OPTIMAL PLANNING AND SCHEDULING OF HIGH RISE BUILDINGS

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ABSTRACT

Objective: The research aims an empirical study on the application of MSP in every single aspect of a project from planning and scheduling phase. Irrespective of nature of work, location or norms in an organization, all the members work on tasks that are varied and involve people who do not usually work together but for the same objective. Methods: A project may have a simple goal that may not require many people or a great amount of capital or it may be complex to a certain extent, calling for various skills and excess of resources. But, the common line is that every human can manage projects. Due to this, the purpose of dealing with the project should not be only execution but the effective and efficient execution of a project is essential which is needed to be emphasized. Construction companies in India executes the project in a traditional way, this sometimes leads uneconomical and tedious too. The traditional method is time-consuming and bit confusion in execution. Findings: This paper will provide how to do planning and scheduling for a building which is a multi-storied (G+8) with Microsoft Project (MSP) software by observing the site conditions, labour productivity, and available resources with proper utilization of time and resources. Application: This approach can be projected to similar projects of the same size.

Key words: Microsoft Project, Planning, Scheduling, Time, Resources


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1. INTRODUCTION

Every person is a manager of projects of their own life. From an employee to CEO of an organization, from a student to administrator, we all do work on various tasks with different deadlines\textsuperscript{1}. Project management is the application of techniques, knowledge, and skills to the activities of a task to reach the project necessities. It is a systematic ability to make success for the organizations enabling to patch the project results to the goals of the organization and further to compete in their respective markets. It also can be defined as the process of planning, scheduling, organizing, monitoring and controlling of resources, protocols and procedures for achieving specific goals. A project is an impermanent agenda planned to produce a distinctive service or product through a clear start time and finish time\textsuperscript{2}.

1.1. The importance of Project Management

The project will start from the right time, but it will proceed further, gets out of the track. Owing to this, it is important to manage all the activities in a right way. Thus, project management plays an important role in arranging the activities which are critical to the project and the process is called as a task to function in an appropriate way. Project management supports the project in better efficiency to deliver services.

1.2. The traditional approach of project management in the construction sector

In a traditional approach, a project can be completed in a sequence of steps. They are distinguished in five developed components\textsuperscript{3}:

- Beginning Phase
- Planning and Designing Phase
- Execution and Construction Phase
- Monitoring and Controlling Phase
- Completion Phase

Every stage may not be there in all the projects since the developments can be aborted before they reach the end. Specific projects will not monitor a hierarchical planning or controlling the procedure, and certain projects will go over the stages 2, 3 and 4 for many times as per the requirement.

It was common practice that most of the small scale construction organizations in India use Microsoft Excel by representing main categories of summaries of activities. Unique colors will be chosen for representing the process of activities, this lead to confusion and complexity in execution of structural activities. Sample representation of activities in Microsoft Excel is represented in
1.3. Microsoft Project (MSP)
Microsoft Project (MSP) is a project management software program developed by Microsoft organization, which is intended to help a project manager in any type of project to improve a plan, to allocate resources, to track the improvement, to accomplish the budget and to examine the amount of work.

Budgets in a project are based on the assigned work and the cost of resources. Resources viz., labour, material, and equipment can be shared among the projects using a mutual resource pond. Every resource has its individual calendar in which days and time are represented for the availability. Resource assigned costs are calculated based on resource rates.

MSP application can create critical path schedules and these can be resource leveled and task networks are pictured in the form of Gantt charts.4,5

2. OBJECTIVES
The research aims an empirical study on the application of MSP in every single aspect of a project from planning and scheduling phase and followed by monitoring and controlling phase. The various objectives are

- To study scheduling technique using Critical Path Method.
- To reduce the total duration of the project.
- To ease the work for the labour.

3. METHODOLOGY
The research methodology was done by phases. It comprises four phases.
Phase – 1:
- Site Supervision
- Observations at site
- Labour productivity

Figure 1 Sample representation of activities in Microsoft Excel
Phase – 2:
- Study of drawings
- Constructability checks

Phase – 3:
- Basic ideas in the improvement of construction plan
- Planning activities
- Work Breakdown Structure (WBS)
- Scheduling activities

3.1. PHASE – 1

3.1.1. Site Supervision
Site supervision includes the understanding of the site and working conditions at the project location. In this activity, one should get to know the various works that are being executed at the site, the degree of quality that is being followed, safety aspects, organization structure, rules, policies adopted etc.

Generally, inspection persons should create certain that every of the subsequent things is followed to:

a) That all workmanship and material are in unity with the specifications and the suitable good practice;
b) The quality control testing of material is at standard level of workmanship; and
c) That all works are to be in accordance with the equal, alignment, dimension, and cross-sections as identified in construction drawings and specifications.

3.1.2. Observation at the site
Observations at the site include knowledge of working procedures, specifications and practical executions on site. These help to identify the different deliverables required for completion of an activity.

3.1.3. Why is observation at the site required?
In preparation of a plan, observations carried out at site play a vital role, as they help to gather the information regarding the following aspects

3.1.4. Material required
Observations made at site lists out the nature of the material required, the quantity of material required, availability of material required in the market (off the shelf, prior order, import etc.). The material required includes the list of major consumables, minor consumables and reusable materials (like shuttering material). The list helps to identify the materials what company has to procure and what to materials to contract.

3.1.5. Labour required
Amount and nature (skilled and unskilled) of labour required to carry out a certain task. Mainly faced constraints in labour mobilization include the availability of construction labour, educating the labour about company’s working procedures, labour skillset etc.
3.1.6. Tools, Plant and machinery required
The observations also include listing out the various tools and tackles, plant and machinery required for successful completion of tasks. This identifies what tools and tackles, plant and machinery to buy, to hire and to contract.

3.1.7. Site conditions and surrounding environment
These include the general site conditions like accessibility, safety procedures, climatic conditions, work permits, labour working efficiency, constructability factors and various other enablers like the store, office, labour camps, water, electricity etc.

3.1.8. Identification of various vendors
Based on the different type of works to be executed and material required at the site to complete the activities, various types of vendors are identified. As per project requirements, contract documents are drafted.

3.1.9. Estimating activity duration
In most scheduling procedures, each work activity has associated associated time length. These durations are used extensively in getting ready a schedule. This duration are inferred from knowing the productivity of labour/machinery and the quantity of work to be executed. Labour productivity is briefly explained under the subhead Labour productivity. The quantity of the work to be executed can be known from Bill of quantities (BOQs).

3.1.10. Labour productivity
Productivity in construction is regularly outlined as output for every Man-hour. As the labour creates an enormous part for the development price and therefore the amount of Man-hours in acting a mission in construction is at a risk to the impact of administration than unit material or capital, this productivity measure is typically denoted to as productivity of labour. But, it is important to notice that productivity of labour could be alive of the effectiveness of associate degree package in using equipment, labour and assets to convert labor energies into helpful productivity and is not a measure of the abilities of labour only. Construction output may be represented in terms of useful entities or rupees. In the earlier case, labour productivity is related to parts of product per Man-hour, for example, cubic meters of concrete placed per hour. In the later case, labour productivity is recognized with the worth of construction (in constant rupees) per Man-hour. Because of the varied nature of the construction industry, a single key for the complete industry is neither substantive nor consistent. So, labour productivity at the site location ought to be determined for computation of varied activity durations that successively helps in preparation of a reliable arrange. Since the scope of activities is unlikely to be identical between completely different comes, unit productivity rates are usually utilized for this purpose. For example, the duration of associate degree activity Did such as concrete formwork assembly can be predictable as:

\[
D_{ij} = \frac{A_{ij}}{P_{ij} \times N_{ij}}
\]

Where Air is the essential formwork space to assemble (in sq. meters), Pij is the average productivity of a typical cluster during this task (measured in sq. meters per hour), and Nij is the range of staffs appointed to the task. Illustration of various labour productivities discovered for various tasks at the site, the actual productivity at the site, and Illustration of Productivity Changes Due to Learning are shown in [Table 1], [Table 2] and [Figure 2].
Table 1 Productivity observed on site conditions

<table>
<thead>
<tr>
<th>S. No</th>
<th>Description of work</th>
<th>Rate/Man-hours</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formwork</td>
<td>5 Sq.m</td>
<td>Incorrect</td>
</tr>
<tr>
<td>2</td>
<td>Cement Plaster</td>
<td>2.31 Sq.m</td>
<td>Incorrect</td>
</tr>
<tr>
<td>3.</td>
<td>Concreting (Columns &amp; Shear walls)</td>
<td>0.2 Cu.m</td>
<td>Correct</td>
</tr>
<tr>
<td>4</td>
<td>Concreting (Beams &amp; Slab)</td>
<td>0.89 Cu.m</td>
<td>Correct</td>
</tr>
<tr>
<td>5</td>
<td>Gypsum plaster</td>
<td>2.24 Sq.m</td>
<td>Incorrect</td>
</tr>
<tr>
<td>6</td>
<td>Brickwork</td>
<td>0.7 Cu.m</td>
<td>Correct</td>
</tr>
<tr>
<td>7</td>
<td>Laying Reinforcement (Beams &amp; slab)</td>
<td>1.48 Kgs</td>
<td>Correct</td>
</tr>
<tr>
<td>8</td>
<td>Laying of floor tiles</td>
<td>1.5 Sq.m</td>
<td>Correct</td>
</tr>
<tr>
<td>9</td>
<td>Bar bending (stirrups)</td>
<td>57.44 Kg</td>
<td>Incorrect</td>
</tr>
</tbody>
</table>

Table 2 Actual productivity at the site

<table>
<thead>
<tr>
<th>S. No</th>
<th>Description of work</th>
<th>Rate/Man-hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formwork</td>
<td>2 - 6 Sq.m</td>
</tr>
<tr>
<td>2</td>
<td>Cement Plaster</td>
<td>5 - 10 Sq.m</td>
</tr>
<tr>
<td>3.</td>
<td>Concreting (Columns &amp; Shear walls)</td>
<td>0.2 Cu.m</td>
</tr>
<tr>
<td>4</td>
<td>Concreting (Beams &amp; Slab)</td>
<td>0.89 Cu.m</td>
</tr>
<tr>
<td>5</td>
<td>Gypsum plaster</td>
<td>10 - 12 Sq.m</td>
</tr>
<tr>
<td>6</td>
<td>Brickwork</td>
<td>24 Cu.m</td>
</tr>
<tr>
<td>7</td>
<td>Laying Reinforcement (Beams &amp; slab)</td>
<td>10 - 15 Kgs</td>
</tr>
<tr>
<td>8</td>
<td>Laying of floor tiles</td>
<td>7 - 10 Sq.m</td>
</tr>
<tr>
<td>9</td>
<td>Bar bending (stirrups)</td>
<td>12 – 18 Kg</td>
</tr>
</tbody>
</table>

Figure 2 Illustration of Productivity Changes Due to Learning
3.2. PHASE – 2

3.2.1. Study of drawings
Study of drawings plays a significant role in the planning of activities. In this course of action, various drawings are identified like Superstructure architectural drawings, Structural drawings, Tile floor layout plan, Door & window schedule, Internal drawings, Reflected ceiling plan, MEP drawings etc. This study helps to recognize the various activities involved in delivering a project.

In this course of study of drawings, firstly, all the activities are recognized and then the sequential order of the activities is deduced. This helps to identify the inter-dependency of the activities and its associated trade. This sequential inference of the activities helps in constructing a WBS which is to be adopted for the successful completion of the project.

By the study of drawings, not only the sequence of activities is known but also the various materials required, trades involved and special agencies (like waterproofers) to be employed can be identified.

Some of the details inferred from the study of drawings are
- Site grade elevation, finish floor level, and building location footprints coordinated with the other disciplines are identified.
- Geometrical information of various items used is known.
- The sequence of zoning can be deduced.
- Coordination of MEP drawings with civil drawings is known.

3.2.2. Constructability checks
Constructability is a project management procedure to analyze construction process from start to finish, during the pre-construction level. It is to spot the difficulties before a project is truly constructed to cut back or stop errors, cost overruns, and delays.

From drawings and practical observations at working site, the space utilization of labour doing a particular task can be known, by this figures, one can assess the number of workers or crews that can work simultaneously for completing a task and can also check the different works that can be executed in the space available.

3.3. PHASE – 3

3.3.1. Planning of activities
- List out all the activities included in the project.
- Identify the total time required for project completion.
- Identify the individual time required for each activity.
- Make adjustments based on project deadlines.
- Estimation of resources.
- Allocate resources for all the activities.
- Next leveling of the resources should be done.
- Estimating cost and effort.
- Based on the plan generated squeezing/relaxing of the resources should be done.
- Identify milestones within the project element.
- Identify separate projects or sub-projects between the milestones.
- Identify the interfaces between projects or sub-projects.
- Identify the information requirement for each of these events, projects, sub-projects, interfaces etc.
- Identify the highest responsibility levels requiring the information.

The determination of project planning is to confirm that the final result is accomplished on time, within the economy, and shows quality. After drafting the plan, the plan must be re-run along with the drawings, this process helps to identify the incorrect sequence or omission of activities if any. This process is illustrated in Figure 3.

**Figure 3** Risk Management Paradigm

### 3.3.2. WBS

WBS is defined as “deliverable-focused, hierarchical grouping of project elements that organizes and defines the total project scope”.

Deliverables are tangible, measurable parts of a project which cannot be further broken-down. Task is not a WBS element but a set of tasks produce a deliverable. Some of the last WBS elements could be tasks, but most probably it is not considered. The Phases and their criteria in WBS are shown in Table 3.

**Table 3** Phases and criteria in WBS

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sub-project phase</td>
<td>A self-determining, deliverable end product requiring processing of multi-tasking having large volume of work</td>
</tr>
<tr>
<td>2</td>
<td>Task phase</td>
<td>A recognizable and deliverable major work comprising one or more work packages</td>
</tr>
<tr>
<td>3</td>
<td>Work package phase</td>
<td>A sizeable, recognizable, measure, cost-able and manageable work item/package of activities</td>
</tr>
<tr>
<td>4</td>
<td>Activity phase</td>
<td>Recognizable lower level jobs, operations or process, which consumes time and resources</td>
</tr>
<tr>
<td>5</td>
<td>Operations phase</td>
<td>A lowest day-to-day tasks, or process which is part of an activity</td>
</tr>
</tbody>
</table>
3.3.3. Why create a WBS using deliverables rather than traditional WBS (trade-wise)?

In general, a Project is broken down into various sub-projects or breaking down the project into various levels of deliverables until it reaches single deliverable.

WBS can be broken down in many ways depending on the requirement of the project. Of such, creating a WBS based on trade (which has been followed traditionally over the past years) is shown in the Figure 4 and Figure 5. Breaking down WBS into trade-wise has gone all wrong because it holds good only for certain level of planning where there were contractors to take only a particular sub-head. The advantage of this type of WBS is that a whole sub-head can be contracted to a single contractor, so the distribution for contractor or project team members this would hold good. But this breaking down has a big flaw i.e., it doesn’t cover interdependencies between different trades. Also, this type of breakdown cannot be adopted in Microsoft Project as it creates a loop while planning activities which are under different sub-heads. WBS based on trade is shown in Figure 4 and Figure 5.

![Figure 4 WBS of a building](image-url)
3.3.4. Scheduling of activities

The Schedule links the scope, work estimates, and deadline into a network of sequential tasks.

- Must Manage: Parallelism (tasks can be undertaken at the same time)
- Dependency (task has an effect on succeeding tasks)

Tools and techniques for Scheduling

- Critical Path Method (CPM).
- Work Breakdown Structure (WBS)
- Gantt Chart
- ETVX – How do you track tasks

Planning separate task expressed as ETVX

- Entry Criteria
  ✓ Before starting
- Tasking
- Validation
- Exit Criteria
  ✓ After finished
ETVX of an individual task and Networking of activities by CPM in MSP is shown in [Figure 6], [Figure 7], [Table 4]

![Figure 6 ETVX of an individual task](image)

![Figure 7 Networking of activities by CPM in MSP](image)
4. RESULTS AND DISCUSSIONS

- Labor productivity must be given extreme importance in calculating the activity duration and reliable plan, and knowing the well-founded methods in the computation of various labor productivities and for its improvement.

- The relationship between the tasks and their interdependencies should be known.
• Identification of various drawings required for the execution of works, and listing out various activities involved in a project and their sequential order should be prioritized.

• Creating a Plan and the key elements of a plan like WBS, activity duration, and their dependencies etc. should be implemented from the basic idea of planning.

• Critical path and critical activities of the project should be identified and Scheduled based on Project start date and Project end date.

• WBS should be created based on the project deliverables and the advantages of creating a WBS using deliverable over WBS created on the basis of trade.

• It is important to crosscheck the drafted plan with the drawings.

• Activity durations, their allotment should be assessed correctly.

• Defining the predecessor/successors relationship between activities and their constraints and understanding the techniques involved in Scheduling. And the last is to identify the risks involved while planning by following certain analysis or techniques like SWOT analysis
  • What was mistaken?
  • What is the probability?
  • What will the loss be?
  • What one can do about it?

REFERENCES


