Advanced Project Planning And Scheduling

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Abstract-

- *Project management is an area which is increasingly in demand in both large and small companies. Many mistakes are made during the first few weeks shaping the project scope, leading up to a plan and a schedule.*
- *Project management focuses on areas like working with clients, managing scheduling and budgeting, and analysing the risks which a project can face.*
- *Various strategies like critical path method, Gantt chart, Work Breakdown Structure, time- scaled arrow diagram, line of balance chart, S-curve, activity on node diagram, resource allocation chart, and so on*
- *Many project management methods is used for work schedules; they could be different in the way of giving less or more information, and selecting them would be based on the goal of our project and project requirements.*

I. INTRODUCTION

General Overview

Project Planning and Scheduling is one of the most important activities for a Project Manager when starting and managing any type of project. Many mistakes are made during the first few weeks shaping the project scope, leading up to a plan and a schedule. During my career as Project Manager and Manager of Project Management Offices I have come across many emerging and junior Project Managers who were lacking the initial understanding of what was important for the lead up to building a schedule.

This course is written for beginners and Project Management juniors, so that you will learn what Project Planning and Scheduling is about.

Project management is an area which is increasingly in demand in both large and small companies. It can help to manage all aspects of a business's daily life, as well as managing important company projects. Studying the Alison learning path in project management will help you to understand the guiding principles of project management, and how it can help a business to achieve better results.

This Alison learning path will interest you if you wish to move into the project management sector, or understand how effective project management can improve your business's efficiency. It will also be beneficial if you are planning on undertaking a project management degree and wish to understand the basics of the subject before commencing your course. The Alison project management learning path will take you from a low level of understanding to an understanding of more complex principles. You will look at important factors which influence project management, such as working with clients, managing scheduling and budgeting, and analysing the risks which a project can face.

Working project in primavera is like a working in group of activities with a systematic work breakdown structure. Primavera is an advance computer integrated enterprise project resource management tool. In any construction industry for project management purpose resource management is a key step. Sometimes project managers speak of resource- constrained scheduling when resource availability and work capacity are the primary factors that determine a project deadline. For simple operation management, resource scheduling is also used, as it allows managers to outline completion dates for tasks assigned to their teams, which they can report to stakeholders such as customers or a board of directors. Resource Scheduling refers to the set of actions and methodology used by organizations to efficiently assign the resources they have to jobs, tasks or projects they need to complete, and schedule start and end dates for each task or project based on resource availability. Depending on industry, resources can be peopleeither employees or independent contractors, equipment and machines this is frequent for construction, manufacturing or maintenance businesses or rooms and facilities. There may also be a need for consumable resources for instance, materials and parts for manufacturing.

- Basically project management deals with project cost and resources. So this software enables an organization to deliver project on time and on budgets through reuse of best practices.
- Primavera uses standard windows interfaces, client/server architecture, web-enabled technology, network based (Oracle and Microsoft SQL server) databases. It stores all projects in a single database system, which allows greater flexibility, increased efficiency, consistency and repeatability and hence saves organizations time and money. Application of Enterprise Project Management (E.P.M.) – For big, complex and multi-level projects in

any organization, it is necessary to have strong coordination and standardization, centralized resource management, higher-level reporting about projects and resources. And for all this one ideal solution available is Enterprise Project Management.

- For a company's multi-level Projects, a continual identifying, prioritizing and investing strategies have to be aligned. This can be done by 'Managing projects as a collective portfolio' for better decisions.
- Human resources are the most valuable and often expensive assets. It is difficult to maximize the productivity and cost-effectiveness, of human resources. So in E.P.M., we have 'Optimizing resources across organization' for proper survival.
- To achieve project success, clear and effective communication should be there with knowledge sharing team members. Project teams can meaningfully get connected and maintain coordination with quality, hence strengthen collaboration across the enterprise for improved productivity.

Overview of resource scheduling

A Resource Schedule will show which resource is assigned to which task. It lists the individual resources of a category (for instance, all employees, or all machines) and shows what each of those resources is assigned to do on a timeline that can be displayed at an hourly, daily, weekly or monthly scale. Individual work items such as tasks or jobs are called Events in Visual Planning and shown as blocks of color on the schedule. Events can also be non-working to represent unavailability (vacations for employees, planned maintenance for equipment, etc.). If multiple types of resources are used, users can easily switch from one resource schedule view to another or display several schedules at once. This is called Multi-Resource Scheduling.

The proposed worked used primavera for Project management techniques can be used to resolve resource conflicts and also useful in minimizing the project duration within limited availability of resources to make the project profitable. A study on the optimization of the schedule of resource constrained construction project.

In today's world construction industry is one of the most widely used and rapidly booming industry of our nation and across the world. Hence, it is considered to be the second largest industry of India in terms of generating huge amount of revenue and employment. Though the construction and infrastructure industry being second largest industry of our nation (India), the identity and recognition of this industry has not been grown in all dimensions of the country

Especially, at the remote places like small villages, rural places and the large part our country is by these small villages and rural habitats. Therefore there is a requirement of certain tools and techniques for the improvement of national economic upliftment, adequate land use and their environment planning to manage with the level of improvement in town and urban areas and the time required to tackle this goal can shortened. There is an intense necessity for effective Project Management.

1.1 Project Management

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you?

Project Planning is a general and most common term in construction management which refers to attain the expected goals and destinations. Planning is the key to bring the expected projects into reality or in existence. Therefore, the term 'Project Planning' has been used at various platforms to get the close meaning of different things. Generally planning involves the breakdown of the undertaken whole project works into small definable, identifiable and quantifiable tasks or activities or works and then constitutes the logical interdependencies between them. Basically, the process of Planning refers to 3 dominant questions, they are as below

i) What is to be done..?
ii) Who does it..?
iii) How to do it..?

Scheduling refers to slotting out the time duration by the thorough and explicit analysis of the planning tem to each and every activity to know the final project duration and the project delivery date. In other words it governs the timing of each work activities recognised by the planning process before or during project execution. Typically it shows and signifies the sequential order or phasing various individual project activities in a systematic way to complete the project. The schedule is a tool or a technic of every project management team which is used and practiced to predict most probable project completion time and thus enabling the in/ on time resources conception which are budgeted on the particular work.

The general steps to develop a proper schedule are as follows

- Proper time estimation of every activities
- Project planner should know the obligations of time for the project completion and delivery.
- The activities such as must start and must finish should be establish well recessed.
- Sorting out of activities which are crucial to timely completion of project should be recognised and kept in mind

The main objective of this study was to understand the role of monitoring and control in the progress and timely completion of a construction project. This objective was achieved through revision of literatures and methodologies involved in monitoring and control. For efficient recourse management planning and controlling of a construction project it is very necessary to use project management software. This study represents the importance of resource management in a large construction project. Only because of efficient resource management by Primavera P6 overall cost of a construction which sometimes increases due to wastage of recourse is controlled delay in time also decrease. The case study proved to be a guideline in understanding the progress of a residential colony construction project. The companies which do not use primavera software tools efficiently have to increase their investments in training and educating their employed project teams. In large construction project efficient resource management reduce the unwanted wastage of resource also cost of overall project. The use of such software's helps to complete the project on schedule time and cost.

Aim

- The main of the study is to Create effective project schedules and control
- Recognize key elements of schedule control and planning
- Apply best practices in scheduling projects

Problem Statement

"The purpose to conduct this study is to find out the advanced project planning and scheduling techniques for a construction project within timely and within budget completion."

Objectives

- To establish an approach that over the long term will reduce uncertainty
- To minimize the chaos and efficiency losses resulting from disconnects with the schedule, priority changes, emergency work
- To study and apply the six-Sigma Technology and Identify impact of delays
- Case study and Questionnaire Survey
- Six Sigma has been evaluated considering financial and technical aspects by construction professionals
- Implications of Six Sigma based on quality, performance and management aspects

Need of the Study

- Goals Become More Achievable
- It Keeps Your Costs Down
- They Prepare You for Unexpected Problems
- Everyone is on the Same Page
- Progress is Easier to Track

Scope of study

- Determining and entering project phases, milestones, deliverables and tasks
- Plan schedule management
- Define project activities
- Sequence activities
- Estimate resources
- Estimate durations
- Develop the project schedule

Problem with current scenario

- The construction industry in general is characterized with highly unorganized, low productivity, cost and time overruns, and conflicts compared with other industries.
- Effective management by applying six-sigma is an innovative to address these problems from systems perspective.
- The Six Sigma technique is mostly used to enhance the quality of product, reduce cost and process improvement for the construction industries
- Identifies the different quality and cost reduction techniques used in selected industries
- Find out various processes which reduces source of variation and improves quality and productivity, results increase in customer satisfaction.

Advantages

- Assists with tracking, reporting on, and communicating progress.
- Ensures everyone is on the same page as far as tasks, dependencies, and deadlines.
- Helps highlight issues and concerns, such as a lack of resources.

- Helps identify task relationships.
- Can be used to monitor progress and identify issues early

Working Principle

- Scope Definition
- Execution strategy
- Identifying / Defining the activities & milestones necessary
- Be Creative
- Be Flexible
- Level of detail
- Discipline integration

II. DATA COLLECTION

Resource Management

A resource is an entity that contributes to the accomplishment of project activities such as manpower, material, money, equipment, time or space.

Importance of Resources in Construction Projects

The crucial factor in successful implementation of a construction project not only depends on the quality & quantity of work, but also largely depends on availability of resources. All activities involved in the project require certain amount of resources. Each activity is allocated with a specific resource and must be completed within the time limit, otherwise it may adversely affect the overall duration of the project. The time and costs are directly dependent on the availability of resources. The time required may be determined by dividing the productivity associated with the resources used on the activity into the defined quantity of work for the activity. The best combination of resources to use for performing a construction activity is based on contractor's ability to identify the interdependencies of the various resources.

Methodology Adopted

This paper introduces a comprehensive framework for resource management particularly related to manpower as resource element in construction domain. This study is carried out in two phases. In the first phase, all the information and data needed to estimate resources were collected. The construction project schedule using the estimated resources was prepared in the form of Gantt chart and resources required for each activity are tabulated. The peak units required for a project day by day are shown in Resource histograms. In second phase, the actual resources available for the project were analyzed by Resource levelling with increased duration. The time-cost implications have been analyzed to alert the management.

Project Management

General Introduction:

The schedule contains different types of activities with different durations based on their nature of work and quantities calculated from drawings. From these quantities, Man power required for various activities are calculated. Based on the quantities, manpower required and realistic durations in the current situations are taken in to account and durations are calculated. Based on the data obtained, network diagram is prepared and relations are assigned to the activities to calculate the critical path. Finally the total duration of the project is calculated by Primavera. After preparing the schedule in Primavera software

In construction industry, planning and scheduling has very much importance. Project schedules are invariably dynamic and uncertain. Unfortunately, most discussions of scheduling in the project management arena focus largely on timing issues without taking into account the link between resource availability and capability and the project schedule; since the duration of each activity is dependent on the availability of resource, the problems arise when work proceeds without taking into account that how limited amount of labor, equipment and materials will impact the scheduling. When project schedules are developed without considering available, the resulting schedule may be misleading or impossible to achieve. Resource related issues are frequently ignored even though they can affect project completion time. Therefore, problem of scheduling activities under resource and precedence restriction with the objective of minimizing the total project, through put duration or the objective function is very important to perform the work as planned.

The process of project management is guided by three key principles:

- Planning
- Controlling
- Managing

Planning a project:

The first step in project management is to define your project.

- ✓ What is the scope of the work? What activities will make up the project and what is their relationship to each other?

You'll also want to identify the major milestones that will help you monitor the project's progress.

- ✓ What is the project duration? What are the dates when the project will begin and end?
- ✓ What resources are available to the project? Beyond labor, think about all the types of resources you will require.
- ✓ Who will perform what tasks? Determining your labor resources and their available work hours is a key part of building a successful project. You'll need to plan for downtime and holidays and determine the regular workweek for various staffing types.
- ✓ How much will the project cost? What are the costs per resource? Are there any hidden project costs?
- ✓ What is the estimated budget? Establishing a project budget estimate in advance helps you monitor possible cost overruns.

The answers to these questions from the framework of your project

Controlling a project

Once you have built your project and estimated your budgeting needs, you save this original plan as a baseline, or target schedule, to help you control the project. A baseline provides a solid point of reference as your schedule changes over time. It allows you to compare the original schedule to the current one and identify significant changes and develop contingency plans.

You control a project to keep it heading in the right direction. You'll want to track work progress and costs, compare them to your baseline, and then recommend what actions should be taken.

Effective project control reaps many benefits. It allows you to keep a close eye on possible problems before they become critical. It lets the project team and senior management view cost and scheduling timeframes based on the reality of the schedule.

Managing a project:

The process of guiding a project from start to finish is the responsibility of a project manager. A good project manager wears many hats, acting at various times as a motivator, communicator, coordinator, and advisor. As you control the project's progress, it is your job to keep your team aware of changes to the schedule and possible consequences. In many ways, you are the project's ambassador, ensuring that your project organization is carrying out its responsibilities for the best possible outcome.

To be an effective project manager also requires consistency when you update your projects. Select a day each week, or biweekly, when you will regularly update projects.

This regular update will include progress on values such as

- Dates on which activities started or finished
- Dates when resources are consumed
- Changes to resource rates

Determine a standard policy for the update and scheduling procedure, and for reporting progress.

The Project Management module provides many tools to assist you in reporting progress to both team members and senior management. Use the Project Web Site option to create a central location where team members can view project progress. Consider the many system reports as a means for communicating change. In addition, senior management can use the Portfolios section of P6 Web Access to summarize project data and easily capture a snapshot of how a project or group of projects is progressing.

Resource Scheduling:

General Information:

Project is a onetime activity with defined objectives which has to be finished in a certain period of time using limited number of resources. The project management comprises the computation of the early and the late start schedule, slack times of the activities and the allocation of the available resources over time to the execution of the activities. The project management techniques such as CPM/PERT has been widely used for scheduling. CPM provides minimum time required for completion of project and gives an advanced warning about future problems.

Some variables affect completion of construction projects such as activity durations, early start time, late start time, early completion time, late completion time and budget of project. The constraints such as weather, traffic, and the limited availability of resources such as skilled workers, machines, equipment, etc., cause increase in duration and cost of project. Therefore, new critical sequences will get developed and float calculated using CPM techniques will lose its significance. Schedules that neglect material constraints may affect the control of projects. Thus for successful completion of project resource scheduling is very important task. Resource scheduling is the futuristic planning of

activities that is limited by the available resources. Resource scheduling includes resource allocation to various activities and resource levelling. Resource levelling is a technique which is used to analyze unbalanced use of resources (usually people or equipment) over time, and resolves over-allocations or conflicts among different resources.

Current Scheduling Methods in Construction Industry

The most common scheduling method used in the construction industry is the Gantt chart (Bar Chart) and Critical Path Method (CPM). Gantt chart (Bar chart) has gained wide acceptance and popularity because of its simplicity and ease of preparation and understanding. No ―theory‖ or complicated calculations are involved. CPM network can show logic dependencies of activities, and estimate and predict the completion date of the project based on mathematical calculations. But both Gantt chart and CPM are unable to accurately model the repetitive nature of linear construction. This includes the inability of CPM to provide work continuity for crews or resources, to plan the large number of activities necessary to represent a repetitive or linear project (Harris, 1996), and the inability of Gantt chart (Bar chart) and CPM to indicate rates of progress, and to accurately reflect actual conditions. (Mattila and Abraham, 1998). The consequence of this is that there have been many attempts to find an effective scheduling technique for linear construction. These include, but not limited to, the Line of Balance (LOB), the vertical production method (VPM), the linear scheduling method, the repetitive project modelling (RPM), the linear scheduling model (LSM), and the repetitive scheduling method (RSM).

Gantt Chart Scheduling Method

The bar chart was originally developed by Henry L. Gantt in and is called a Gantt chart. A bar chart is ―a graphic representation of project activities which are shown in a time-scaled bar line with no links shown between activities‖. It quickly became popular in construction industry because of its ability to graphically represent a project‘s activities on a time scale. A bar chart has become a vehicle for representing many pieces of a project‘s information. A project must be broken into smaller, usually homogeneous components, each of which is called an activity or task. Bar charts basically use the x-axis to depict time, and the y-axis is used to represent individual activities.

LINE OF BALANCE (LOB)

The line of balance (LOB) method was originated by the Goodyear Company in the early 1940s and was developed by the US Navy during the Second World War for the programming and control of both repetitive and non-repetitive projects.

A common characteristic of LOB techniques is the typical unit network. Representative construction projects that fit into this category are a repetitive housing project or a high-rise building.

Work Breakdown Structure (WBS)

Successful project management depends in a large degree on the project manager's ability to specify the work content of projects in terms of its products (deliverables) and activities. One of the principal tools for planning and controlling the work content is the WBS. The WBS is commonly used at the beginning of a project for defining project scope, organizing Gantt schedules and estimating costs. It lives on, throughout the project, in the project schedule. A WBS is a product oriented family tree of phases, activities and tasks which organizes, defines and graphically displays the total work to be accomplished in order to achieve the final objectives of a project. It is a fundamental project management technique for defining and organizing the total scope of a project, using a hierarchical tree structure. Each descending level represents an increasingly detailed definition of the project. It is a system for subdividing a project into manageable work packets, components or elements to provide a common framework for scope schedule, costs, allocation of responsibility, communications, risk assessment monitoring and control.

The Project Management Institute define the WBS as "a hierarchical structure that defines and organizes the total project scope based on deliverables, with each descending level in the hierarchy representing an increasingly detailed definition of the project work". The aim is to ensure complete and proper definition of the entire work.

The highest level of the structure represents the entire project. This is then subdivided into smaller elements that represent the next level in the hierarchy. The process continues until such a level when the entire project is deemed to have been sufficiently decomposed to allow for effective and efficient project control.

The last level entries in the structure are referred to as work packages and represent the level where responsibility for the performance of the work in each work package is assigned to an individual or organization. Clearly therefore, two issues that must be addressed in developing the WBS are the decomposition criteria and the level of detail. These are discussed in the following paragraphs.

Steps in creating a WBS

- ✓ Identify main deliverables from project statement of work or other project concept
- ✓ documentation. For a construction project, at the tactical phase, these documentations can be in the form of detailed drawings, specifications and bills of quantities.
- ✓ Logically decompose each main deliverable into lower level entries. The process continues for all subsequent lower level entries until an appropriate level of detail is reached. Decomposition should be based on the 100% rule which puts as follows: "The next level decomposition of a webs element is 100 percent of the work applicable to the next higher.
- ✓ Examine, adjust and validate the WBS. This entails checking for completeness, making adjustments where necessary and ensuring that the developed structure addresses the main objectives of the project.

Application of Organizational Breakdown Structure

It represents the hierarchy in project for a responsible management. It usually shows the top to bottom level personnel in any business. After defining the hierarchy, one can associate responsible personnel on individual projects i.e. on EPS node and also projects within. So directly/indirectly one is assigning the responsibilities, accountabilities and authorities over the work heads.

A proper and completed work breakdown structure must be defined in a project to assign a committee or person for each task. The OBS will mirror the structure of the WBS. Major category work will be assigned to senior committee members and lower level tasks to the groups or individuals. By doing this, project manager becomes the responsible person for the project and indirectly gets authority to re-assign groups or individuals working in it. The access and privileges to nodes are assigned through the OBS. A maximum 25 levels can be created in primavera.

4.2 Difference between Traditional Construction and Lean Construction

Traditional Construction	*Six-Sigma Construction*
• *Uses the same activity centered approach used in mass production and project management*	• *Defines a clear set of objectivesfor delivery process*
• *Aims to optimize the project activity by activity and identifies customer value in design*	• *Aims at maximizing performanceto the customer at the project level*
• *Breaks the project into pieces and puts them in a logical sequence focusing on each activity*	• *Designs concurrently product and process*
• *Considers control as monitoring each activity against its schedule and budget projections*	• *Applies production control throughout the entire project life*

Future proposal for development

- Metro rail project
- Highway Project
- River Interlinking Project
- Seaport project
- Air taxi Project

Problems facing construction industry

- Environmental clearance Procedure
- Shortcomings in advanced innovative technique
- Wastage of resources
- Delay in target project date
- Quality of construction
- Lack of transfer of information
- Dispute among stakeholder
- Delay in supply of material

Proposal for the solution

By using six-Sigma construction technique

- Better quality of design
- More efficient schedule
- Rework reduction
- More efficient workflow
- Reduction of time
- Reduction of wastage
- Less change in orders
- More efficient flow of information
- Higher value for developer

Summary of construction tools

- Value Stream Mapping
- Concurrent Engineering
- Daily Huddle Meetings
- 5S
- First Run Studies
- Visual Management

- Fail Safe for Quality
- Construction Process Analysis
- Kanban (Pull System)
- Just-In-Time
- Work Standardization
- Last planner system
- Statistical Process Control (SPC)
- Work Structuring
- Pareto Analysis
- Poka-Yoke (Error Proofing)
- Continuous Flow
- Six Sigma
- Failure Mode and Effects Analysis (FMEA)
- Bottleneck Analysis
- Kaizen
- PDCA (Plan, Do, Check, Act)
- 5 Whys
- Muda Walk
- Root Cause Analysis
- Check Sheet
- Synchronize/Line Balancing
- Jidoka/Autonomation
- FIFO line (First In, First Out)
- Team Preparation

1. Value stream mapping	Technique for visually analyzing, documenting and improving the flow of a process in a way that highlights improvement opportunities.
2. Concurrent engineering	This methodology involves the various tasks parallel executed multi-disciplinary teams with the aim of optimizing engineering cycles of products for efficiency, quality, and functionality
3. Daily Huddle Meetings	This a technique used for communicating and for everyday meeting process of the project team in order to accomplish workers involvement. With project awareness and problem-solving contribution alongside some training that is given by different tools, the satisfaction of job (sense of growth, self-esteem,) will increase
4. 5S	Stands for Seiri, Seiso, seiton, Seiketsu and Shitsuke, (meaning Sort, Straighten, Shine, Standardize, and Sustain). This is a process for waste removal from the workplace through the use of visual controls
5. First Run Studies	Trial execution of a process with a specific end goal to decide the best means, strategies, sequencing, among others to perform it. First run studies are done a couple of weeks ahead of the scheduled execution of the process, in order to secure some time to acquire diverse or extra essentials and resources. In construction, this is used for redesigning critical assignments. This is part of continuous improvement effort, and incorporate efficiency studies and review work techniques by redesigning and streamlining the distinctive functions involved. The techniques involve the use of photographs, video files or graphics to demonstrate the process.
6. Visual Management	This is information communication technique employ to increase efficiency and clarity in processes through the use of visual signals.
7. Fail Safe for Quality	This relies on the generation of ideas which alert for potential defects. This is almost the same as Poka-Yoke techniques but it can be extended to safety. However, the concentration in safety is on potential hazards rather than potential defects, and it is identified with the risk assessment technique. It requires action plan that avoids bad outcomes
8. Construction Process Analysis	This actualizes process charts and top-view flow charts common among process analysis methods. These diagrams and charts depend on standardized symbols and effectively describe process flow and enable a quick determination of areas where problems exist in the process. The charts comprise of six symbols; Operation, Storage, Transportation, Volume Inspection, Delay, and Quality Inspection. The process diagram records every progression or step of a construction operation. Furthermore, it records flow within units, sections, and departments
9. Kanban (Pull System)	This is a Japanese word which literally means “billboard or signboard”. It is an information control process which regulates

	the movements or flow of resources so that parts and supplies are ordered and released as they are needed
10. Just-In-Time	This is a technique aimed primarily at minimizing flow times within a production as well as response times from suppliers and to end users. In any case, JIT is a way of thinking, working and managing to eliminate wastes in processes.
11. Work Standardization	Manufacturing documented procedures that capture best practices. This "living" documentation that is easy to change
12. Last planner system	The last planner is a person or group of people with the task to control production unit. They are responsible necessitating control of workflow, verify supply stream, design, and installation in all the production units.
13. Statistical Process Control (SPC)	This is a quality control tool that monitors and control process in order to ensure that system output variables operate to its full potential through periodic measurement.
14. Work Structuring	This is used for the development of process design and operation in alignment with the supply chain structure, allocation of resources, product design, and assembly design efforts with the objective of making work process more reliable and quick while delivering quality to the client.
15. Poka-Yoke (Error Proofing)	This is a mechanism design to detect and prevent errors in processes with the aim of achieving zero defects.
16. Pareto Analysis	This is a bar graph that is used for analyzing data about the frequency of the causes or problems in processes. It visually depicts which situation are more important.
17. Continuous Flow	This means to constantly provide or process and produce through a progressive system of uninterrupted steps in the process
18. Six Sigma	Sets of tools and techniques for improving quality through identification and removal of defects and reduction of variability in processes. Six Sigma is able to achieve process quality of 99.99966% that is free from defects
19. Failure Mode and Effects Analysis (FMEA)	This is a step by step approach for identifying potential failures in product or service, design, and manufacturing, etc. The failures are further ranked to determine the seriousness of their consequences in order to take actions to eliminate them, starting with the highest ranked ones.
20. Bottleneck Analysis	This is the identification of the part of the process that put a limitation on the overall productivity in order to improve the performance of that part.
21. Kaizen	This is Japanese business philosophy for continuous improvement. This is an approach that seeks to improve quality and efficiency through the elimination of waste from the value stream
22. PDCA (Plan, Do, Check, Act)	This is an iterative approach for improvements implementation. It involves; Plan (set up a plan and expect results); Do (execute the plan); Check (verify anticipated result achieved); and Act (evaluate; do it again).
23. 5 Whys	This is a quality management tool for problem-solving and it tries to find the root cause of an issue. It stipulates that workers should be asking why five times repeatedly until they identify the underlying root or the nature of the issue and its solution becomes clear. The procedure tries to fix a system by eliminating the root cause to avoid its recurrence
24. Muda Walk	Muda is a Japanese word meaning waste. Muda walk is a technique used to identify waste through observation of operations, how work processes are conducted, and noting areas where improvements are needed.
25. Root Cause	This is a problem-solving technique that

Analysis	focuses on discovering and resolving the real problem instead of quick fix application that only solve problem symptoms.
26. Check Sheet	Also known as Defect Concentration Diagram. This is a structured form prepared for collecting and analyzing data. It is a generic tool adapted for a variety of purposes including observation and a collection of data on the frequency of patterns of problems, events, defects, causes, etc.
27. Synchronize/Line Balancing	This involves levelling of workload across all processes in a value stream to remove excess capacity and bottlenecks.
28. Jidoka/Automation	The purpose of Jidoka is to design machines to partially automate the manufacturing process and operations in order to separate people from machines so that operators carry out other task(s) while the machines are running.
29. FIFO line (First In, First Out)	This is an approach for handling work request in order of flow from first to the last.
30. Team Preparation	This is a process of conducting training on waste, continuous flow and standardizes work for the lean team or employees

III. DATA ANALYSIS

Data Collection Techniques

VSM on a budget for a simple review that might produce results or at least help you to better understand VSM; value stream mapping is simple pencil/pen and page grab and with step by step instruction to the responsible person. Formed sketch,chart is your process. Your map should show the step by step improving in process for eliminating waste and idle time.

Process of Value stream mapping

- Using fundamental lean mapping tools to identify and address issues in the value stream
- Planning and implementing a lean six-sigma value-stream improvement project to achieve sustainable gains
- Identifying a project's anticipated improvements in performance and communicate them to leadership to secure alignment
- Fundamentals of Lean Six-sigma Thinking

  An overview of lean thinking and what it means for an organization to be lean
- Identifying waste in non-production value streams

  The 7 types of waste and what they might look like in various processes
- Scoping a value-stream improvement project (based on a case study)

  Aligning leadership and gaining agreement on the goals and objectives of the project
- Identifying key stakeholders and the participants of the implementation team
- Drawing a current-state map

  Understanding a value-stream map and the metrics that support the transformation Use of the value-stream mapping tool to document and analyze a current-state map Identifying the changes necessary to create a future-state map with a current-state map
- Using lean tools to create a future-state map that addresses identified problems and achieves project objectives.
- Planning, implementing, and managing value-stream improvement using the Plan-Do- Check-Act cycle (PDCA).

Procedure of value stream mapping

- Preparation for team- Identify the mapping team , the project or product and how the project or product will be mapped
- Current state – All the data related to current state is collected from the respected stakeholder engineer, owner, architecture worker, supervisor and manager.
- Future state mapping – After analyzing the current state data the gap between the planned project and actual project is found and some changes required to fulfil the current requirement for data is proposed
- Planning and implementation- Develop the action plan what to do for fulfil the gap and implement the plan.

Pre stage

In this stage on quick walk through along the entire process was done in order to get sense of material flow and sequence of flow. General template was used for every process which includes series of questions to get back ground information of the individual value stream. It was designed in order to gain more detailed information about each of the process with regards to their suppliers, customers and processes which allow a greater understanding of the process. After that all information were summarized in to one page document called Supplier Input Process Information Output

Customer. Finally select the product/project to be considered based on the production/process matrix. Finally select a product family which represent more than 10 % of volume of production capacity to create value stream map.

Current state map

The data collection was started in the raw material receiving bay through each of the individual processes identifying the linkages between the states of production and establishing the flow of information and material resources. Different variables such as cycle time, waiting time, set up time; First Time Through was obtained through work study techniques namely time and motion study and activity sampling. The current value stream map contains three layers mainly communication, process and time line.

Process	Issue	Solution
Process 1	Excessive material and people movements	Eliminate temporary relocation of material
	Unavailability of right raw material at right time in right order	Process standardization at site
Process 2	Poor distribution of work elements among workers	Work balancing
	Undefined job allocation among the workers	Work standardization
	Search for material and equipment	Implement the good housekeeping system
Process 4	High set up time Poor distribution of work element among the workers	dentify external set up work Work balancing
	Undefined job allocation among the workers	Work standardization
	Search for material and equipment	Implement the good housekeeping system
	Low First Time Through	Standardize the process
	Wasting time for Search for material and equipment	Implement the good housekeeping system
Process 9	Less standardized work process	Standardize the process
Process 3,5,7	Low FTT%-Levelling done by trial and error	Improve the sensitivity Of instrument

Planning and Implementation

When the future state map was completed for each issue highlighted an action plan was developedwhich is used as visual control tool to share information about kaizen projects

Identifying wastes from current process:

Fig: Steel Inventory

The large space is occupied because of the steel inventory. Heavy Inventory holding cost is paid to the security agency. Three watchmen work at the steel yard in Day, Evening and Night shifts. Daily wages paid to each is Rs. 240. So, money spent for the security of steel yard is Rs. 720 each day. Therefore, for 11 days the expense for security of steel yard is Rs. 7920.

Fig: Waste of cut pieces of steel

Waste is generated due to the cut pieces of steel. Error in cutting or bending steel or mistake in reading of bar bending schedule (BBS) causes the waste in steel. So, the money spent in cutting, bending and shifting of steel is Rs.4080 and the money spent in security is Rs.9820 for 11 days.

Total money spent is total time spent for the whole procedure = 11 days.

Recommendations for improvement in current process

To avoid such expenses in cutting and bending of steel and its holding cost, it was suggested by the author to order readymade steel on site. Readymade steel is a company made steel prepared as per client requirements and bar bending schedule given. There are many benefits for using ready-made steel in construction works

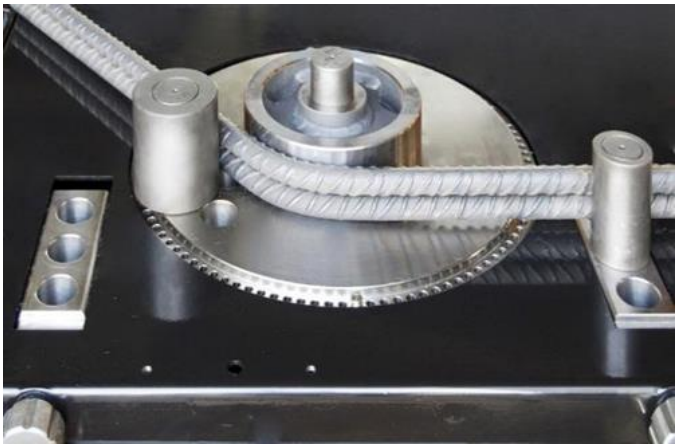


Fig: Steel bending machine

Readymade steel providers give a faster delivery of final product. It can be received at site on the 8th day of indent.

Following are the benefits of using readymade steel for this case study:

- Rs.4080 paid to the Labors for cutting, bending and shifting of steel can be saved.
- Space for the steel inventory is saved. It can be used for other purposes.
- Security is no longer required at steel yard. Rs.7920 is saved.
- No waste generation by cut pieces of steel.
- Procurement planning can be improved.
- 11 days were reduced to 8 days. 3 days are saved.

But, these are the improvements in the parallel activities. It would not affect the main activities of slab. Our focus is to propose a future state which reduces the slab cycle time by identifying waste in the current process for main activities or by applying innovative ideas

Current process of construction

Current process of construction in the current process, there is no wasteful process was found. But, there is a room for improvement by using innovative technique.

- It is possible to fix the column off-site and erected using crane.
- Off-site column fixing can be started two days earlier using safety stock of steel.
- Risk of working on heights can be avoided.
- Slab can be completed within 13 days, instead of 15.

Limitation

- Large scale companies are ready to implement take training and arranging workshop but small or medium scale company did not
- It is more use on automotive industry that is production than construction industry, as all process are well controlled in automotive industry and construction industry did not
- It is very lengthy process as implementation can gave only result overall it requires it requires time, money, and engagement of employee.

IV. CASE STUDY

3.1 PLANNING& SCHEDULING

- Determining and entering project phases, milestones, deliverables and tasks
- Understanding, choosing and entering dependencies and deadlines
- Determining human and material resources and costs
- Assigning and fine tuning resources within their availability
- Optimize and present the plan to stakeholders for approval
- Life Cycle Costing
- Concepts on Cost
- Developing Project Budget
- Developing the Project Quality Plan
- Developing the Communication Management Plan
- Developing the Risk Management Plan / Risk Register
- Selecting the Contract Type
- The Vendor Selection Process
- Planning best practices and checklists
- Baseline the schedule

EXECUTING

- Team Building and Motivation

- Leadership Styles
- Conflict Management
- Solving Team Problems
- Tracking strategies and updating schedule
- Taking corrective actions to bring project back on track
- Analyzing and revising the schedule
- Status reporting
- Executing best practices and checklists

MONITORING AND CONTROLLING

- The Monitoring and Controlling Loop
- Managing Changes
- Managing Corrective and Preventive Actions
- Measuring and Reporting Performance
- Project Reporting
- The Seven Basic Tools of Quality
- Quality Control Measurements
- Performance Appraisals
- Status Review Meetings
- Project reporting strategies
- Progress reporting using reports and views
- Forecasting efforts, dates and costs
- Maintain and control baseline
- Monitoring and controlling best practices and checklists

Day 1
Context of Project Planning & Scheduling

- Role of the project scheduler
- Principles of schedule development
- Estimating effort and duration
- tracking assumptions
- Logic diagrams & dependencies
- Critical path, float, constraints, milestones, baselines
- Duration & effort-driven scheduling
- Assignment: Bar (Gantt) chart for Kiddie roller coaster project

Day 2
Developing a Project Schedule

- Workshop: Create case study schedule
- Integrating schedules
- Project schedule reality check
- Base-lining the schedule
- Fast-tracking the schedule

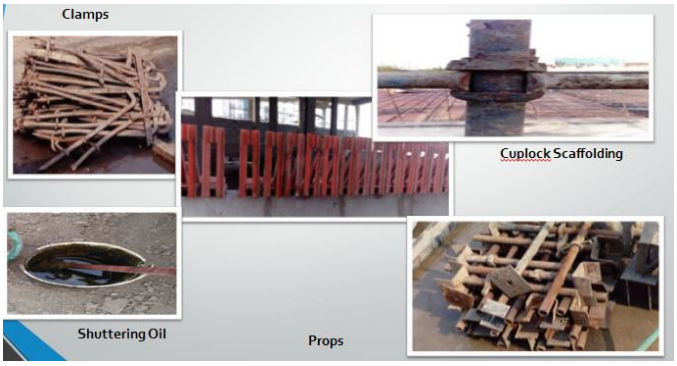
- Introducing principles of schedule control
- Schedule evaluation criteria
- Assignment: Schedule evaluation

Day 3
Updating & Tracking the Schedule

- Identifying progress
- Recognizing scheduling games
- Schedule reporting & control
- Schedule reporting methods
- Bar chart update
- Assignment: Drawing progress bars
- Performance measurements
- Updating and maintaining the schedule
- Measuring schedule variances against the baseline
- Workshop: Identifying the impact of a change
- Quantifying delay

6.2 SITE DETAILS:

- Structure Type: Residential Building Construction
- Construction Type: RCC Construction
- Name of the builder: Fortune, Pune
- Location: Handewadi, Pune
- Total project Cost: 12.45 Crores
- Total Length: 50/30 m
- Date of Commencement: November 2022
- Completion period: 36 Months
- Construction Type: RCC Frame Structure.
- No. of Floor: G+12 Floor
- Total Area of Building: 2, 15000Sq.ft.
- Plinth Area: 10150/- Sq.ft
- RCC Contractor Name: Mr.Tilekar
- Authority Engineer: Harshi Chaddha
- Local Authority: PMRDA, Pune
- Walls: 230 mm thick brick masonry walls only at periphery.
- RCC Design Consultant: G. A. BHILLARE STRUCTUAL CONSULTANT PVT. LTD.



V. CONCLUSION

In conclusion, planning and scheduling construction projects is very crucial in order to avoid project delays and cost overruns. So, the progress and completion of the construction project during the whole period of working will depend on how effective is the manager's schedule. The more detailed and clear the plan, the better and more understandable it will be.

- Identify project team roles and methods of project conflict resolution
- Plan and estimate percent complete for schedule and budget management
- Identify methods for schedule compression or recovery of time
- Develop risk management plans
- Identify methods for budget and scheduling estimates
- Develop a resource histogram and balance resources
- Perform earned value analysis on an actively tracked project plan