payment</td>
<td>Owner</td>
</tr>
<tr>
<td>Substructure Footing &amp; Excavation</td>
<td>8</td>
<td>Heavy rain, Water collection in pit</td>
<td>Natural Case</td>
</tr>
<tr>
<td>PCC for Footing</td>
<td>4</td>
<td>Heavy rain, Water collection in pit</td>
<td>Natural Case</td>
</tr>
<tr>
<td>CIP for Footing</td>
<td>4</td>
<td>Heavy rain, Water collection in pit</td>
<td>Natural Case</td>
</tr>
<tr>
<td>Column and Reinforcement Steel</td>
<td>4</td>
<td>Heavy rain, Water collection in pit</td>
<td>Natural Case</td>
</tr>
<tr>
<td>Site Survey</td>
<td>4</td>
<td>Unavailability of labor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Underwater Service Work</td>
<td>4</td>
<td>Water seepage, Less labor on job</td>
<td>Natural Case</td>
</tr>
<tr>
<td>Site &amp; Building Construction</td>
<td>4</td>
<td>Unavailability of labor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Work Load</td>
<td>4</td>
<td>Precipitation, Durability</td>
<td>Contractor</td>
</tr>
</tbody>
</table>

### Table 6.2 Details of Various Delays Occurred in the Project (Cont.)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Delayed by (Day(s))</th>
<th>Reason for Delay</th>
<th>Responsible for delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply of Cement &amp; Fly Ash</td>
<td>3</td>
<td>Shipmenet delayed</td>
<td>Supplier</td>
</tr>
<tr>
<td>Supply of Reinforcement Steel &amp; Site</td>
<td>2</td>
<td>Shipmenet delayed</td>
<td>Supplier</td>
</tr>
<tr>
<td>Concrete &amp; RCC umbrella beam</td>
<td>39</td>
<td>Mason unavailable, Rain</td>
<td>Natural Case &amp; Contractor</td>
</tr>
<tr>
<td>Risk Shuttering Work</td>
<td>39</td>
<td>Unavailability of labor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Reinforcement work</td>
<td>8</td>
<td>Racksmith unavailable, Less equipments</td>
<td>Contractor</td>
</tr>
<tr>
<td>Shuttering</td>
<td>2</td>
<td>Plumber</td>
<td>Contractor</td>
</tr>
</tbody>
</table>

7. CONCLUSION
The building under consideration is a commercial project that integrates all needs of the students into one centrally located plaza. Once complete, it will serve as a one-stop shop by providing general and medical stores, laptop service center etc. As per original schedule, the project commenced on 15 Jun 2017 and was scheduled to be completed on 15 Dec 2017, but was delayed by four months. After updating, the scheduled completion of the project was estimated to be on 06 Feb 2017. At present, majority of the works have been completed except for the approach road. Also, demolition of temporary structures like the overhead water tanks and the final tiling is under way and will be completed soon.

• By comparison, it is observed that application of adequate planning and scheduling helped in the lessening of the project duration.
• A more proficient schedule for the project was prepared using Oracle’s Primavera P6.
By observation of the updated schedule, it was evident that the finishing stage which includes external and internal painting, block work, flooring, etc. was the most time consuming.

Improper communication between contractors and the planning department was observed to be the foremost cause for most delays.

Activities that caused delays to the project were identified and rescheduled appropriately.

Delay due to the excavation and dewatering processes had a major impact as it rendered various other activities on hold due to labor re-allotment.

Delay during excavation due to natural causes could have been anticipated by the engineers and definite precautions to thwart exposure could have been implemented.

Bricks used for cladding required special and superior curing techniques that the labor was not familiar with. Hence it was not completed on schedule.

Importing of foreign fixtures and furniture caused delay due to improper communication.

Better communication could have been established between local and foreign engineers which would eliminate delays in the fountain work.

REFERENCES


