PROJECT MANAGEMENT

Unit III – Project Planning and Management

3.1 Introduction to Project Planning

Project planning is one of the most important activities in project management. Before any work begins, the project manager and the team must carefully think about what needs to be done, how it will be done, who will do it, and how long it will take. A good plan increases the chances of project success significantly.

> **Definition**
> *"Project planning is the process of defining the project scope, objectives, and steps required to achieve them, including the identification of resources, timelines, risks, and quality standards."*

Without proper planning, a project is likely to go over budget, miss deadlines, or fail to meet the customer's requirements. Planning is not done just once – it is updated continuously as the project progresses.

Why is Project Planning Important?

- It gives the project a clear direction and purpose.
- It helps identify potential problems early so they can be prevented.
- It ensures that resources (people, money, equipment) are used efficiently.
- It provides a baseline against which actual progress can be measured.
- It improves communication among team members and stakeholders.
- It reduces uncertainty and increases confidence in project delivery.

Key Outputs of Project Planning

- **Project Plan:** A document describing the scope, schedule, budget, quality plan, risk plan, and communication plan.
- **Work Breakdown Structure (WBS):** A hierarchical breakdown of the total project work into smaller, manageable tasks.
- **Schedule:** A timeline showing when each task will start and finish.
- **Resource Plan:** Details of who will do each task and what materials are needed.
- **Risk Register:** A list of identified risks with their probability, impact, and response plans.

3.2 Project Planning Process

Project planning is not a single action but a structured process with multiple steps. Each step builds on the previous one to create a comprehensive plan for the project.

Step 1: Define the Project Scope

The scope defines exactly what the project will deliver and what it will NOT deliver. It sets the boundaries of the project. The scope is documented in a Scope Statement or Project Charter, which is approved by the stakeholders.

- What is the goal of the project?
- What are the deliverables (outputs)?
- What is excluded from the project?
- What are the constraints (budget, time, resources)?

Step 2: Create the Work Breakdown Structure (WBS)

The WBS breaks the project into smaller, manageable pieces of work. It is a hierarchical structure where the top level is the overall project, and lower levels are smaller tasks and sub-tasks. Each item at the lowest level of the WBS is called a Work Package.

Example WBS for a software project: Software Development → Requirements → Design → Development → Testing → Deployment.

Step 3: Identify and Sequence Activities

Each Work Package is broken down into specific activities (tasks). The dependencies between activities are then identified. For example, coding cannot start until the design is complete. These dependencies determine the sequence in which activities must be performed.

Step 4: Estimate Duration and Resources

For each activity, the team estimates how long it will take and what resources (people, equipment, materials) are required. Estimation techniques include:

- **Expert Judgement:** Using the experience of senior team members or domain experts.
- **Analogous Estimation:** Using data from similar past projects.
- **Three-Point Estimation (PERT):** Calculating the average of Optimistic, Most Likely, and Pessimistic time estimates. Formula: Expected Time = (O + 4M + P) / 6

Step 5: Develop the Schedule

Using the activity list, dependencies, and duration estimates, the project schedule is created. Tools used include Gantt Charts, PERT Charts, and the Critical Path Method (CPM). The schedule shows the start and end dates of each activity and the overall project.

Step 6: Estimate Costs and Create Budget

The cost of each activity is estimated based on resource rates and durations. The total project budget is the sum of all activity costs, plus contingency reserves for unexpected risks.

Step 7: Plan for Quality, Risk, and Communication

- Quality Plan: Defines quality standards and how they will be measured.
- Risk Plan: Identifies risks and prepares response strategies.

- Communication Plan: Defines who gets what information, when, and how.

3.3 Agile Project Management

Agile Project Management (APM) is an iterative approach to planning and guiding project processes. Unlike traditional project management, which is plan-driven and sequential, Agile project management focuses on continuous delivery and adaptation.

> **Definition**
> *"Agile Project Management is an iterative approach to delivering a project throughout its life cycle, where requirements and solutions evolve through collaboration between self-organising teams and their customers."*

Key Features of Agile Project Management

- **Iterative Delivery:** The project is divided into short iterations (sprints), each delivering a working piece of the product.
- **Customer Collaboration:** The customer is actively involved throughout the project, not just at the beginning and end.
- **Adaptive Planning:** The plan is updated at the start of each iteration based on feedback and changing requirements.
- **Self-Organising Teams:** Teams have the freedom to decide how to complete their work.
- **Continuous Improvement:** At the end of each iteration, the team reflects and improves its processes.

Agile vs Traditional Project Management

Aspect	Traditional (Waterfall)	Agile
Planning	Detailed upfront plan	Rolling wave, iterative planning
Scope	Fixed at the start	Flexible, evolves over time
Customer Role	Involved at start and end	Involved throughout
Delivery	Single final delivery	Incremental frequent delivery
Change Handling	Difficult and costly	Easy and welcomed
Team	Hierarchical structure	Self-organising cross-functional
Risk	High (discovered late)	Low (discovered early each sprint)

Agile Project Management Framework (DSDM)

The DSDM (Dynamic Systems Development Method) is a popular Agile project management framework. It organises the project into three phases:

- **Pre-Project Phase:** Business needs are identified and the project is formally approved.
- **Project Lifecycle Phase:** Feasibility study, business study, functional model iteration, design and build iteration, and implementation.
- **Post-Project Phase:** Benefits realisation – checking if the project delivered the expected business value.

3.4 Gantt Chart

A Gantt Chart is the most commonly used project scheduling tool. It is a horizontal bar chart that visually shows the schedule of a project, including all activities, their start and end dates, and their durations.

> **Definition**
> *"A Gantt Chart is a type of bar chart that illustrates a project schedule, showing the start and finish dates of the various activities (tasks) of a project against a timeline."*

Gantt Charts were developed by Henry Gantt in the early 1900s and are still widely used today in both traditional and Agile projects.

Components of a Gantt Chart

- **Task List (Y-axis):** On the left side, all project tasks are listed from top to bottom.
- **Timeline (X-axis):** Across the top, the time scale (days, weeks, months) is shown.
- **Bars:** Each task is represented by a horizontal bar. The length of the bar shows the duration of the task.
- **Dependencies:** Arrows or lines connect tasks that depend on each other.
- **Milestones:** Key events or checkpoints shown as diamond shapes on the chart.
- **Progress Tracking:** The bars can be shaded to show how much of each task has been completed.

Advantages of Gantt Charts

- Simple and easy to understand – even non-technical stakeholders can read them.
- Provides a clear visual overview of the entire project schedule.
- Shows task dependencies and relationships clearly.
- Helps identify which tasks can be done in parallel.
- Easy to update as the project progresses.
- Useful for communicating project status to stakeholders.

Limitations of Gantt Charts

- Can become very complex and hard to read for large projects with hundreds of tasks.

- Does not show the relative importance of different tasks (critical path is not obvious).
- Does not show resource allocation (who is doing each task).
- Does not handle uncertainty well – it assumes fixed durations.

3.5 PERT Chart (Program Evaluation and Review Technique)

PERT is a statistical tool used in project management to analyse and represent the tasks involved in completing a project. It was developed by the United States Navy in 1957 for the Polaris submarine missile project.

> **Definition**
> *"PERT (Program Evaluation and Review Technique) is a project management tool used to schedule, organise, and coordinate tasks within a project. It uses network diagrams to represent the sequence of activities and their dependencies."*

Key Concepts in PERT

- **Events (Nodes):** Points in time that mark the start or completion of an activity. Represented as circles in the network diagram.
- **Activities (Arrows):** The tasks that need to be completed. Represented as arrows connecting the events.
- **Optimistic Time (O):** The minimum time required to complete the task if everything goes perfectly.
- **Most Likely Time (M):** The most realistic time estimate for the task under normal conditions.
- **Pessimistic Time (P):** The maximum time required to complete the task if everything goes wrong.
- **Expected Time (TE):** Calculated using the formula: TE = (O + 4M + P) / 6

PERT Three-Time Estimate Formula

PERT uses three time estimates for each activity to handle uncertainty:

Expected Time (TE) = (Optimistic + 4 × Most Likely + Pessimistic) ÷ 6

Example: If O = 3 days, M = 5 days, P = 9 days, then: TE = (3 + 4×5 + 9) ÷ 6 = (3 + 20 + 9) ÷ 6 = 32 ÷ 6 = 5.33 days

Advantages of PERT

- Handles uncertainty by using three time estimates.
- Identifies the critical path (longest path through the network).
- Good for research and development projects where durations are uncertain.
- Helps calculate the probability of completing the project on time.

Limitations of PERT

- Complex to create and understand for large projects.
- Time estimates are subjective and may be inaccurate.
- Does not show resource allocation.

3.6 CPM – Critical Path Method

The Critical Path Method (CPM) is a project scheduling technique used to identify the longest sequence of dependent tasks in a project. This longest sequence is called the Critical Path. Any delay in the activities on the critical path will directly delay the entire project.

> **Definition**
> *"The Critical Path Method (CPM) is a step-by-step project management technique for process planning that defines critical and non-critical tasks with the goal of preventing timeframe problems and process bottlenecks."*

Key Concepts in CPM

- **Critical Path:** The longest path from the start to the end of the project. Activities on this path have zero float (slack). Any delay here delays the whole project.
- **Float (Slack):** The amount of time a task can be delayed without delaying the project. Critical path activities have zero float. Non-critical activities have positive float.
- **Early Start (ES):** The earliest time an activity can begin.
- **Early Finish (EF):** The earliest time an activity can be completed. EF = ES + Duration.
- **Late Start (LS):** The latest time an activity can start without delaying the project.
- **Late Finish (LF):** The latest time an activity can finish without delaying the project.

Steps to Find the Critical Path

- **Step 1:** List all activities and their dependencies.
- **Step 2:** Draw the network diagram.
- **Step 3:** Calculate Early Start (ES) and Early Finish (EF) for each activity (Forward Pass).
- **Step 4:** Calculate Late Start (LS) and Late Finish (LF) for each activity (Backward Pass).
- **Step 5:** Calculate Float = LS – ES (or LF – EF).
- **Step 6:** Activities with Float = 0 are on the Critical Path.

PERT vs CPM Comparison

Feature	PERT	CPM
Time Estimates	Three estimates (O, M, P)	Single deterministic estimate

Uncertainty	Handles uncertainty well	Assumes fixed durations
Focus	Time management	Time and cost management
Best Used For	R&D, new/uncertain projects	Construction, manufacturing
Network Type	Event-oriented	Activity-oriented
Cost Control	Not included	Included (cost crashing)

3.7 Microsoft Project

Microsoft Project (MS Project) is the world's most widely used project management software. It helps project managers create schedules, assign resources, manage budgets, track progress, and generate reports – all in one tool.

> **Definition**
> *"Microsoft Project is a project management software product developed by Microsoft, designed to assist project managers in developing plans, assigning resources to tasks, tracking progress, managing budgets, and analysing workloads."*

Key Features of MS Project

- **Gantt Chart View:** Automatically creates Gantt charts when tasks are entered.
- **Network Diagram (PERT/CPM):** Shows task dependencies in a network format.
- **Resource Management:** Assign team members to tasks and track their workload.
- **Budget Tracking:** Enter costs for resources and tasks; compare planned vs actual costs.
- **Critical Path Highlighting:** Automatically identifies and highlights the critical path.
- **Baseline Tracking:** Save the original plan as a baseline and compare it with actual progress.
- **Reporting:** Generate various project reports including resource usage, cost, and schedule variance.
- **Integration:** Integrates with other Microsoft tools like Excel, SharePoint, and Teams.

Advantages of MS Project

- User-friendly interface familiar to most office users.
- Automates schedule calculation and critical path analysis.
- Strong resource management and cost tracking capabilities.
- Excellent reporting and dashboard features.
- Widely used and supported industry-wide.

Limitations of MS Project

- Expensive – requires a paid Microsoft licence.
- Complex for beginners – steep learning curve.
- May be overkill for small, simple projects.

3.8 Primavera Project Management Software

Oracle Primavera (P6) is an enterprise-level project management software used in large, complex industries such as construction, engineering, oil and gas, aerospace, and government. It is considered the industry standard for large-scale project management.

> **Definition**
> *"Primavera P6 is an enterprise project portfolio management software that provides robust tools for project scheduling, resource management, cost control, and risk analysis for large and complex projects."*

Key Features of Primavera P6

- **Multi-Project Management:** Can manage hundreds of projects simultaneously across a portfolio.
- **Advanced Scheduling:** Supports CPM and PERT scheduling with thousands of activities.
- **Resource Levelling:** Automatically balances resource allocation to avoid over-allocation.
- **Baseline Management:** Supports multiple baselines for comparing planned vs actual performance.
- **Risk Analysis:** Built-in risk management tools to quantify and mitigate project risks.
- **Earned Value Management (EVM):** Tracks project cost and schedule performance against the baseline.
- **Reporting:** Highly customisable reports and dashboards for executives and project managers.
- **Integration:** Integrates with Oracle ERP systems, SAP, and other enterprise tools.

MS Project vs Primavera

Feature	MS Project	Primavera P6
Target Users	Small to medium projects	Large enterprise projects
Industry	General business, IT	Construction, engineering, O&G
Project Size	Up to few hundred tasks	Thousands of tasks
Multi-Project	Limited	Excellent (portfolio management)
Cost	Moderate	High
Learning Curve	Moderate	Steep
EVM Support	Basic	Advanced
Integration	Microsoft ecosystem	Oracle/SAP/ERP systems

3.9 Role of the Project Manager

The Project Manager (PM) is the person responsible for leading and managing the project from start to finish. The PM is the central point of responsibility and accountability for the project's success or failure.

> **Definition**
> *"A Project Manager is a professional who organises, plans, and executes projects while working within constraints such as budgets and schedules. They lead and direct projects from inception to completion."*

Core Responsibilities of a Project Manager

- **Scope Management:** Define the project scope clearly and prevent scope creep (uncontrolled expansion of work).
- **Time Management:** Create the project schedule and ensure tasks are completed on time.
- **Cost Management:** Manage the project budget and control spending.
- **Quality Management:** Ensure the project deliverables meet the required quality standards.
- **Risk Management:** Identify, assess, and respond to project risks.
- **Communication Management:** Keep all stakeholders informed of project progress and issues.
- **Team Leadership:** Motivate, guide, and resolve conflicts within the project team.
- **Stakeholder Management:** Manage expectations and maintain relationships with all stakeholders.

Key Skills of a Project Manager

- Leadership – the ability to inspire and guide the team.
- Communication – clear and effective verbal and written communication.
- Problem Solving – the ability to think critically and resolve issues.
- Negotiation – managing conflicts and reaching agreements.
- Organisational skills – managing multiple tasks and priorities simultaneously.
- Technical knowledge – understanding of the project domain.
- Risk awareness – anticipating problems before they occur.

3.10 Objectives of Activity Planning

Activity planning is the process of identifying and organising all the individual tasks (activities) that must be completed to deliver the project. It is the foundation of the project schedule.

Key Objectives of Activity Planning

- **Feasibility Assessment:** To determine whether the project can realistically be completed within the given time, cost, and resource constraints.

- **Resource Allocation:** To identify all resources (people, equipment, materials) required for each activity and allocate them efficiently.
- **Target Setting:** To set realistic deadlines and milestones for the project team.
- **Coordination:** To coordinate the work of different team members and departments to avoid conflicts and duplication.
- **Progress Monitoring:** To provide a baseline against which actual progress can be measured.
- **Risk Identification:** To identify activities that carry the highest risk so that contingency plans can be prepared.
- **Motivation:** To give team members clear goals and deadlines, which increases motivation and accountability.

3.11 Project Schedules

A project schedule is a document that lists all project activities with their planned start dates, end dates, durations, and dependencies. It is the master timetable of the project.

Types of Project Schedules

- **Master Schedule:** A high-level summary schedule showing all major milestones and phases of the project.
- **Detailed Schedule:** A comprehensive schedule showing every task with its start date, end date, duration, and assigned resource.
- **Rolling Wave Schedule:** Used in Agile projects. Near-term work is planned in detail; far-future work is planned at a high level.
- **Milestone Schedule:** Shows only the key milestones (major achievements) of the project without detailed tasks.

Components of a Project Schedule

- Activity Name – a brief description of each task.
- Duration – how long the activity will take.
- Start Date – when the activity will begin.
- End Date – when the activity will finish.
- Dependencies – which activities must be completed before this one can start.
- Assigned Resources – who is responsible for completing the activity.
- Milestones – key events or checkpoints in the project.

3.12 Activities, Sequencing, and Scheduling

What is an Activity?

An activity (also called a task) is a specific piece of work that must be performed to complete the project. Activities are the lowest level of the Work Breakdown Structure (WBS). Each activity has:

- A clear start and end point.
- An estimated duration.
- A defined output or deliverable.
- An assigned resource (person or team responsible).

Activity Sequencing

Activity sequencing is the process of identifying and documenting the relationships (dependencies) between project activities. This determines the order in which activities must be performed.

Types of Activity Dependencies

- **Finish-to-Start (FS):** Activity B cannot start until Activity A finishes. (Most common type.) Example: Testing cannot start until coding is finished.
- **Start-to-Start (SS):** Activity B cannot start until Activity A starts. Example: Quality review can start once coding starts.
- **Finish-to-Finish (FF):** Activity B cannot finish until Activity A finishes. Example: Documentation cannot finish until development finishes.
- **Start-to-Finish (SF):** Activity B cannot finish until Activity A starts. (Rare.) Example: A new system cannot go live until the old system starts being phased out.

Types of Dependencies

- **Mandatory Dependencies (Hard Logic):** Dependencies that are inherent to the nature of the work and cannot be changed. Example: Foundation must be laid before walls are built.
- **Discretionary Dependencies (Soft Logic):** Dependencies based on best practices or preferences that can be changed if needed. Example: Code review before testing is a best practice but not mandatory.
- **External Dependencies:** Dependencies involving parties outside the project team. Example: Waiting for a vendor to deliver hardware before installation can begin.

Activity Scheduling

Activity scheduling is the process of determining the specific start and end dates for each activity based on the duration estimates, resource availability, and dependencies. The schedule is typically created using:

- Gantt Charts – for visual timeline representation.
- CPM (Critical Path Method) – to identify the critical path and calculate float.
- PERT – to handle uncertainty in activity durations.
- Resource Levelling – to adjust the schedule based on resource constraints.

Schedule Compression Techniques

When the project schedule needs to be shortened without reducing scope, two main techniques are used:

- **Crashing:** Adding extra resources (more people, overtime) to critical path activities to shorten their duration. This increases cost.
- **Fast Tracking:** Performing activities in parallel that were originally planned to be done sequentially. This increases risk but does not increase cost.