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Brief Overview of Project Scheduling Process

Pooja Soni[1], Nilesh Ware[2],
[1]Defence Institute of Advance Technology, Pune,
[2]Assistant Professor, Defence Institute of Advance Technology, Pune.

***Abstract*:- This paper is the result of extensive literature survey about project scheduling and it's the tools and technique. Scheduling is to complete the project within a specified time limit by allocating a specific start and end point of time according to the milestones and outcomes of the tasks by logically interlinking tasks and determine dependent and interdependent task. This paper discussed various technique used during six steps of project scheduling process. As a project is unique so does its schedule in the last the paper gives consideration to Trailor your project schedule according to the project requirement.**

INTRODUCTION

Project scheduling is the part of project planning phase. Project scheduling is the process of identifying, defining and organizing tasks, allocation of resources for each identified task, and setting timelines for a project to complete its deliverable and objectives. The schedule is used to track progress, and make necessary adjustments to make sure that the project is completes within its scope and decided schedule and budget[3].

To create the detailed action plan that organizes all project to-dos and their deadlines is part of project scheduling. Project schedules involve breakdown of task of projects into smaller, more manageable milestones and work packages.

Sometimes Project scheduling and project planning are frequently used interchangeably, but they are not the same thing. project scheduling is just one piece of the project planning. Project schedule is the roadmap for your project. After you scope or deliverable decide of the project. You can say your destination is decided now project schedule will give the roadmap to reach your destination, that what is the time of journey what are milestone in between your journey[4]. Also, along with robust schedule for a successful project, coordination between technical person and management are very necessary.

PROJECT SCHEDULING PROCESS

According to PMBOK project scheduling have majority of 6 steps

1) Plan Schedule Management
2) Define Activities
3) Sequence Activities
4) Estimate Activity Durations
5) Develop Schedule
6) Control Schedule [1]

The detailed description of each step:

PLAN SCHEDULE MANAGEMENT:

This step involves developing a plan for how to developed the project schedule, monitored and controlled. The plan developed should defines project's scheduling methodology, including the tools and techniques that are going to use for scheduling. This step involves creating a plan to manage the project schedule throughout the project. It also includes details that will be included in the schedule, the format and frequency of status reports, and the process for updating and communicating the schedule[5].

Few tools and techniques used in this step:

Historical information- Historical information such as existing practices policies and procedures and set standard in the organization can be a valuable input for the Schedule Management process, and provide basis for understanding how similar projects were planned and executed in the past, and can help project managers make more informed decisions when developing their own project schedules.

Expert judgment: Experienced professionals, subject matter experts are asked to provide guidance on how to develop an effective schedule management plan.

Meetings: Meetings with stakeholders and the project team can help identify project requirements and constraints and develop the scheduling approach.

Project management software: Software tools can assist with creating the schedule management plan using the historical information available within the organization[6].

DEFINE ACTIVITIES:

In this step, the complete list of specified tasks that must be completed in order to complete the project is identified. The project is divided into more manageable parts. The project manager identifies all of the micro level activities that must be finished to accomplish the project's goals.

Few tools and techniques used in this step:

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Work Breakdown Structure (WBS): The decomposition of a project into smaller, more manageable components. This technique involves breaking down the project into smaller, more manageable components or work packages. WBS should be flexible and dynamic. Because it needs to refine the schedule later stages because complete technical knowledge and details is not available before the start of project[7].
Templates: Standard templates can help to make sure that each and all relevant activities are included in the project schedule.
Rolling Wave Planning: In this technique the near future task is planned in detail and while the future task is not planned in details
Expert judgment and brainstorming: Project stakeholder can have brainstorming sessions with experienced professionals or subject matter experts to define project activities and dive deep into detail of every activity[8].

SEQUENCE ACTIVITIES

In this step, the project manager determines the order in which project activities should be performed. This step involves putting the identified activities in the correct order and determining dependencies between them. This includes identifying which activities need to be completed before others can start and determining any constraints that might impact the schedule. This step involves putting the identified activities in the correct order and determining dependencies between them. This includes identifying which activities need to be completed before others can start and determining any constraints that might impact the schedule[9]. The tools and techniques used in this step include dependency determination, leads and lags, and network diagrams.
Few tools and techniques used in this step[10]:
Network diagram: It is visual representation of logical relationship of different activities. Presentation can be of two type -
Precedence Diagramming Method (PDM): A technique that uses boxes or nodes to represent project tasks, and arrows to show the dependencies between tasks.
Arrow Diagramming Method (ADM): A technique similar to PDM, but uses arrows to represent the tasks and nodes to show the dependencies between them.
PDM is a scheduling technique that uses arrows to represent the dependencies between project activities. Activities have 4 kinds of relationship or Dependencies Start point-to-start point , Start point-to-end point , Finish point -to-start point , Finish point -to-finish point
The internal or external characteristics of activities and necessary or discretionary attributes may also be used to describe dependencies. Dependencies that are necessary externally, necessary internally, discretionary externally, and discretionary within dependencies[11].
Various kind of network diagram are[12]:-
CPM: It is a technique used to determine the longest path of activities in a project, which helps to identify the project's critical path and critical activities. CPM is useful for large, complex projects with many interdependent tasks.
PERT: It is a variation of CPM that allows for uncertainty in task duration estimates. PERT uses statistical analysis to calculate a range of possible project completion dates, which helps project managers to plan for unexpected delays.
Graphical Evaluation and Review Technique (GERT): A technique that allows for conditional and probabilistic branching, and is useful for modeling complex projects with uncertain outcomes.
Gantt Charts – This is the most tradition and popular scheduling tool. But when the project became complex it is not recommended to use Gantt chat[2].

ESTIMATE ACTIVITY DURATIONS

In this step, the project manager estimates the time required to complete each project activity. This step involves estimating how long each activity will take to complete. This includes identifying the amount of time required for each activity, taking into account factors such as resource availability, the complexity of the task, and any constraints or dependencies[13].
Few tools and techniques used in this step:
Expert judgment: Experienced project managers or subject matter experts can provide guidance on how to estimate activity durations.
Analogous estimating: This technique uses historical data from similar projects to estimate activity durations.
parametric estimating
Three-point estimating: This technique uses a range of estimates for activity durations, including an optimistic estimate, a pessimistic estimate, and a most likely estimate.
(formula)
Leads and lags: Leads allow an activity to start before the previous activity is complete, while lags require a delay before the next activity can start

DEVELOP SCHEDULE:

In this step, the project manager creates the project schedule by combining the activity sequences and duration estimates. This step involves putting all of the previous steps together to create a comprehensive project schedule. This includes determining the start and end dates for each activity, taking into account any dependencies, constraints, and resource availability. The tools and techniques used in this step include schedule network analysis, critical path analysis, and schedule compression[14].
Few tools and techniques used in this step:

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Critical path method (CPM): CPM is a scheduling technique that identifies the critical path, which is the sequence of activities that will take the longest to complete.
Schedule network analysis: This technique uses project management software to calculate the critical path and duration along with other important scheduling information.
Resource-constrained project scheduling (RCPS): A method that takes into account the availability of resources (such as labor, equipment, and materials) when creating a project schedule.
Resource Leveling: A technique that involves adjusting the start and end dates of tasks to ensure that resources are not over- or under-utilized.
Resource Smoothing: A technique that involves adjusting the duration of tasks to ensure that resources are not over- or under-utilized.
Simulation method – The famous one is Monte Carlo Simulation. It is a method that uses probability distributions to simulate the likelihood of different outcomes for a project, and can help identify and manage risks.

CONTROL SCHEDULE:

In this step, the project manager monitors the project's progress and makes adjustments as necessary to keep the project on track. This step involves monitoring the project schedule throughout the project to ensure that it stays on track. This includes comparing actual progress against the planned schedule, identifying any variances, and taking corrective action if necessary. The tools and techniques used in this step include performance reviews, schedule change control systems, and variance analysis[15].
Few tools and techniques used in this step:
Earned value management (EVM): EVM is a technique for measuring project performance by comparing the work completed to the work planned.
Schedule compression: This technique involves shortening the project schedule by reducing the duration of critical path activities.
Schedule change control system: This system ensures that all schedule changes are properly reviewed
Burndown Charts: Charts that show the amount of work remaining in a project over time.
What-if Analysis: A technique that involves exploring different scenarios or options for a project to determine or find out the best course of action to control project schedule.
Kanban: Kanban is used for Agile project management. It involves using a visual board to track tasks and work in progress, and to manage workflow. It can be used for project scheduling by assigning due dates to tasks and prioritizing work.
Overall, project scheduling is a critical component of project planning, as it helps to ensure that projects are complete within deadline and assigned budget. By following the six steps outlined above and using the appropriate tools and techniques, project managers can create effective schedules that help to ensure project success.

Table1. Summary of tools and technique used for project scheduling

Step	Tools
Plan Schedule Management	Expert judgment, Historical information, meetings
Define Activities	Work Breakdown Structure (WBS), Decomposition, Templates, brainstorming, rolling wave planning,
Sequence Activities	Network diagram (AOA and AON), Gantt chart
Estimate Activity Durations	Bottom-Up Estimating, Three-Point Estimating, Parametric Estimating, Analogous Estimating, Expert Judgment,
Develop Schedule	Critical path analysis, simulation, resource optimization technique,
Control Schedule	Earned value analysis, Kanban board(Agile), Burndown chart, What-if scenario analysis, Variance analysis Trend analysis, Performance reviews,

For small scale projects where the targets are not that large and the processes are not that complex, it may be possible to merge some of these processes together to simplify the project scheduling practice. For example, the planning, defining, and sequencing of activities can be combined into a single process where the project planner identifies the tasks need to finish the project, puts them in correct order, and estimates the resources needed to perform the task.
Similarly, estimation of the activity resources and durations can be combined into a single process where the project manager estimates the time and resources required to complete each task. Finally, the development of the schedule can be done depending on the details collected from the preceding steps. However, it is important to note that merging these processes together may not always be appropriate or advisable, as it may result in important details being overlooked or missed. merging processes together can also reduce the level of detail in project plan, which may make it harder to identify possible risks and dependencies that can impact success of project. It is important to evaluate each project individually and determine the most appropriate scheduling practices based on its unique characteristics and requirements[16].
Therefore, it is recommended that project managers use their judgement and consider the specific needs of their project before deciding to merge any of these processes together. While small scale projects may not require the same level of detail and complexity as larger projects, they still require careful planning and management to ensure they are completed successfully within the desired timeframe and budget. In summary, while merging some of the project scheduling practice processes together may be feasible for small scale projects, but careful evaluation is need for project unique needs and potential risks before doing so.
Each step should be focused to make robust schedule. Starting in the right direction is important for getting success. In project management project planning is the step where we decide the direction of project.
It's worth noting that different methodologies such as Agile, Waterfall, etc. have different steps and variations of them.

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TAILORING OF PROJECT SCHEDULE

Tailoring of project schedule involves adapting the project scheduling processes and tools that suits the unique needs and characteristics of a particular project. Here are some considerations to keep in mind when tailoring project schedule[17]:

Type of Life Cycle:

There are different types of life cycle approaches, including traditional (waterfall), agile, and hybrid approached which combines elements of both the waterfall and agile approaches. The approach should provide a clear understanding of the project timeline and deliverables.

Project complexity:

Complexity of the project will also impact the project scheduling. More complex projects may require more detailed scheduling and tracking, while simpler projects may need a more straightforward approach.

Stakeholder requirements:

Different stakeholders have different requirements and expectations Ensure you understand these requirements and tailor the schedule management accordingly.

Team structure:

The size and structure of the project team can impact schedule management. Larger teams may require more detailed schedules and tracking to ensure everyone is on the same page.

Organizational culture:

Every organization has its own unique in term of culture and dealing with tasks. Consider the organizational culture when tailoring your project schedule management approach to ensure it aligns with organizational norms and values.

Duration and Resource:

Duration refers to the hours required to complete a specific task, while resource availability refers to the number of resources (e.g., personnel, equipment, materials) available to complete the task. The correlation between resource availability and productivity is an important consideration in project scheduling. If there is a shortage of resources, it may take longer to complete the task, which can affect the overall project timeline. Several factors influence project durations, including the scope of work, available resources, project complexity, and risk. Resource availability can also have a significant impact on productivity, as inadequate resources can lead to delays and lower quality work.

Correlation between resource productivity and its availability depends on various factors, including the skill or expertise of the resources, their motivation, and quality of equipment and tools available. In general, having sufficient resources can improve productivity and reduce project duration, but it is essential to balance resource availability against other project constraints.

Technology Support:

Technology support is critical in developing, recording, transmitting, receiving, and storing project schedule model information which can greatly enhance project scheduling capabilities. Having readily accessible technology enhance the accuracy and efficiency of project scheduling. For example, project management software can help automate many of the tasks involved in project scheduling, track progress, and generate reports which reduce the risk of errors and improving the accuracy of project data. This can also help to ensure that everyone in team stays on schedule.

Readily accessible technology can also facilitate collaboration and communication among project team members, stakeholders, and other participants, enabling faster and more effective decision-making. It is essential to ensure that technology support is readily accessible, reliable, and secure to ensure the success of the project.

Furthermore, the application of technology can enhance the transparency and accountability of project schedule. With project management software, stakeholders and team members can access real-time information about the project progress including, milestones, task deadlines. It will build confidence and trust among stakeholders, as they can see the progress of the project and have a clear understanding of its status.

Additionally, technology can provide advanced analytics and reporting capabilities, allowing project managers to track project performance and identify potential issues or risks. With the use of data visualization tools, project managers can quickly and easily understand complex project data and make informed decisions.

But it's crucial to make sure the technology is suitable for the project's requirements and that the team members have the expertise and training required to use it efficiently. The technology should also be adaptable to changes in the project and should be able to integrate with other project management tools and systems used by the team.

By taking these considerations into account, you can tailor your project schedule management approach to ensure it meets the unique needs and characteristics of your project.

PROJECT SCHEDULING SOFTWARE

1. Microsoft Project: It is popular project management software that is used for project scheduling. It used to create project plans, including activity or tasks, milestones, and its dependencies, and to assign resources and set project timelines. The software includes features such as critical path analysis, Gantt charts and resource management, and it generate project progress reports

2 Trello: It uses Kanban-style approach for simple project scheduling. It allows users to create project boards with lists of tasks and cards, and to assign team members and due dates to each task. While Trello may not be suitable for complex and large projects.

3. Primavera P6: This software tool is designed for large, complex projects. It allows users to create detailed project schedules with thousands of tasks and dependencies. The software also includes advanced reporting and analytics features. It is widely used in industries such as construction, engineering, and oil and gas.

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4 Asana: It is a cloud-based software that can be used for project scheduling. It allows users to create task lists, calendars, and project timelines, and allows users to assign tasks, set due dates, and track project progress. The software also includes collaboration features such as team messaging and file sharing.
5 Jira: This is widely used for software development projects. It includes features such as Agile planning, backlogs, sprint planning, and can be used for project scheduling as well as issue tracking and bug reporting. Jira integrates with other software development tools such as GitHub and Bitbucket.
6 Procore: Procore is a cloud-based construction project management tool that can be used for project scheduling
7 Microsoft Excel: It is not a project management software but still it is widely used for small project scheduling due to its wide popularity in industry and ease of use. Most of the scheduling process done with the experience and domain expertise's of user
Others project scheduling software Oracle Project Portfolio Management, Smartsheet, Wrike, GanttProject, Monday.com, Basecamp, TeamGantt, LiquidPlanner, Basecamp, Zoho Projects, Workfront which have more or less same features. These software tools allow users to create, manage, and track project schedules, and to collaborate with team members and stakeholders. They also offer features such as automated workflows, alerts, and analytics, which can help to improve project efficiency and reduce project risk[18].

CONCLUSION

Project scheduling is not a one-time activity but a continuous process during project. As the project progresses, schedule may require to revised to accommodate changes in requirements, resources or scope. Therefore, it is important to maintain flexibility and adaptability schedule to included knowledge gained, better understanding of the risk, Technique like PERT GERT CPM CCM, Gantt chart is visual representation that gives better understanding of project schedule and help in decision making for managers. tailoring the project schedule according to life cycle type, considering duration and resource factors, project dimensions, and technology support managers can create a detailed and realistic project schedule that meets the project's needs and objectives. Regular reviews of the project schedule should be conducted to identify any deviations from the plan and take corrective action. Involvement of all stakeholders in the project scheduling process is important to ensure that their expectations are met, and their needs are considered. Effective flow of information and collaboration among project stakeholders can help to ensure that the project schedule is realistic, achievable, and aligned it with the project scope.

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