Software Project Management Concept

Software engineering is an engineering branch associated with development of software product using well-defined scientific principles, methods and procedures. The outcome of software engineering is an efficient and reliable software product. Software project management has wider scope than software engineering process as it involves communication, pre and post delivery support etc. The job pattern of an IT company engaged in software development can be seen split in two parts:

- Software Creation
- Software Project Management

Projects

A project is well-defined task, which is a collection of several operations done in order to achieve a goal (for example, software development and delivery).

A Project can be characterized as:

- Every project may has a unique and distinct goal.
- Project is not routine activity or day-to-day operations.
- Project comes with a start time and end time.
- Project ends when its goal is achieved hence it is a temporary phase in the lifetime of an organization.
- Project needs adequate resources in terms of time, manpower finance, material and knowledge-bank

Software Projects

A Software Project is the complete procedure of software development from requirement gathering to testing and maintenance, carried out according to the execution methodologies, in a specified period of time to achieve intended software product.

Software Projects Vs Other Types of Project

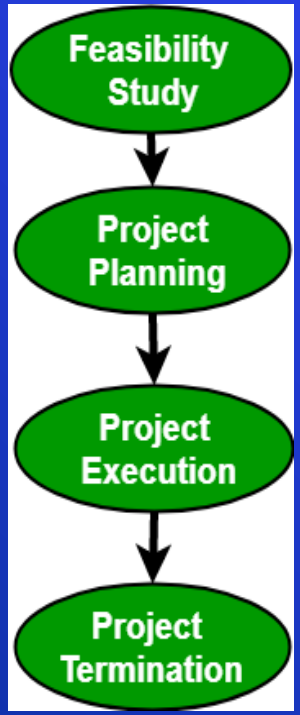
Many techniques in general project management do apply to software projects also. However following are some of the characteristics that makes software projects bit difficult.

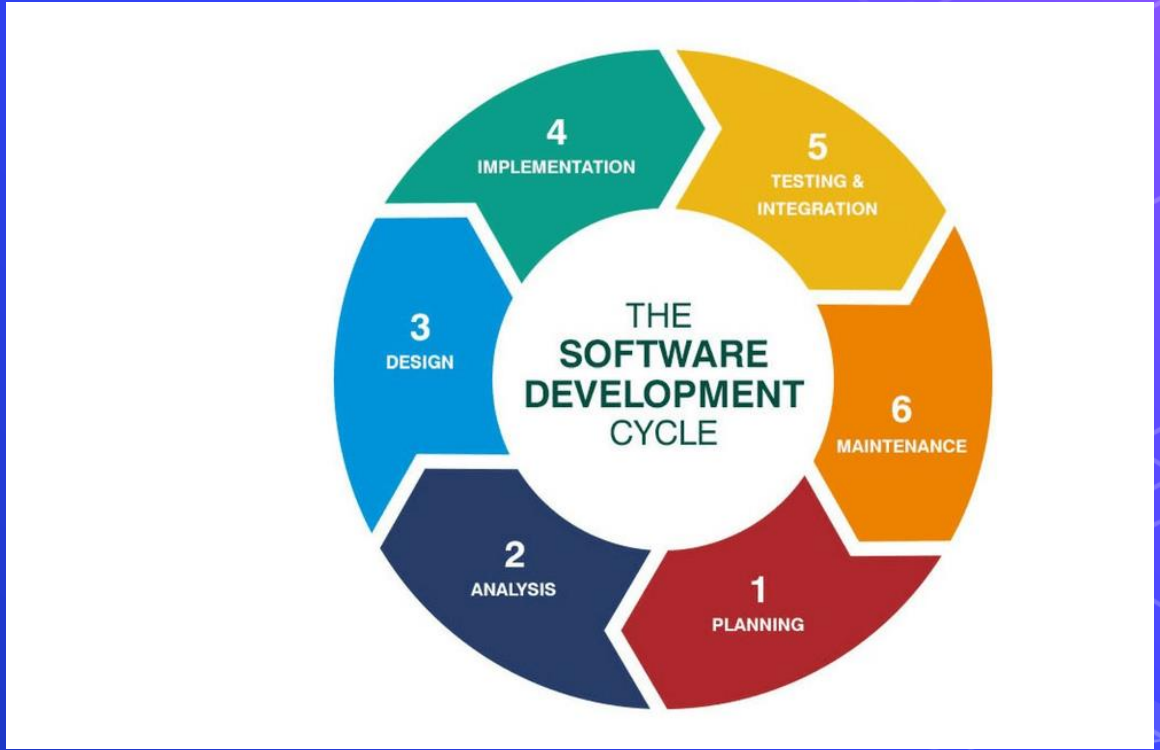
- **Invisibility:** When a physical artifact such as in construction of bridge progress is clearly visible. But with software progress is not immediately visible.
- **Complexity**: Per dollar, pound or Euro spent, software products contain more complexity.
- **Conformity:** The traditional Engineers works with physical systems which are clearly governed by consistent physical laws.

But software engineers have to conform to the human client's or organizational requirements and if they are inconsistent in what they need then developing software can be a difficult job.

- **Flexibility:** The software is very easy to adapt with the change in needs.

ACTIVITIES COVERED BY SPM





Well we all know that Software projects covers many activities to achieve a goal but the major three successive processes that brings a new system into being-includes:

- **The feasibility study:** it is the study to find out whether a project is worth starting; to see if developmental and operational cost are feasible; and to see if there is value of the benefits from the system.
- **Planning:** If feasibility study indicates that the project is viable, then project planning can start. We can make the detailed planning of the earlier stages of the project and start working on it.

Planning may include forming a team, deciding a schedule and work allocation, resource requirement analysis, calculating cost, effort and time.

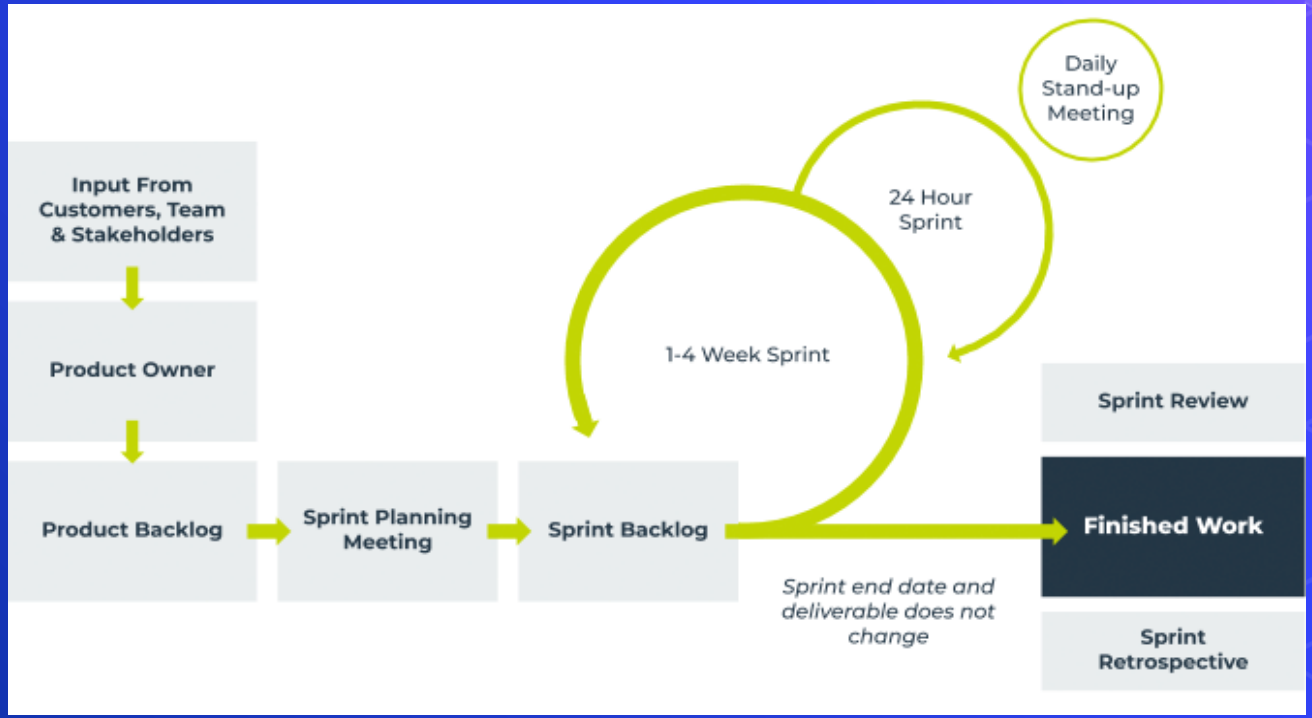
- **Project Execution:** Now the execution of project can start. Generally project execution involves Design and implementation phase. “Design is making decision about the form of product to be created” “Implementation means coding, integration and testing of software”

Why Project Management Is Important For Software Development

- Software project management focuses on developing a product that will have a positive effect on an organization. Without project management, a software development team may begin working on a project without any clear vision or guidance, resulting in more frequent errors and confusion.

- Part of software project management involves making everyone involved aware of the purpose of the project and what steps are required to meet the end goal. Learn more about project management for software development and what it entails.

BENEFITS OF SPM



Importance of SPM

Reducing Risks & Unexpected Costs: During the software development process, things can change quickly. It is important for team members to know what risks they face and how to best handle these risks. The iterative and incremental approach to software project management involves handling changes and reducing inherent risks to avoid major business interruptions and unexpected costs. This methodology is an excellent choice for large-scale companies that work on multiple projects at one time that present a high degree of risk. There are several software project management approaches, such as Agile project management, that have evolved from the incremental and iterative approaches.

Importance of SPM

Measuring Product Quality : Using a standardized methodology, businesses are able to define project quality to ensure that the product delivered meets customer expectations. Quality is an important component of software development but measuring product quality is not always easy. Project quality relies on identifying target customers and their unique requirements, quality control focuses on identifying and correcting defects after production. Software project management aims to discover defects before implantation to achieve a higher rate of customer satisfaction.

Problems in Software Project Management

The dynamic nature of projects and constantly changing requirements and business landscape are making it difficult for project managers to manage time and resources within the allocated budget.

- **The Not Enough Planning Ahead: I**n the race to bring products into the market quickly, many teams compromise on the planning phase, often not realizing that proper planning lies at the crux of every successful project. If you want your project to meet its goals, planning ahead is the most important factor in getting it off the ground. Irrespective of time-to-market pressures, make sure to take out time in planning the scope, budget, resources, and tools.

- **Unmanaged Deadline :** When teams begin working on a project, they tend to set the bar too high – often aspiring to achieve milestones that are impractical. Although it is good to want the product to meet several specifications, setting out with expectations that are too optimistic often leads to setting them up for failure.
- **Budgeting issues :** Most managers consider financial issues as one of the biggest hurdles in effective project management.

Software Project Manager

A software project manager is a person who undertakes the responsibility of executing the software project. Software project manager is thoroughly aware of all the phases of SDLC that the software would go through. Project manager may never directly involve in producing the end product but he controls and manages the activities involved in production.

A project manager closely monitors the development process, prepares and executes various plans, arranges necessary and adequate resources, maintains communication among all team members in order to address issues of cost, budget, resources, time, quality and customer satisfaction.

Characteristics of Good Software Project Manager

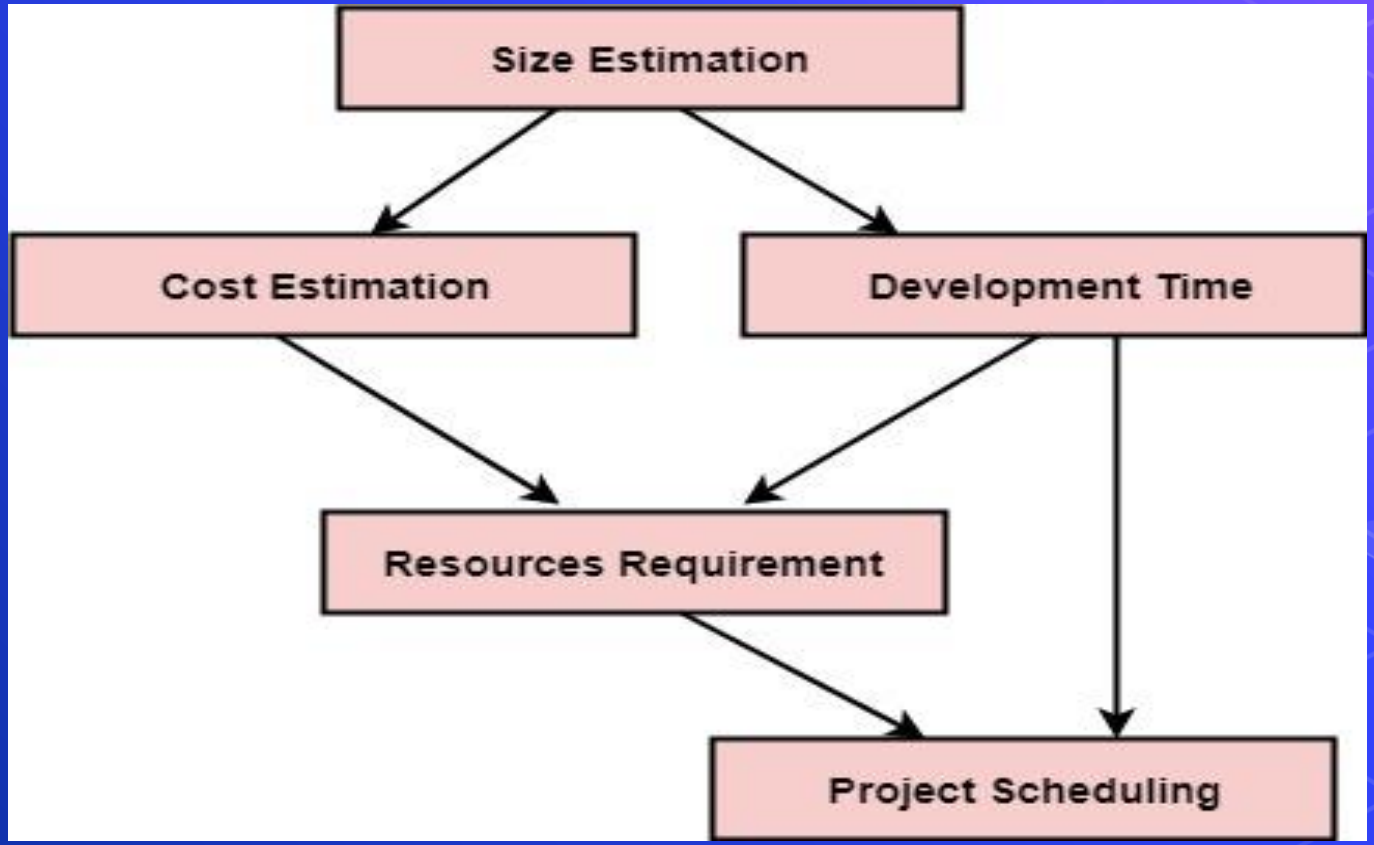
- **Organized :** In order to set realistic timelines and stay within budget for each and every project, a project manager needs to be a well managed and organized. Seeing a project through from beginning to end in an organized and proficient way often entails being able to utilize the right tools to set goals and milestones, as well as schedule meetings and assign tasks.
- **Communication :** As with any role, communication is important. However, for a project manager, excellent communication skills are paramount. This is because their role acts as an information pipeline for both the client and company as a project progresses.

- **Leadership :** A good project manager is also a good leader; someone who can managing people effectively. Keeping up with your team's level of productivity on a current project as well as being clear about what should be prioritized and the best way to manage time takes real leadership. Successful leaders can comfortably delegate tasks, track their team's progress, hold them accountable, and even share credit for a job well done.

- **Vision :** Planning ahead means accounting for potential pitfalls and necessary revisions. This way, if and when they happen, the project does not fall behind schedule. By having enough foresight, a project manager is able to anticipate and prevent mistakes before they can halt a project.
- **Technical Expert:** Since project management software and other related programs are essential in accomplishing the project goals, an effective project manager needs to have sound technical knowledge to understand the issues that are related to the technical aspect. Knowledge of theory as well as the technical side can greatly help the manager in taking strategic initiatives when needed.

- **Problem Solving :** A skilled project manager is able to quickly problem solve an issue before it has a domino like effect and causes the whole project to lag. Good problem solvers are creative and not afraid to take action.
- **Team Building:** Part of a project manager's job is to oversee his or her team during a project. In order to inspire coworkers to do their best work, a project manager needs to be an effective team builder. Team building often entails showing compassion when needed and cultivating an environment where everyone feels they can approach you and ask questions. When your team is comfortable asking questions as they work on an assignment, they're less likely to make mistakes that will need to be corrected down the road. Encouraging this kind of participation and offering helpful as well as positive feedback streamlines projects.

Project Planning



Thanks!

Any questions?

Objective of activity planning

The objective of software project planning is to provide a framework that enables the manager to make reasonable estimates of resources, cost, and schedule.

A detailed plan for the project, however, must also include a schedule indicating the start and completion times for each activity. This will enable us to:

- ensure that the appropriate resources will be available precisely when required;
- avoid different activities competing for the same resources at the same time;
- produce a detailed schedule showing which staff carry out each activity;
- produce a detailed plan against which actual achievement may be measured;
- produce a timed cash flow forecast;
- replan the project during its life to correct drift from the target

- **Feasibility assessment:-** Is the project possible within required timescales and resource constraints?
- **Resource Allocation:-** What are the most effective ways of allocating resources to the project. When should the resources be available.
- **Detailed Costing:-** How much will the project cost and when is that expenditure likely to take place?
- **Motivation:-** Providing targets and being seen to monitor achievement against targets is an effective way of motivating staff.
- **Co-ordination:-** When do the staff in different departments need to be available to work on a particular project.

Work Breakdown Structure (WBS)

A work breakdown structure (WBS) is a visual, hierarchical and deliverable-oriented deconstruction of a project. It is a helpful diagram for project managers because it allows them to break down their project scope and visualize all the tasks required to complete their projects.

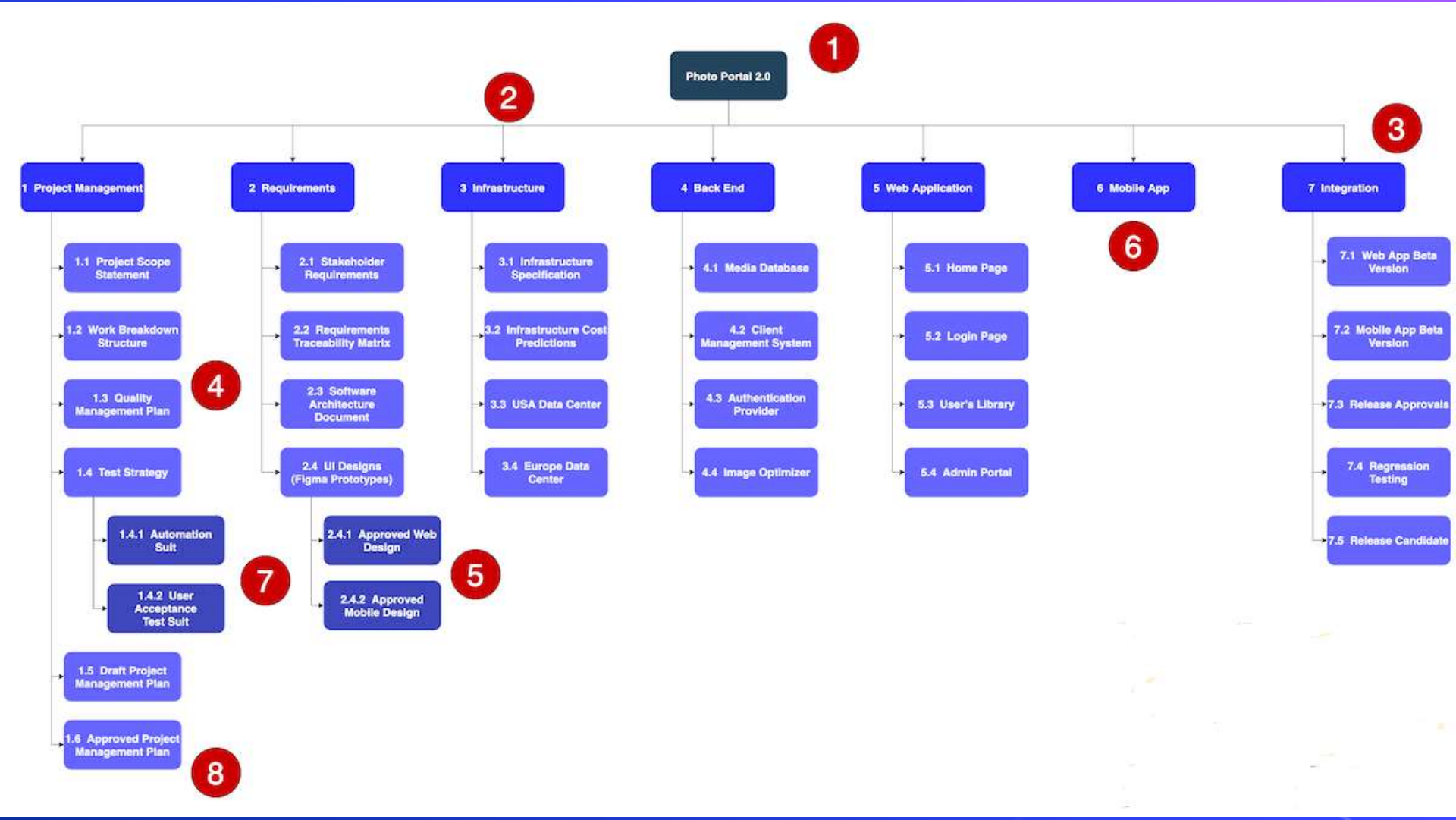
All the steps of project work are outlined in the work breakdown structure chart, which makes it an essential project planning tool.

Project managers make use of project management software to lay out and execute a work breakdown structure. When used in combination with a Gantt chart that incorporates WBS levels and task hierarchies, project management software can be especially effective for planning, scheduling and executing projects.

Why use a WBS in project management?

There are a number of reasons why breaking down a large project is beneficial. It helps to :

- Estimate the cost of a project.
- Establish dependencies.
- Determine a project timeline and develop a schedule.
- Write a statement of work (or SOW, one of your other acronyms).
- Assign responsibilities and clarify roles (and use our roles and responsibilities template to outline duties).
- Track the progress of a project.
- Identify risk.


1
Photo Portal 2.0
2
3
1 Project Management
2 Requirements
3 Infrastructure
4 Back End
5 Web Application
6 Mobile App
7 Integration
6
1.1 Project Scope Statement
1.2 Work Breakdown Structure
1.3 Quality Management Plan
4
1.4 Test Strategy
1.4.1 Automation Suit
1.4.2 User Acceptance Test Suit
7
1.5 Draft Project Management Plan
1.6 Approved Project Management Plan
8
2.1 Stakeholder Requirements
2.2 Requirements Traceability Matrix
2.3 Software Architecture Document
2.4 UI Designs (Figma Prototypes)
2.4.1 Approved Web Design
2.4.2 Approved Mobile Design
5
3.1 Infrastructure Specification
3.2 Infrastructure Cost Predictions
3.3 USA Data Center
3.4 Europe Data Center
4.1 Media Database
4.2 Client Management System
4.3 Authentication Provider
4.4 Image Optimizer
5.1 Home Page
5.2 Login Page
5.3 User's Library
5.4 Admin Portal
7.1 Web App Beta Version
7.2 Mobile App Beta Version
7.3 Release Approvals
7.4 Regression Testing
7.5 Release Candidate

Network Planning Model

The network planning is the categorization of the activities involved in project implementation in a sequential order followed by a schematic presentation of the activities necessary for the entire project.

These techniques show the relationship between project activities, project duration, critical activities, constraints of non-critical activities and resource utilization.

The steps of Network Planning Models are :

- Identify and list the category of activities involved from the start to the completion of the project. The activities are grouped in categories which are different from each other.
- Arrange the list of activities, as in A above, in sequential order of their performance. There may be activity which can be started only after the completion of some other activity, whereas there may also be some other independent activity which can be started simultaneously.

There two different variants in network planning techniques:

1. Critical Path Method (CPM)
2. Program Evaluation and Review Technique (PERT).

Critical Path Method (CPM)

The critical path method (CPM) is a technique where you identify tasks that are necessary for project completion and determine scheduling flexibilities. A critical path in project management is the longest sequence of activities that must be finished on time in order for the entire project to be complete. Any delays in critical tasks will delay the rest of the project.

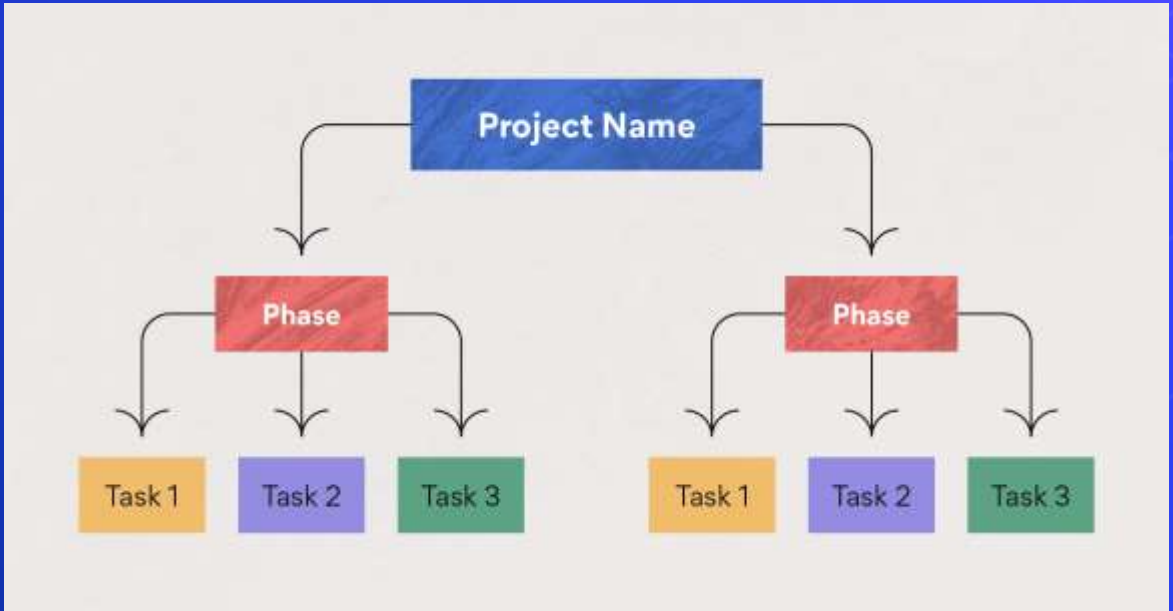
CPM revolves around discovering the most important tasks in the project timeline, identifying task dependencies, and calculating task durations.

CPM was developed in the late 1950s as a method to resolve the issue of increased costs due to inefficient scheduling. Since then, CPM has become popular for planning projects and prioritizing tasks. It helps you break down complex projects into individual tasks and gain a better understanding of the project's flexibility.

How to find the critical path

1. List activities

Use a work breakdown structure to list all the project activities or tasks required to produce the deliverables. The list of activities in the work breakdown structure serves as the foundation for the rest of the CPM.



For example, let's say the marketing team is producing a new interactive blog post. Here are some tasks that might be in the work breakdown structure:

Task ID	Task	Duration (days)
A	Create outline	1
B	Write draft	5
C	Edit and create final draft	2
D	Design post visuals	4
E	Add animations to visuals	2
F	Upload post	1

2. Identify dependencies

Use a work breakdown structure to list all the project activities or tasks required to produce the deliverables. The list of activities in the work breakdown structure serves as the foundation for the rest of the CPM.

Based on your work breakdown structure, determine the tasks that are dependent on one another. This will also help you identify any work that can be done in parallel with other tasks.

Here are the task dependencies based on the example above:

- Task B is dependent on A
- Task C is dependent on B
- Tasks C and D can run in parallel
- Task E is dependent on D
- Task F is dependent on C, D, and E

The list of dependent tasks is referred to as an activity sequence, which will be used to determine the critical path.

3. Create a network diagram

The next step is to turn the work breakdown structure into a network diagram, which is a flowchart displaying the chronology of activities. Create a box for each task and use arrows to depict task dependencies.

You'll add other time-bound components to the network diagram until you have the general project schedule figured out.

4. Estimate task duration

To calculate the critical path, the longest sequence of critical tasks, you first need to estimate the duration of each activity.

To estimate the duration, try:

- Making educated guesses based on experience and knowledge
- Estimating based on previous project data
- Estimating based on industry standards

5. Calculate the critical path

Calculating the critical path can be done manually, but you can save time by using a critical path algorithm instead.

Here are the steps to calculate the critical path manually:

Step 1: Write down the start and end time next to each activity.

The first activity has a start time of 0, and the end time is the duration of the activity.

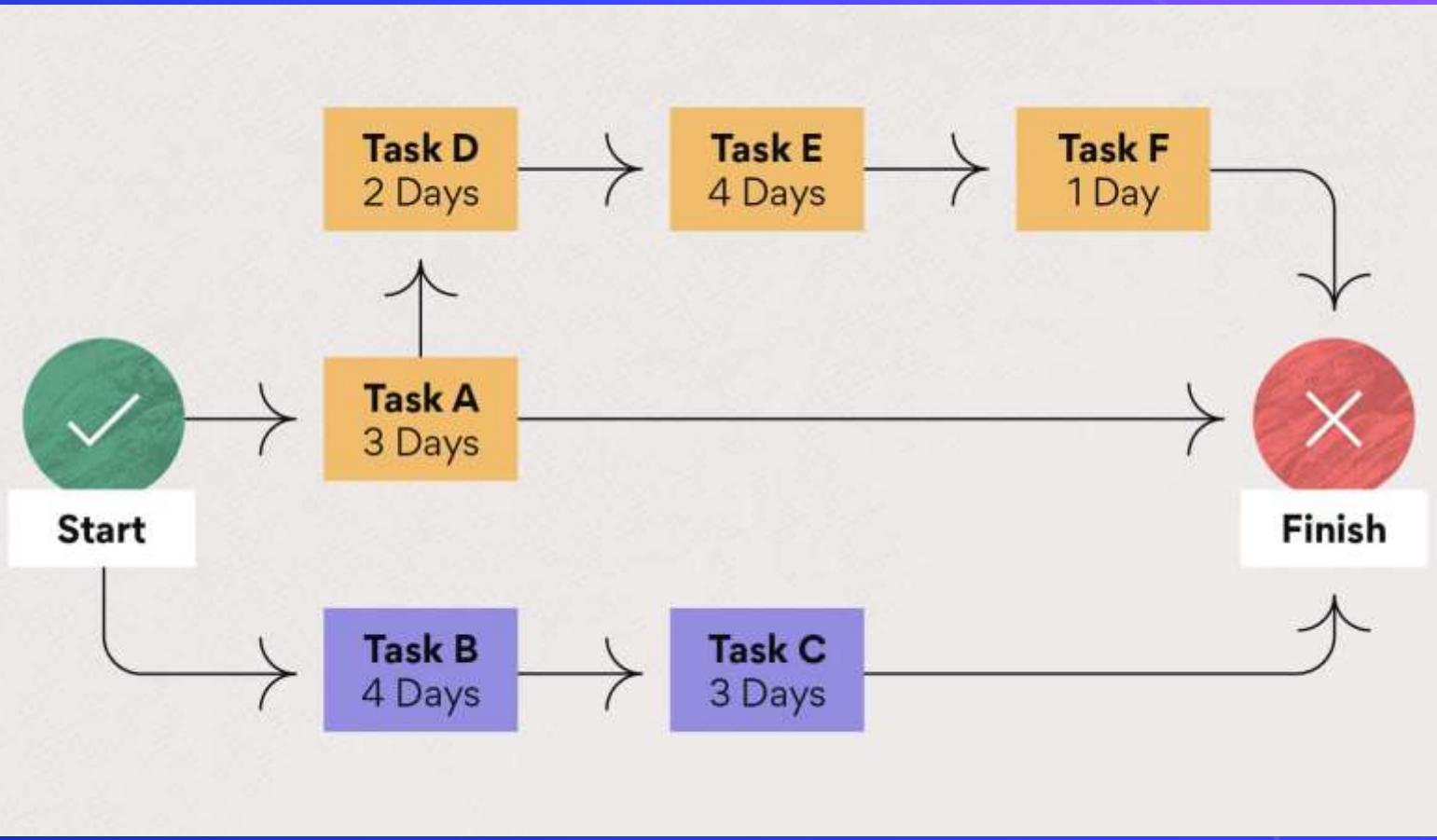
The next activity's start time is the end time of the previous activity, and the end time is the start time plus the duration.

Do this for all the activities.

Step 2: Look at the end time of the last activity in the sequence to determine the duration of the entire sequence.

Step 3: The sequence of activities with the longest duration is the critical path.

Using the same example above, here's what the critical path diagram might look like:


Task D
2 Days
Task E
4 Days
Task F
1 Day
Task A
3 Days
Start
Finish
Task B
4 Days
Task C
3 Days

6. Calculate the float

Float, refers to the amount of flexibility of a given task. It indicates how much the task can be delayed without impacting subsequent tasks or the project end date.

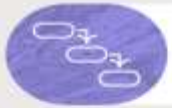
Finding the float is useful in gauging how much flexibility the project has. Float is a resource that should be used to cover project risks or unexpected issues that come up.

Critical tasks have zero float, which means their dates are set. Tasks with positive float numbers belong in the non-critical path, meaning they may be delayed without affecting the project completion date. If you're short on time or resources, non-critical tasks may be skipped.

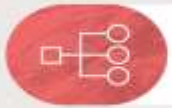
Calculating the float can be done with an algorithm or manually. Use the calculations from the section below to determine the total float and free float.

Finding the critical path

1. List project tasks and details



2. Identify task dependencies for the project



3. Create a network diagram of tasks

4. Estimate each task duration

5. Find the critical path based on longest sequence

6. Calculate the total float

How to use the critical path method

CPM provides visibility into your project's progress, allowing you to monitor tasks and their completion times. Below are some additional applications of CPM.

Compress schedules : Though not ideal, there are times when project deadlines may be pushed up. In those situations, there are two schedule compression techniques you can use: fast tracking and crashing

1. **Fast tracking:** Look at the critical path to determine activities that can be performed simultaneously. Running parallel processes will speed up the overall duration.
2. Crashing: This process involves allocating more resources to speed up activities. Before obtaining more resources, make sure that it would still be within the project scope and let the stakeholders know of any changes .Having the critical path plotted out can help you choose the appropriate strategy to meet updated deadlines.

Resolve resource shortages: Keep in mind that CPM doesn't take resource availability into account. When there is a resource shortage, like an overbooked team member or lack of equipment, you can use resource leveling techniques to solve the issue.

These techniques aim to resolve resource overallocation issues and ensure that a project can be completed with the resources that are currently available. Resource leveling works by adjusting project start and end dates, so you may have to readjust the critical path or apply this technique to activities with float.

Compile data for future use : The schedule created from CPM is subject to change since you're working with educated estimates for activity durations. You can compare the original critical path to the actual critical path as the project runs. This data can be used as a reference to get more accurate task duration estimates for future projects.

Project Evaluation and Review Technique (PERT)

Project Evaluation and Review Technique (PERT) is a procedure through which activities of a project are represented in its appropriate sequence and timing. It is a scheduling technique used to schedule, organize and integrate tasks within a project. PERT is basically a mechanism for management planning and control which provides blueprint for a particular project. All of the primary elements or events of a project have been finally identified by the PERT.

In this technique, a PERT Chart is made which represent a schedule for all the specified tasks in the project. The reporting levels of the tasks or events in the PERT Charts is somewhat same as defined in the work breakdown structure (WBS).

How to make Pert Chart

To create a PERT chart, follow the five steps of the process lifecycle, which includes everything from identifying tasks to managing project completion.

1. Identify project tasks

The first step in creating a successful PERT chart involves identifying and collecting necessary project information and tasks. You can begin the project planning phase similar to how you'd typically start the initial project management phase.

Early planning ensures that you're prepared to defined dependencies and connect tasks during the next phases.

2. Define task dependencies

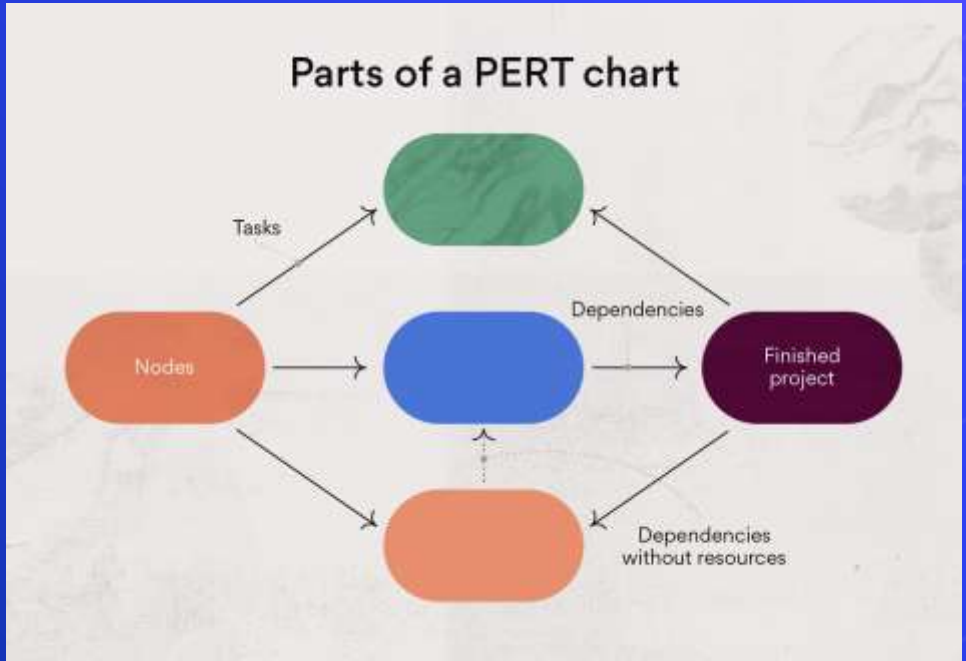
A task dependency is a task or milestone that relies on another task to be completed before the task at hand can be started. This is sometimes referred to as a logical relationship and is often used in a work breakdown structure.

Creating dependencies can help you properly track work, ensure tasks are completed, and establish clear communication. For complex projects, plan timelines and project duration properly ahead of time.

In a PERT diagram, dependencies are visualized by connecting and numbering tasks. While not as comprehensive as other methods like a work breakdown structure, it helps to show a high-level visualization of tasks and the work needed to complete them.

3. Connect project tasks

Once task dependencies have been created, you can work on creating your PERT chart by connecting project tasks to one another. These connections consist of arrows, which represent tasks, and nodes, which represent events or milestones.



4. Estimate project time frame

Now it's time to estimate your overall project time frame using the critical path method (CPM) and the PERT formula. The critical path is the longest sequence of tasks that must be completed to successfully finish a project.

The objective is to find the longest path that will take the most time to complete in order to estimate the shortest overall project duration. Time estimates can be calculated based on the following:

- **Optimistic time:** The minimum amount of time needed to accomplish a task.
- **Pessimistic time:** The maximum amount of time needed to accomplish a task.
- **Most likely time:** The best estimate of how long it will likely take to accomplish a task.

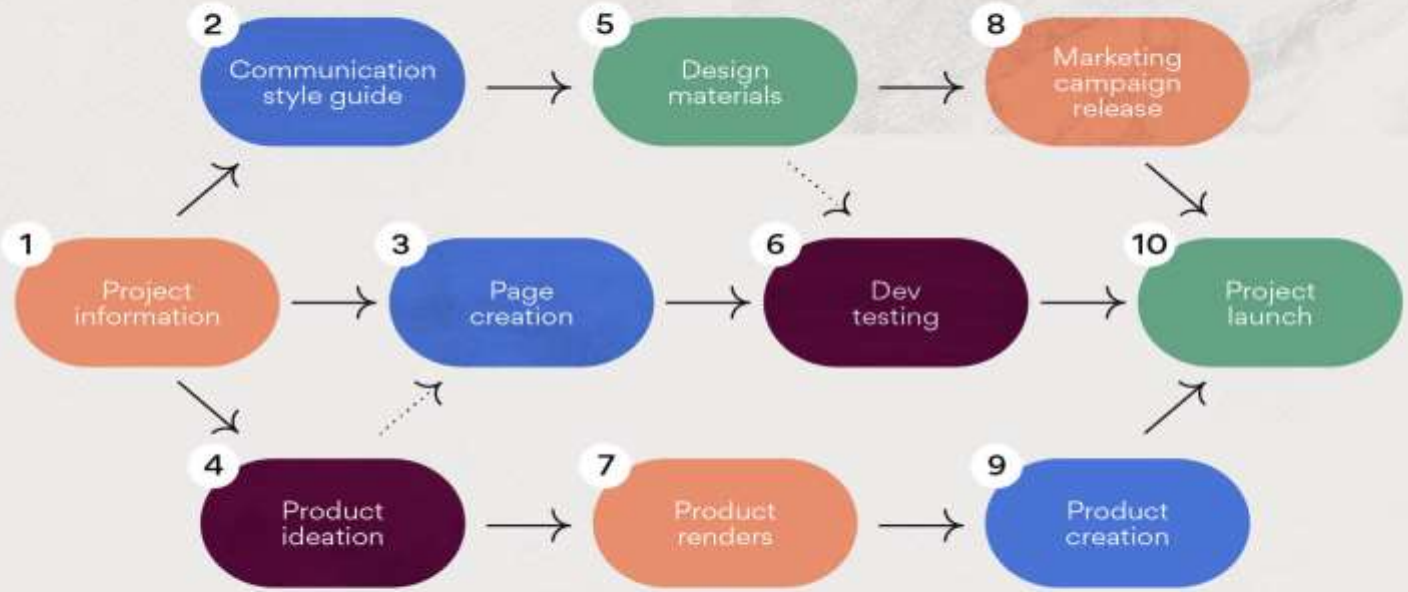
5. Manage task progress

The final step in creating a PERT chart is to manage task progress to project completion. This can be done by closing dependencies and mitigating issues along the way until all tasks are completed.

Remember that a PERT diagram should be updated throughout the project as changes occur. This could be paired with a change control process, which helps map and communicate project changes.

Once all tasks within the project have been completed, you can archive materials in a shared space to be referred to later on if needed.

PERT chart example



CPM VS PERT

CPM and Project Evaluation and Review Technique (PERT) were both developed in the 1950s. PERT is used to estimate uncertainty around project activities by applying a weighted average of optimistic and pessimistic. It evaluates the time needed to complete an activity.

The main difference between PERT and CPM is their level of certainty around activity durations—PERT is used to estimate the time required to complete activities, whereas CPM is used when the activity durations are already estimated.

Let's see how the two techniques compare:

- PERT manages uncertain project activities, CPM manages predictable project activities.
- PERT focuses on meeting or minimizing project duration, CPM focuses on time-cost-trade offs.
- PERT is a probabilistic model, CPM a deterministic model.
- PERT has three estimates for each activity, CPM just one.

Precedence Diagramming Method (PDM)

The precedence diagramming method (PDM) is a graphical tool used for scheduling activities in a project plan. PDM maps out project development by creating a visual representation of critical paths and dependencies.

The primary output of PDM is a project schedule network diagram. The project schedule network diagram is an input in new projects' "develop schedule" process. Precedence diagramming uses nodes to represent activities and links them with lines and arrows illustrating paths and dependencies. It's a quick and easy visual scheduling tool for project managers.

Precedence Diagramming Method (PDM) advantages

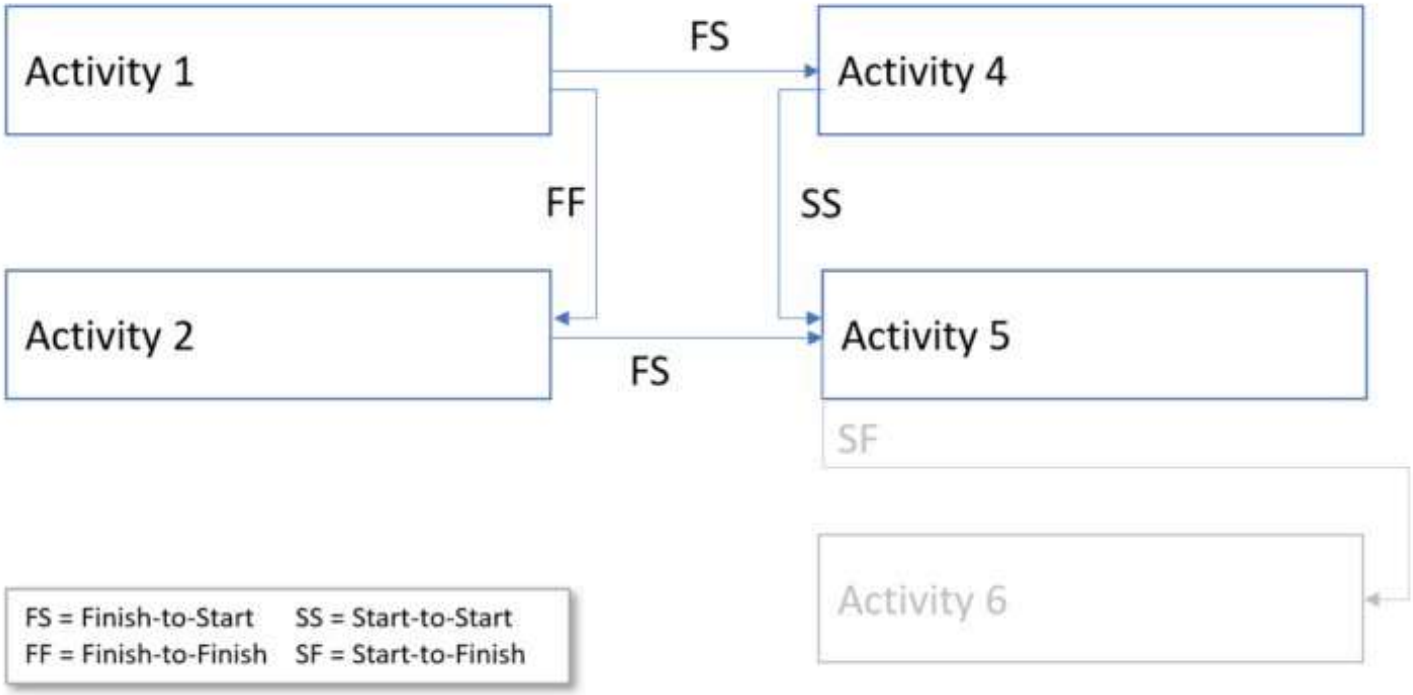
- Precedence diagramming method (PDM) helps project managers define a clear and proper sequence of project tasks and activities
- PDM highlights paths, relationships, and dependencies between activities to ensure successful delivery
- PDM helps teams know their priorities and assignments at a glance
- PDM serves as a visual communication and project update tool for project managers, teams, and stakeholders
- PDM helps identify missing activities and develop an accurate project schedule

Precedence diagramming method example

Every precedence diagramming method example must include activities, durations, and dates. The project manager starts by identifying activities with a critical path and finding and connecting dependencies to ensure the workflow is ordered optimally. There are four ways to illustrate a project schedule network diagram. These form the connection between activities in a precedence diagram. They are:

- **Finish-to-Start (FS)**: In this case, task B cannot start until task A has been completed
- **Start-to-Start (SS):** In this case, task B cannot start until task A starts
- **Finish-to-Finish (FF):** In this case, task A cannot be completed until task B is completed
- **Start-to-Finish (SF):** In this case, task B cannot be completed until task A starts

Example of a Precedence Diagram



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Shortening the project duration

If we wish to shorten the overall duration of a project we would normally consider attempting to reduce activity durations. In many cases this can he done by applying more resources to the task - working overtime or procuring additional staff, for example. The critical path indicates where we must look to save time -if we are trying to bring forward the end date of the project, there is clearly no point in attempting to shorten non-critical activities.

Identifying critical activities

The critical path identifies those activities which are critical to the end date of the project; however, activities that arc not on the critical path may become critical. As the project proceeds, activities w ill invariably use up some of their float and this will require a periodic recalculation of the network. As soon as the activities along a particular path use up their total float then that path will become a critical path and a number of hitherto non-critical activities will suddenly become critical.

It is therefore common practice to identify 'near-critical' paths - those whose lengths are within, say. 10-20% of the duration of the critical path or those with a total float of less than, say, 10% of the project's uncompleted duration.

The importance of identifying critical and near-critical activities is that it is they that are most likely to be the cause of delays in completing the project. We shall see, in the next three chapters, that identifying these activities is an important step in risk analysis, resource allocation and project monitoring.

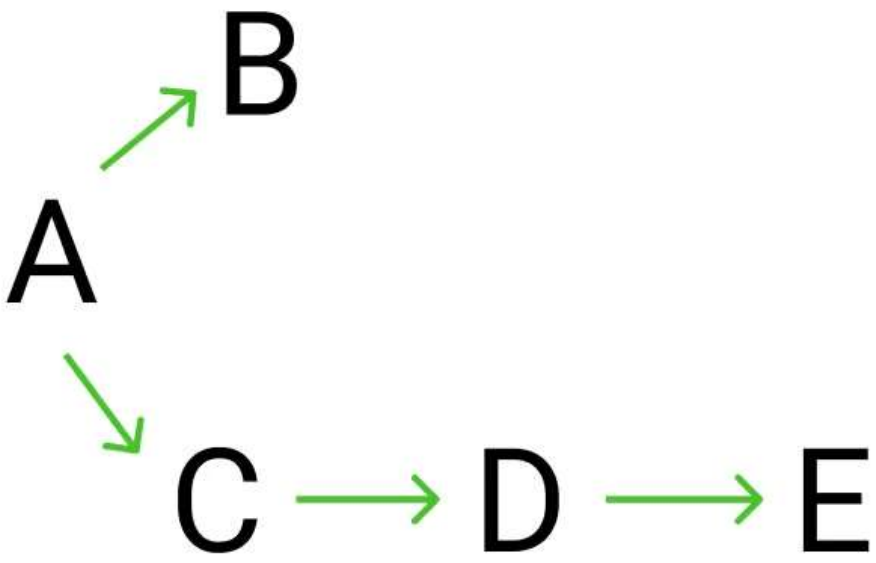
Forward Pass

A forward pass in project management is a technique used to move through a project network diagram. The forward pass helps you understand the project duration and calculate the early start and early finish values (meaning, the earliest day each project task can begin and wrap up).

The easiest way to understand a project management forward pass is with an example.

Imagine that you're tackling a project that has five different tasks or activities (A, B, C, D, and E). You've already figured out what each activity is dependent on (otherwise known as that task's predecessors) and how long each one should take.

Activity	Dependent on	Duration
A	–	2 days
B	A	5 days
C	A	3 days
D	C	1 day
E	D	4 days


B
A
C
D
E

Above very rough network diagram, and now you're ready to get a little more technical with the boxes that are typically used for project calculations. Each box contains six quadrants that represent the following:

- **Activity:** The specific project activity (A, B, C, D, or E)
- **Duration**: How long that specific project activity takes
- **Early start:** The earliest day of the project timeline you can start that activity
- **Early finish:** The earliest day of the project timeline you can finish that activity
- **Late start:** The latest day of the project timeline you can start that activity
- **Late finish:** The latest day of the project timeline you can finish that activity

Backward Pass

A backward pass in project management is a technique used to move through a project network diagram. The backward pass identifies your late start and late finish values, so that you can understand the project's duration and eventually find the critical path.

There is both a backward and forward pass in project management. So, if you're not already familiar with the forward pass, start there as that's what you'll do first.

As with the forward pass, you and your team are tackling a project that has five different tasks (A, B, C, D, and E). You know each task's predecessors as well as how long each one should take

Thanks!

Any questions?

Unit-3: Software Estimation Techniques

Project estimation techniques help project managers accurately estimate essential elements, such as cost and scope, within their projects. In IT operations, these techniques can be used to properly plan for resource allocation. These estimation techniques allow PMs to provide better forecasts to clients and more accurately budget the funds and resources they need for project success.

In this chapter, we'll discuss what project elements should be estimated, the different project estimating techniques available, and how you can start using estimation techniques in project management.

An estimate is a rough calculation of something. For example, a project cost estimate is a general idea of the price model for a project.

Estimation techniques are ways to create project estimates. When your client or another project stakeholder asks you to estimate an aspect of the project, these techniques help you come up with a realistic number to give them.

Why are project estimates important?

Without accurate estimates, it's impossible to plan your project. If you don't have an idea of how long the project will take or what resources you will need, there is no way to ensure you'll have the right people, materials, or tools available when you need them.

- **Cost:** is one of the main constraints in project management. If you don't have enough money to complete the project, it will fail. If you can accurately estimate project costs early on, you can help set client expectations and ensure you have enough money to get the work done. Cost estimation involves predicting how much money you will need for the project as well as when you will need the funds.
- **Time:** Time is another of the main project constraints. Being able to estimate both the overall project duration and when individual tasks will take place is vital to project planning. Estimating your project schedule enables you to arrange for people and resources to be available when you need them. It also allows you to manage client expectations around when they should receive key deliverables.

- **Scope:** is the third key project constraint. Project scope is all the work that must be done to finish the project or deliver a product. By estimating how much work is involved and exactly what tasks need to occur, you can ensure that you have the right materials and expertise for the project. The three main constraints are often referred to as three sides of a triangle. This is because whatever changes are made to one constraint will inevitably impact the other two. To accurately estimate the budget, you must know the scope and schedule. If one of the three ends up being greater or less than you expected, it will likely result in the other two estimates being off as well.

- **Risk :** Project risk is an unexpected event that could impact your project, for better or for worse. Estimating risk involves predicting what events may occur during the project's life cycle and how seriously they could impact the project. By estimating what risks could impact your project and how they will affect it, you are better able to plan for potential issues and create risk management plans.

- **Resources:** Project resources are the assets you need to get the project done. Resources can be tools, people, materials, subcontractors, software, and more. Resource management helps you ensure you have all the resources you need and use them as efficiently as possible. Without estimating what resources you will need, and when, it's challenging to plan how you will manage them. This can lead to people sitting around idle or materials not showing up until weeks after you need them.

- **Quality :** Quality focuses on how well the project deliverables are completed. Products that have to meet demanding quality regulations, such as environmental restrictions, may require more money, time, and other resources than a product with lower-level requirements. Estimating the level of quality that the customer requires helps you plan and estimate the other five aspects of your project. All six project factors are interrelated, so predictions for one can impact the estimates for the other five. For this reason, using the same project estimate techniques in all six areas can improve your accuracy.

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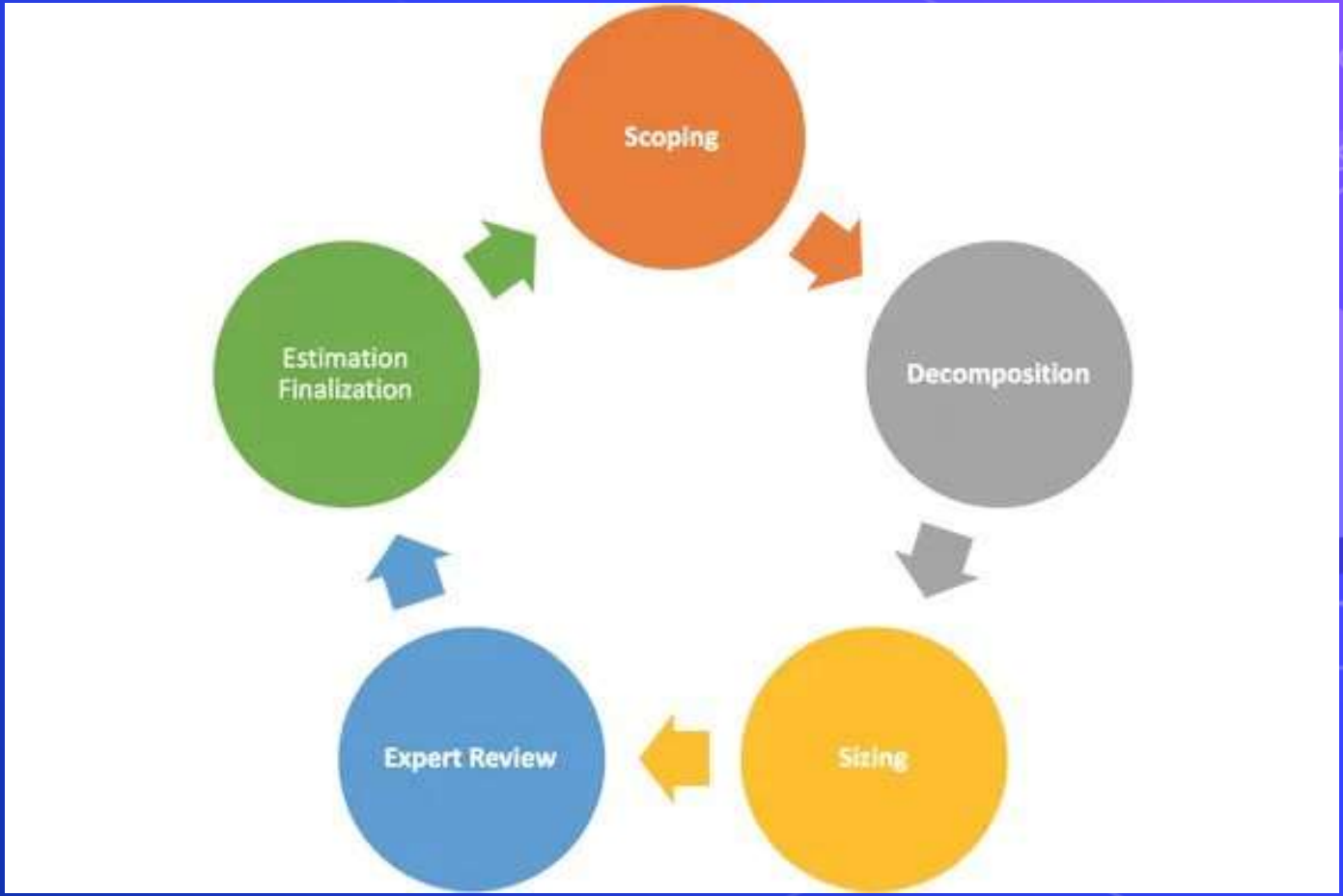
Software Effort Estimation

Effort estimation is the process of forecasting how much effort is required to develop or maintain a software application. This effort is traditionally measured in the hours worked by a person, or the money needed to pay for this work.

Effort estimation is used to help draft project plans and budgets in the early stages of the software development life cycle. This practice enables a project manager or product owner to accurately predict costs and allocate resources accordingly.

The estimation is a process to find the most accurate sizing figure for the software project effort, for example, how many months you will need to develop the software, how many resources you will need to finish the project in the required time. And this translated to money at the end.

The estimation is important because it gives the project team some confidence about the required effort and time to plan ahead for the project. Moreover, not all software project is time and material contracts, some of them are fixed cost projects and this estimate will be used as a foundation to negotiate the project cost.


Scoping
Decomposition
Sizing
Expert Review
Estimation Finalization

The Estimation Process

- **Scoping: F**irst to scope the project even if you do not have the full detailed requirements but you can assume some of them or add margins later. While in most cases you will have a defined scope to start with. You can read this article to understand what is the scope and how it is different from the requirements specifications. You can always list your assumptions to justify the outcome of the estimation process and its results.
- **Decomposition:** In this step, will need to break software into smaller components and functions and you can categorize them to a different set of elements, this is similar to work breakdown structure but only for the software components not all the working activities for the software. May also collect different data from the project team or the customer to ensure that listed all functionalities
- **Sizing:** In this step, and for more validation, can be use different estimation techniques to analyze the different estimation outputs and may take an average of these estimates as well.

The Estimation Process

- **Expert and Peer Review :**After initial estimate, will need at some point to ask for expert opinion for some new functionalities you may not aware off, or for considering a review from your peers that you have done the correct estimation. Moreover, may need to do some analogy based techniques for similar components or functions developed before or maybe a similar project to ensure that estimation on the correct path.
- **Estimation Finalization:** This can be considered the final step as aggregate all the estimations from all components and functions and have a baseline estimate. We can go another round across the process until reaching the correct estimate which will be approved by the Project team and the Management as well.

Why is effort estimation important?

- **Understanding a project:** When estimating the effort for development, it can help team members to understand each task they need to complete, along with any dependencies. Although you might have a clear scope, conversations you have when estimating effort can help clarify project requirements and user requests
- **Improving collaboration:** Collaboration is a key concept in the agile framework, and teams meet regularly to discuss priorities and status to accomplish this. During estimation meetings, each team member can express their opinions on efforts, priorities and resource needs.
- **Creating an accurate budget:** When you evaluate the effort to complete a project, you can determine what team members, tools and time you need. This can help you create an accurate project budget by estimating wages and the cost of each resource.

Why is effort estimation important?

- **Making an accurate schedule :** Organizations often rely on accurate delivery schedules and provide this information to employees and customers. Using the various estimation techniques can help ensure you build an accurate schedule based on expert input and historical data.
- **Managing resources and assignments:** By evaluating the resources you need for a project and the tasks to complete, you can estimate what resources you will need. This can help if development teams, such as QA, share resources or assignments to ensure each can meet their schedules.
- **Improving risk management :** Estimating effort at the start of a project can help you identify potential risks, like breaching a budget or schedule. With these identified, you can create mitigation plans and prioritize monitoring high-risk situations.

Expert judgment

Expert judgment is when you call in an expert to get a skilled opinion. It's an estimation methodology for project planning that relies on the expert's opinion to estimate quantitative project details, such as timelines and potential resources.

Expert judgement is one of the most common project management planning tools. They suggest expert judgment as a potential tool in every single one of their six processes. Specialized knowledge is expensive, so hiring a skilled full-time employee to give expert judgement is not always cost-effective. Instead, many companies hire external experts to complete assessments, using them to monitor and control project work in specific areas.

When and how to use expert judgment

One of the reasons expert judgement is so common is because it can be applied to a variety of situations. It's a useful way to get external insight into your work, but it's subjective and needs guidelines. Often, you'll use expert judgment to assist with resource management. For example, an expert can help to determine how many resources you need to launch a new product, feature, or even a new company if you're in the startup stages. Following points will clear when expert judgment use.

- **When the stakes are high:** If high-impact project coming up, it helps to get validation from experts before you move forward.
- **Before project planning:** if developing a project charter before you create a project plan, you might want to bring in an expert to review it and confirm that your project is viable.
- **For Cost management :** When you're determining cost estimates for product pricing or even hiring, having an expert on hand will help you get as close as possible to a realistic number.
- **During decision-making.** You can use expert judgment in a decision-making framework, such as during routine decisions. If you use RAPID, having an expert as the decision-maker role helps you get full use of expert opinions.
- **For Risk Management :** An expert can review and analyze your risk assessment, risk analysis, and risk responses to determine how high-risk different scenarios are, so you can be prepared for any likely outcome.

Get expert judgment

It's not enough to just talk to an expert—you need to clarify what you want and expect from them in order for the relationship to be successful. By clearly defining the inputs, outputs, and expectations of the project, you and your expert can benefit from a structured expert judgment process that satisfies everyone.

- **Research the problem:** Before you can engage your expert, you must have a thorough understanding of your problem. Make sure you know exactly what's already been completed, where the issue stands, and what you need from your expert.
- **Write out your questions :**Be as specific as possible here. The more targeted your questions, the better your expert's answers will be. Using your research from the previous step, develop clear questions. The questions you ask can be complex, but should be clear enough for the expert to understand and answer.
- **Select your experts:** Choose the experts that best fit the needs of this specific problem or project. For example, if you're working on product distributions, you'll want to involve experts who understand your industry's supply chain and the target market. Then explain the problem to them, sharing all resources and project documents so they have the knowledge they need to pass effective judgment.
- **Submit your questions:** Send your questions off to your selected experts. If you're using project management software, you can attach relevant analyses and documents directly to the questions. Then when your experts respond, you can see their answers in real-time.

Get expert judgment

- **Review and analyze their judgements:** Once you have answers from your experts, it's up to you to review them and determine how you're going to use the information. To further mitigate bias, you might want to use a peer review process made up of multiple experts to ensure you're getting the most accurate data.
- **Aggregate judgements in a report:** Create a report of all the judgements you receive. Save it as one central source of truth, so you can easily share the results with stakeholders..
- **Communicate results:** Once you have your results neat and tidy, send them out to all stakeholders for review. At this stage, you'll also start to discuss if you need another round of expert judgment. Mostly, you repeat the process if stakeholders spot errors or have additional questions.

Estimation By Analogy

Analogous Estimation uses a similar past project information to estimate the duration or cost of your current project, hence the word, "analogy". You can use analogous estimation when there is limited information regarding your current project.

Analogous estimation is a technique which uses the values of parameters from historical data as the basis for estimating similar parameter for a future activity. Parameters examples: Scope, cost, and duration. Measures of scale examples – Size, weight, and complexity.

Because the project manager's, and possibly the team's experience and judgment are applied to the estimating process, it is considered a combination of historical information and expert judgment.

In such cases, analogous estimation is the best solution. It may not be perfect but is accurate as it is based on past data. Analogous estimation is an easy-to-implement technique. The project success rate can be up to 60% as compared to the initial estimates.

When is analogous estimating used?

Here are a few uses of analogous estimation, so you can understand when and how to choose this method :

- **In the initial stages of the project:** Analogous estimation is one of the best ways to put an initial value on a project and its parts. You can use analogous estimation at this stage of the project to determine if the project is viable or whether to make a bid for that project. As the project progresses, you can refine your estimates.
- **When you have limited estimation resources:** You might use analogous estimating if you have little to no past data available to make an exact comparison but need to create an estimation to decide whether to pursue a project
- **When little project detail is available:** If you have few details or no access to the current project's information, use analogous estimation to analyze its cost and duration.
- **When you need only a rough estimate:** When a company is bidding on a project, they only need a basic estimate of its cost and duration. An analogous estimation might be the most resourceful option.
- **When you need expert judgment :** A project manager might use comparison if they have the experience and knowledge to make an analogous estimation based on their involvement in similar previous projects.

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Analogous Estimation Steps

The project manager and team have to collectively do analogous estimation.

- **Step 1** – Identify the domain of the current project.
- **Step 2** – Identify the technology of the current project.
- **Step 3** – Look in the organization database if a similar project data is available. If available, go to Step (4). Otherwise go to Step (6).
- **Step 4** – Compare the current project with the identified past project data.
- **Step 5** – Arrive at the duration and cost estimates of the current project. This ends analogous estimation of the project.
- **Step 6** – Look in the organization database if any past projects have similar modules as those in the current project.
- **Step 7** – Look in the organization database if any past projects have similar activities as those in the current project.
- **Step 8** – Collect all those and use expert judgment to arrive at the duration and cost estimates of the current project.

Advantages of analogous estimating

- **It saves time. :**Top- and middle-level management's time is valuable, and this estimation tool can quickly provide them with a basic estimate using a minimum amount of parameters.
- **It saves money.** Because analogous estimating requires little documentation and few processes, it is a good choice if cost is a factor.
- While analogous estimating is most appropriate during the initial stages of project planning, you can use it to refine your estimation at any point throughout the project.It is useful when you have little historical data for a project.
- It requires few resources and is easy to perform.

Disadvantages of analogous estimating

The few downsides of analogous estimating include:

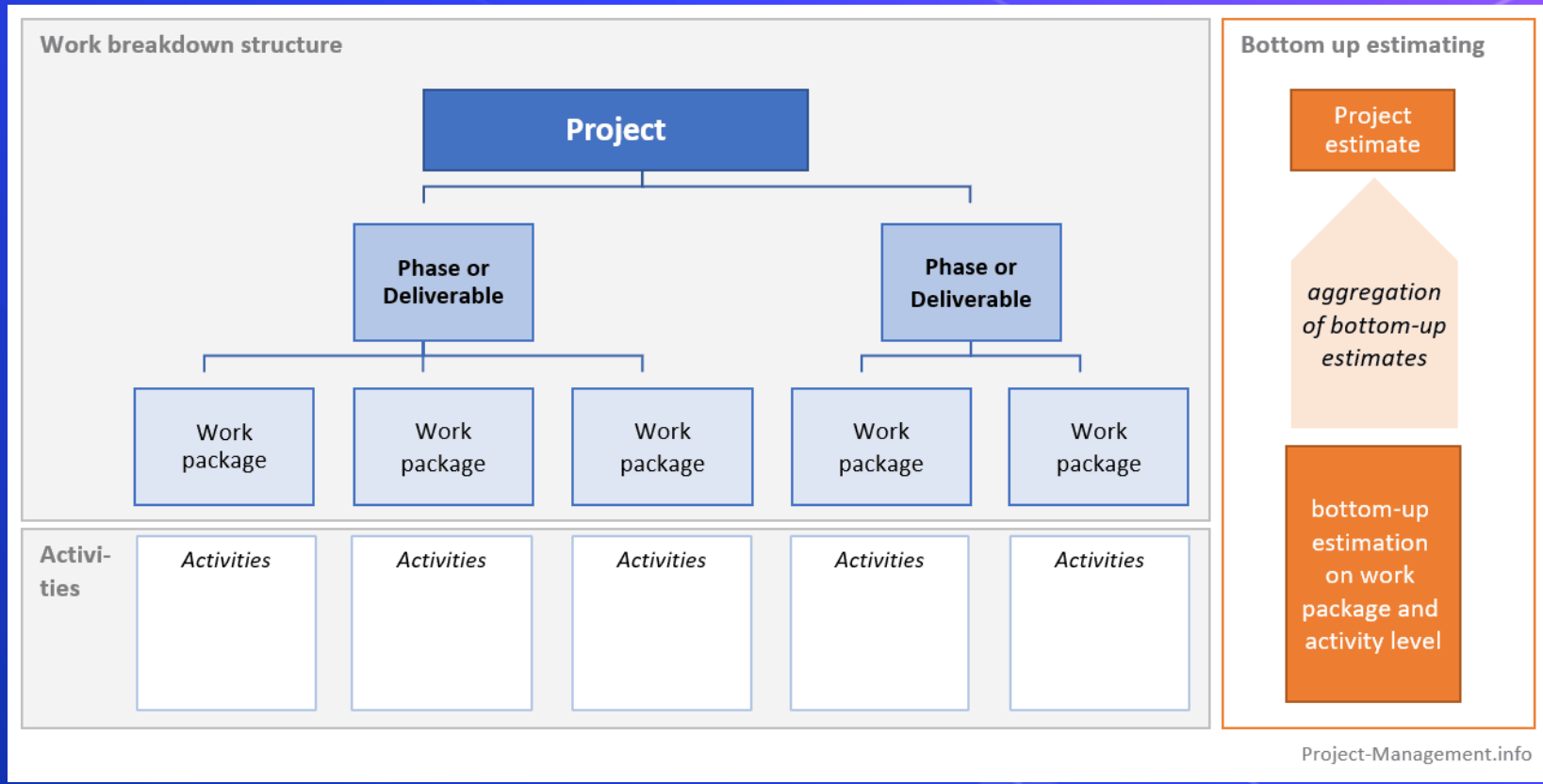
- Because it functions at a basic level, analogous estimating is not as accurate as other project estimation techniques.
- When using analogous estimation, project managers assume that various factors of a similar past project will remain the same for the current project. Because variables such as resources and inflation rates change constantly, the figures managers use in their estimation might not be accurate.
- Analogous estimation is more appropriate for the initial planning stages of a project than the executing stages.

Bottom-Up Estimating

Bottom-up estimating is a technique that helps determine the overall cost and timeline of a project. It works by gathering all the details of a project at the most minute level. It provides a better, more accurate forecast than other project planning methods because it allows managers to see every available element of the project before it even begins.

Bottom-up estimating in project management is a method of estimating project duration or cost by aggregating the estimates of the lower-level components of the Work Breakdown Structure (WBS). In this article, we'll dive deep into what bottom-up estimating is, the pros and cons of bottom-up estimating, and how it differs from a 'top-up' estimating approach.

Bottom-up estimating is a technique that involves estimations on a granular level for parts of a project. These are then aggregated to a total estimate for the entire project. It is often referred to as one of the most accurate ways of estimating. Estimating cost, duration or resource requirements of a project typically starts with a rough order of magnitude in the beginning. This is followed by more accurate estimates later in a project.



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Advantages of Bottom-up estimating

- **Highly Accurate:** Laying out the project's scope can be very challenging since it involves estimating the exact details of the project and the people involved in its execution. Bottom-up estimating allows team members to see all the components of a project in one place, and it saves them time and effort by estimating separately.
- **Saves Time:** By estimating the work package in advance, a manager can make better decisions and avoid costly mistakes. It also helps avoid surprises down the road. Even though there is a large time investment up front, the idea behind the method is that it will prevent wasted time down the road.
- **Reduce Risk :** A bottom-up estimate allows the manager to address issues related to the estimates without making significant changes. This allows the team to avoid making significant errors.
- **Improves success :** A bottom-up analysis also allows managers to implement strategies to help the team execute the project more effectively. A comprehensive bottom-up analysis also allows the manager to identify potential issues before they occur, which allows the team to react more effectively to those that arise.
- **Increases productivity:** The team's autonomy and control are also distributed through the various members of the team, which allows them to work efficiently.

Disadvantages of Bottom-up estimating

- **Not scalable :** Bottom-up estimation requires project managers to start from square one on each new project. There are opportunities to pull details from related projects from the past. But the point of bottom-up estimation is to create a forecast based on the individual components of this particular assignment.
- **Time-consuming:** The project planning work is front-loaded. It can take days, weeks, or even months to gather all the necessary information. For teams with a high volume of incoming projects or staffing issues, this may not be ideal.
- **Slow-moving:** Bottom-up estimation is typically not done in a hurry and is therefore incompatible with last-minute projects or work that has a short timeline.

Top-Down Estimating

Top-down estimating is a method of evaluating a project or budget as a whole and then separating it into smaller components. With a top-down approach, professionals create an overall plan or budget for a project without defining the particulars. These professionals would then give the project budget or plan to others who can better evaluate the specific costs or plan details.

Top-down estimating is most often used by managers, investors and other major leaders or stakeholders in a company. Company leaders and related professionals often have long-term visions or goals for a department, location or the entire company. However, these company leaders may not know as much about the specific processes, tools or costs associated with the details of their proposed project. A top-down approach allows primary stakeholders within a business to plan projects with ambitious scopes while leaving the details to others with more knowledge about the project specifics.

Example: You need to update the FAQ section on your website. This is a task your team has completed in the past. The scope is clear, the timeline defined, the subtasks straightforward. A perfect time for a simple, top-down approach.

Bottom-up vs. Top-down estimating

- In top-down estimating, management estimates the project based on the previous work on the same or similar projects.

- Bottom-up estimation is ideal for unique projects or work that is unlike anything the team has done before. Top-down estimation, however, is ideal for duplicate projects, recurring assignments, or work that needs to be completed ASAP.

Parametric Estimating

Parametric estimating is a statistical and accuracy-based technique for calculating the time, cost, and resources needed for project success. Combining historical and statistical data, parametric estimating uses the relationship between variables to deliver accurate estimations.

Often used during a project or in the project planning phase, parametric estimating applies a formula or algorithm for making these calculations, using the specific cost or time needed to implement and finish a project or task.

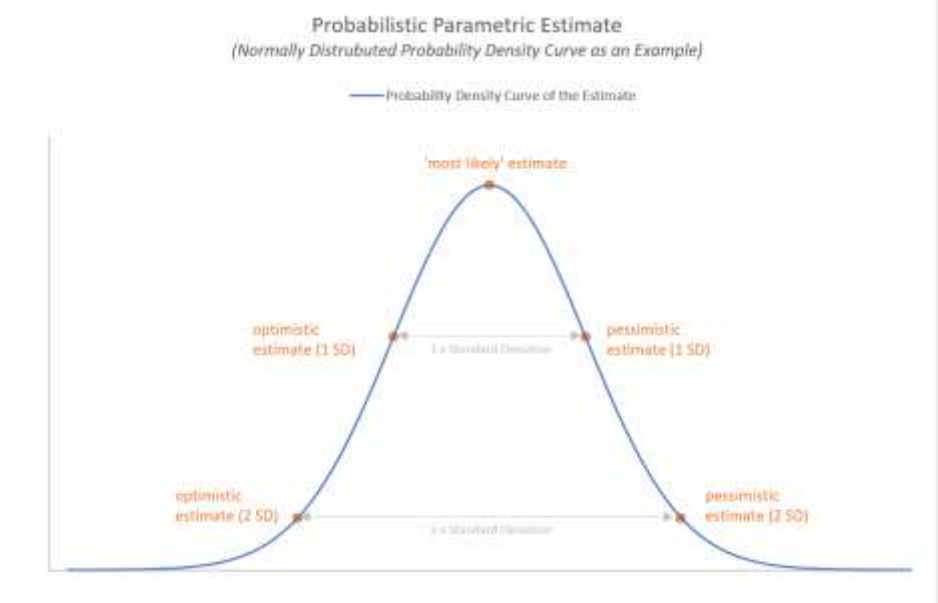
To calculate the cost or duration per parameter, a set of historical data is required. This could be obtained from previous projects (companies in construction, consulting, IT and other industries sometimes store such data centrally) publicly available market data or agencies that provide statistics for benchmarking.

While parametric estimation is a common technique to estimate costs in different levels of granularity, the form of its implementation varies greatly.

Some projects build complex statistical models and perform a comprehensive regression analysis for various parameters. They might also develop algorithms and assign a significant number of resources for deploying and (back)testing such models. This is an approach applicable to large projects or so-called ‘mega projects’ where even small shortcomings in the accuracy of estimates could cause a material impact.

Type of Parametric Estimating

- **Deterministic Estimates:** The deterministic result type of the parametric estimation is a single number for the amount of cost or time needed, calculated based on parametric scaling. It is sometimes manually adjusted to account for differences between the current and historic projects (e.g. different levels of experience of the teams) or to add a contingency reserve.
- **Probabilistic Estimates:** This result type is not producing a single estimate but a range of estimates based on the probability of different cost and duration amounts. This is often presented in the form of a probability density curve as shown in the below chart.



Thanks!

Any questions?

Unit-4: Software Evaluation and Costing

Project Evaluation

Project evaluation is the process of measuring the success of a project, program or portfolio. This is done by gathering data about the project and using an evaluation method that allows evaluators to find performance improvement opportunities. Project evaluation is also critical to keep stakeholders updated on the project status and any changes that might be required to the budget or schedule.

Project evaluation prompts changes in internal workflow, detects patterns in the target audience of the project, plans for upcoming projects or reports the value of projects to external stakeholders.

Types of project evaluation

The following are common types of project evaluation to implement in your projects:

There are several principles of project evaluation that ensure evaluations are credible and contribute to the overall success of the organization. These principles provide a foundation that guides the evaluation process from start to finish. Project evaluation principles include:

Pre-Project Evaluation

Before beginning a project, your team could evaluate whether it is feasible to complete successfully. This often takes place naturally in the developmental stage of projects and is crucial for the effective execution of the project. It is important that all involved are aware of the objectives and goals before work begins.

Ongoing evaluation

Throughout the life cycle of the project, you may use metrics to verify completed tasks. This includes budget, percentage of completed tasks and the overall quality of the work delivered so far. Try to remain focused on your original objectives and goals as the project is underway, so your team remains on track.

Self-evaluation

At any point in the life cycle of the project, an individual can conduct a self-evaluation. Self-evaluation analyzes if their work is contributing to greater objectives and goals. Recognizing strengths and weaknesses, measuring their successes, and determining the scope of their impact can increase their ability to work effectively as part of the team.

External evaluation

Another option is hiring external agencies to perform evaluations for your projects. These agencies typically have no prior connection or involvement in the project, leading to a high level of impartiality when conducting the evaluation and concluding. External evaluation is valuable for projects that include a large number of stakeholders or have several moving pieces.

Project Evaluation Steps

Regardless of when you choose to run a project evaluation, the process always has four phases:

Planning

The ultimate goal of this step is to create a project evaluation plan, a document that explains all details of your organization's project evaluation process. When planning for a project evaluation, it's important to identify the stakeholders and what their short-and-long-term goals are. You must make sure that your goals and objectives for the project are clear, and it's critical to have settled on criteria that will tell you whether these goals and objects are being met.

Implementation

While the project is running, you must monitor all aspects to make sure you're meeting the schedule and budget. One of the things you should monitor during the project is the percentage completed. This is something you should do when creating status reports and meeting with your team. To make sure you're on track, hold the team accountable for delivering timely tasks and maintain baseline dates to know when tasks are due.

Project Evaluation Steps

Completion

When you're done with your project, you still have work to do. You'll want to take the data you gathered in the evaluation and learn from it so you can fix problems that you discovered in the process. Figure out the short- and long-term impacts of what you learned in the evaluation

Implementation

Once the evaluation is complete, you need to record the results. To do so, you'll create a project evaluation report, a document that provides lessons for the future. Deliver your report to your stakeholders to keep them updated on the project's progress.

Benefits of Project Evaluation

Project evaluation is always advisable and it can bring a wide array of benefits to your organization. As noted above, there are many aspects that can be measured through the project evaluation process. It's up to you and your stakeholders to decide the most critical factors to consider. Here are some of the main benefits of implementing a project evaluation process.

- **Better Project Management:** Project evaluation helps you easily find areas of improvement when it comes to managing your costs, tasks, resources and time.
- **Improves Team performance:** Project evaluation allows you to keep track of your team's performance and increases accountability.
- **Better Project Planning:** Helps you compare your project baseline against actual project performance for better planning and estimating.
- **Helps with Stakeholder Management:** Having a good relationship with stakeholders is key to success as a project manager. Creating a project evaluation report is very important to keep them updated.

Strategic assessment

is used to assess whether a Project fits in the long-term goal of the organization. It is usually carried out by senior management. It needs a strategic plan that clearly defines the objectives of the organization. It evaluates individual projects against the strategic plan or the overall business objective

Technical Assessment

Consists of evaluating whether the required functionality against hardware and software can be achieved with current affordable technologies.

Cost-benefit Analysis

A cost-benefit analysis (CBA) is a process that is used to estimate the costs and benefits of decisions in order to find the most cost-effective alternative. A CBA is a versatile method that is often used for the business, project and public policy decisions.

The analysis evaluates the costs versus the benefits of a potential project. The difference between the costs and the benefits determines whether the project is worth the effort, cost, and resources.

The process begins with a list of expenses and benefits. The expenses include employee salaries, cost of office equipment, and brand damage. The benefits include increased revenue, enhanced user experience, and brand equity.

This analysis helps in painting a clear picture of the project performance rate. It is a systematic approach to zero in on the next project. A cost-benefit analysis leads you to a sensible financial decision. This ensures that the project you choose to go ahead with runs as expected and sticks to the set budget.

The Process of Cost-Benefit Analysis

We'll go step-by-step through the easy process of a cost benefit analysis. These are key steps that establish whether the proposed project is worth taking up. Let's dive in.

- **Step 1: Define Project Goals & Objectives:** The very first step is to list down the goals and objectives of the proposed project. These define the project outcomes and also drive the next steps of cost-benefit analysis
- **Step 2: List Down Alternative Scenarios:** Next, list down alternative scenarios by comparing similar previous projects. This helps gain a better perspective of the feasibility of a potential project.
- **Step 3: Identify & Schedule Benefits & Costs:** Compile a list of costs and benefits. Take into consideration all costs and benefits. These may include financing cost, staff cost, and improved brand equity.
- **Step 4: Identify Project Stakeholders:** Identify the stakeholders with an interest in the project's outcome. The stakeholders may be project managers, project sponsors, team members, customers, and users. Further, determine the skill set required at every stage of the project execution.

The Process of Cost-Benefit Analysis

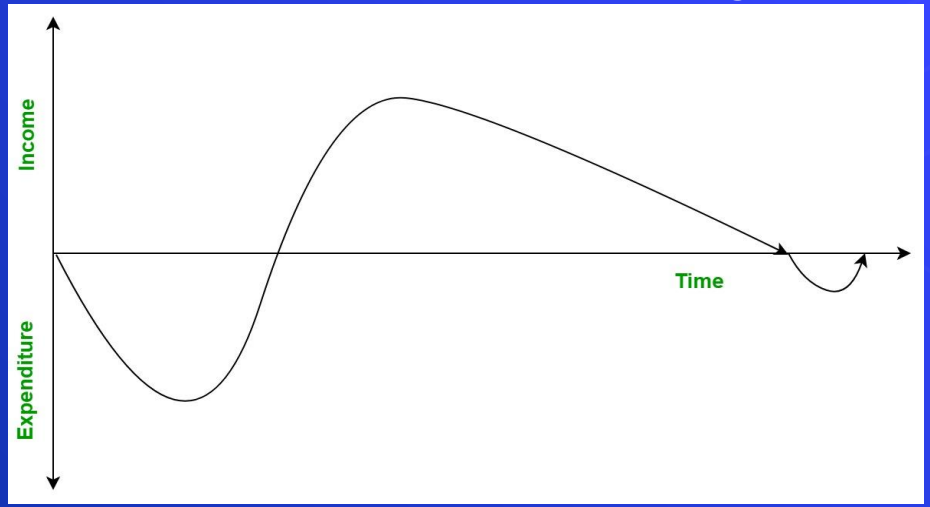
- **Step 5: Track Measurement Metrics :** Make a detailed list of various measurement metrics. The list will comprise return on investment (ROI), internal rate of return (IRR), discount rate, payback period, etc.
- **Step 6: Convert to Common Currency:** Convert all the costs and benefits listed into a common currency. Do this so that you have a common unit of measurement for better analysis and convenience.
- **Step 7: Measure Net Present Value (NPV):** In this step, you measure the profit from the present value of cash flow over a period of time. This helps in analyzing the profitability of a potential project.

- **Step 8: Perform Sensitivity Analysis:** This step allows you to do an in-depth study of all the variables listed in the previous steps. Identify the robustness of the analysis done by far and the areas of improvement. Compare alternatives and identify the scope of each alternative..

Cash flow forecasting

Cash flow is the movement of the money in and out of an organization. It involves the expenditure and income of an organization.

In simple words, it is the estimation of the cash flow over a period of time. It is important to do cash flow forecasting in order to ensure that the project has sufficient funds to survive. It gives an estimation that when income and expenditure will take place during the software project's life cycle. It must be done time to time especially for start-ups and small enterprises. However, if the cash flow of the business is more stable then forecasting cash flow weekly or monthly is enough.



Cash flow is of two types:

- **Positive Cash Flow:**
  If an organization expects to receive income more than it spends then it is said to have a positive cash flow and the company will never go low on funds for the software project's completion.
- **Negative Cash Flow:**
  If an organization expects to receive income less than it spends then it is said to have a negative cash flow and the company will go low on funds for the software project's completion in future.

Importance of Cash Flow Forecasting:

- It allows the management to plan the expenditures based upon the income in future.
- It helps the organization to analyze its expenditures and incomes.
- Makes sure that the company can afford to pay the employees and suppliers.
- Helps in financial planning.

Risk Evaluation

Risk is inevitable in a business organization when undertaking projects. However, the project manager needs to ensure that risks are kept to a minimal. Risks can be mainly divided between two types, negative impact risk and positive impact risk.

Not all the time would project managers be facing negative impact risks as there are positive impact risks too. Once the risk has been identified, project managers need to come up with a mitigation plan or any other solution to counter attack the risk.

Risk Management is an important part of project planning activities. It involves identifying and estimating the probability of risks with their order of impact on the project.

Risk Analysis

Risk Analysis in project management is a sequence of processes to identify the factors that may affect a project's success. These processes include risk identification, analysis of risks, risk management and control, etc. Proper risk analysis helps to control possible future events that may harm the overall project. It is more of a pro-active than a reactive process. Following are the steps to analysis risks effectively in an organization:

- Risk Identification
- Risk Quantification
- Risk Response
- Risk Monitoring and Control

Risk Identification

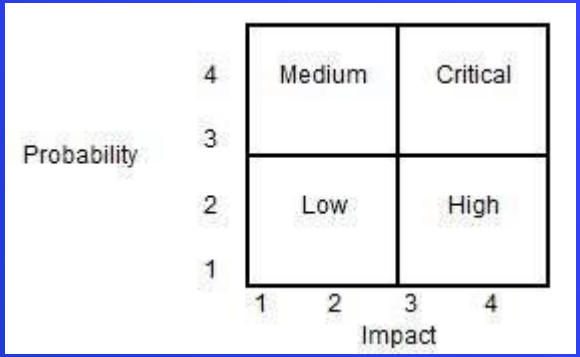
Managers face many difficulties when it comes to identifying and naming the risks that occur when undertaking projects. These risks could be resolved through structured or unstructured brainstorming or strategies. It's important to understand that risks pertaining to the project can only be handled by the project manager and other stakeholders of the project.

Risks, such as operational or business risks will be handled by the relevant teams. The risks that often impact a project are supplier risk, resource risk and budget risk. Supplier risk would refer to risks that can occur in case the supplier is not meeting the timeline to supply the resources required.

Resource risk occurs when the human resource used in the project is not enough or not skilled enough. Budget risk would refer to risks that can occur if the costs are more than what was budgeted.

Risk Quantification

Risks can be evaluated based on quantity. Project managers need to analyze the likely chances of a risk occurring with the help of a matrix.



Using the matrix, the project manager can categorize the risk into four categories as Low, Medium, High and Critical. The probability of occurrence and the impact on the project are the two parameters used for placing the risk in the matrix categories. As an example, if a risk occurrence is low (probability = 2) and it has the highest impact (impact = 4), the risk can be categorized as 'High'.

Risk Response

When it comes to risk management, it depends on the project manager to choose strategies that will reduce the risk to minimal. Project managers can choose between the four risk response strategies, which are outlined below.

- Risks can be avoided
- Pass on the risk
- Take corrective measures to reduce the impact of risks
- Acknowledge the risk

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- Acknowledge the risk

Risk Monitoring and Control

Risks can be monitored on a continuous basis to check if any change is made. New risks can be identified through the constant monitoring and assessing mechanisms.

Risk Management Process

Following are the considerations when it comes to risk management process:

- Each person involved in the process of planning needs to identify and understand the risks pertaining to the project.
- Once the team members have given their list of risks, the risks should be consolidated to a single list in order to remove the duplications.
- Assessing the probability and impact of the risks involved with the help of a matrix.
- Split the team into subgroups where each group will identify the triggers that lead to project risks.
- The teams need to come up with a contingency plan whereby to strategically eliminate the risks involved or identified.
- Plan the risk management process. Each person involved in the project is assigned a risk in which he/she looks out for any triggers and then finds a suitable solution for it.

Selection of Appropriate Report

Why is project reporting essential to project management?

Without quality project management reports, the project team and project stakeholders end up being in the dark, unable to put their finger on what's going on with the project. As a result, it's all too easy for the project to fail, simply because the right insights aren't getting through and therefore, appropriate decisions aren't being taken.

Project reporting fulfills the need for information in the project management process so that data is taken from where it's generated, and delivered to where it's interpreted and applied. Overall, project management reports are important because it:

- Shows the project team what they are working, so they can explain why it's working and focus more on it.
- Uncovers what's not working so the team can investigate and determine an appropriate course of action i.e. what to do about it with the help of the project dashboard.
- Gives the team a 360° overview of how the project is doing so they can determine what steps to take next.

Types of project management reports

Below is a collection of the reports you'll need to manage your projects and what valuable insights each of them provides.

- Project Status Report
- Project Health Report
- Team Availability Report
- Risk Report
- Variance Report
- Time Tracking Report

Project Status Report

The project status report is a critical report that shows stakeholders a general snapshot of how well the project is advancing toward its targets. The project status report can be thought of as a general update that's designed to keep stakeholders or project progress, emerging issues, and key points to note, all at a glance.

Project Health Report

Project health reports are designed to update stakeholders on the overall health of the project, derived from whether the project is either advancing as projected, in danger of stagnating or completely stagnated.

The project health report answers the following questions:

- Are we on track to deliver this project on target? Have we stagnated?
- How far off are we from the target?
- What needs the most attention to get us back on track?

Project health reports make it easy to identify when something's wrong so the team can identify what and get it out of the way

Team availability reports

The team availability report functions like a team calendar that shows every team member's schedule so it's easy to see who's occupied and when they are busy. This way, stakeholders who are planning for a project or requiring input anywhere can see which team members can be assigned, those who can safely take on more work, as well as those who are at full capacity and might need assistance.

Risk reports

A risk report identifies the blockers hindering a project's successful completion and presents it for the stakeholders' analysis. The risk report is designed to not only display existing or potential obstacles but to offer a sense of the danger they pose to the project so the project's stakeholders can take adequate steps to eliminate project risks or adapt the project.

Variance Report

It’s quite common for teams to deviate from the project’s key targets without even knowing. In the end, this results in project failure after time and resources have been expended.

A variance report helps the project team and stakeholders to ensure that doesn’t happen. You can track the target project milestones and objectives of the project along with the work that’s getting done.

With a variance report, the team can see if the work they’re getting done is actually the project’s targets or whether they’re just spending time without ticking off the following:

- project milestones
- project objectives
- project deliverables.

Time tracking report

Project time tracking helps the project team & stakeholders see how much time is getting spent by team members at every stage of the project management process. A time tracking report helps the team to see how much time overall is spent on specific tasks and how much individual team members spend on tasks.

- Time tracking reports help in assigning team members to tasks where they’re more efficient,
- Tracking time spent on tasks for compensation,
- as well as optimizing systems and processes so work gets done faster.

Choice of Process Models

Software processes are the activities for designing, implementing, and testing a software system. The software development process is complicated and involves a lot more than technical knowledge. Software processes are the activities for designing, implementing, and testing a software system. The software development process is complicated and involves a lot more than technical knowledge.

There are many different software processes but all involve:

- **Specification** – defining what the system should do;
- **Design and implementation** – defining the organization of the system and implementing the system;
- **Validation** – checking that it does what the customer wants;
- **Evolution** – changing the system in response to changing customer needs.

Types of Software Process Model

A software process model is an abstraction of the software development process. The models specify the stages and order of a process. So, think of this as a representation of the order of activities of the process and the sequence in which they are performed.

The models specify the various stages of the process and the order in which they are carried out. The most used, popular and important SDLC models are given below:

- **Waterfall Model** – The waterfall model is a breakdown of project activities into linear sequential phases, where each phase depends on the deliverables of the previous one and corresponds to a specialization of tasks. The approach is typical for certain areas of engineering design.

Types of Software Process Model

- **V Model-** The V-model represents a development process that may be considered an extension of the waterfall model and is an example of the more general V-model. Instead of moving down in a linear way, the process steps are bent upwards after the coding phase, to form the typical V shape. The V-Model demonstrates the relationships between each phase of the development life cycle and its associated phase of testing. The horizontal and vertical axes represent time or project completeness (left-to-right) and level of abstraction (coarsest-grain abstraction uppermost), respectively.
- **Incremental model-** The incremental build model is a method of software development where the model is designed, implemented and tested incrementally (a little more is added each time) until the product is finished. It involves both development and maintenance. This model combines the elements of the waterfall model with the iterative philosophy of prototyping.

Types of Software Process Model

- **Iterative Model-** An iterative life cycle model does not attempt to start with a full specification of requirements by first focusing on an initial, simplified set user features, which then progressively gains more complexity and a broader set of features until the targeted system is complete. When adopting the iterative approach, the philosophy of incremental development will also often be used liberally and interchangeably.

- **RAD Model-** RAD is an incremental prototyping approach to software development that end users can produce better feedback when examining a live system, as opposed to working strictly with documentation. It puts less emphasis on planning and more emphasis on an adaptive process.

Types of Software Process Model

- **Spiral Model-** A spiral model looks like a spiral with many loops. The exact number of loops of the spiral is unknown and can vary from project to project. This model supports risk handling, and the project is delivered in loops. Each loop of the spiral is called a Phase of the software development process. The initial phase of the spiral model in the early stages of Waterfall Life Cycle that is needed to develop a software product. The exact number of phases needed to develop the product can be varied by the project manager depending upon the project risks
- **Agile Model-** Agile is an umbrella term for a set of methods and practices based on the values and principles expressed in the Agile Manifesto that is a way of thinking that enables teams and businesses to innovate, quickly respond to changing demand, while mitigating risk. The Agile movement proposes alternatives to traditional project management. Agile approaches are typically used in software development to help businesses respond to unpredictability which refer to a group of software development methodologies based on iterative development, where requirements and solutions evolve through collaboration between self-organizing cross-functional teams.

Structured Methods

Structured methodologies (or structured systems analysis and design) have been used to document, analyze, and design information systems since the 1970s. Structured refers to the fact that the techniques are step by step, with each step building on the previous one. Structured methodologies are top-down, progressing from the highest, most abstract level to the lowest level of detail – from the general to the specific. Structured development methods are process-oriented, focusing primarily on modeling the processes, or actions that capture, store, manipulate, and distribute data as the data flow through a system. These methods separate data from processes.

The primary tool for representing a system's component processes and the flow of data between them is the **data flow diagram (DFD)**. The data flow diagram offers a logical graphic model of information flow, partitioning a system into modules that show manageable levels of detail. It rigorously specifies the processes or transformations that occur within each module and the interfaces that exist between them

Why Need Structured Methodology

Most information systems development organizations use structured methodology because it offers the following advantages:

- Improve project management & control
- Make more effective use of experienced and inexperienced development staff
- Develop better quality systems with low cost
- Make projects resilient to the loss of staff
- Enable projects to be supported by computer-based tools such as computer-aided software engineering (CASE) systems
- Establish a framework for good communications between participants in a project
- Enable projects to deliver the product on time because it allows to plan, manage and control a project well
- Respond to the changes in the business environment while project progresses
- Improves the overall productivity by encouraging on-time delivery, meeting business requirements, ensuring better quality, and using human resources effectively.

Thanks!

Any questions?

Unit-5:Risk Management

- Risk Identification
- Planning
- Evaluation and Management

Categories of Risk

Business risks are uncertain factors, internal or external, that threaten the financial health of an organization. Examples of external business risks would be natural disasters or cyberattacks. Internal business risks are threats that come from within the company, such as falling out of compliance, having too much debt, or labor disputes.

Types of Risk

The following are common types risk:

Cost Risk

Cost risk is an escalation of project costs. It is the risk that the project will cost more than the budget allocated for it. Perhaps the most common project risk, cost risk is due to poor budget planning, inaccurate cost estimating, and scope. The risk is higher when clients want too much even though the project has few resources only. Cost risk can lead to other project risks such as schedule risk and performance risk.

Schedule Risk

Schedule risk is the risk that activities will take longer than expected, and is typically the result of poor planning. It's closely related to cost risk, because slippages in schedule typically increase costs and also delay the outcome of the project, including its benefits. Delays result in missed timelines and a possible loss of competitive advantage. Schedule risk leads to cost risk because longer projects cost more. It can also lead to performance risk, missing the timeline to perform its intended mission.

Performance Risk

Performance risk is the risk that the project will fail to produce results consistent with project specifications. This is a common risk that is difficult to attribute to any single party. A project team can deliver the project within budget and schedule and still fail to produce the results and benefits. On the other hand, performance risk can lead to cost risk and schedule risk when the performance of a team or technology results in an increase in cost and duration of the project. In sum, the company lost money and time on a project that failed to deliver.

Operational Risk

Operational risk stems from poor implementation and process problems, including but not limited to: procurement, production, and distribution. In short, this project risk is part of performance risk because the expected outcome doesn't happen at all or in the way that project managers had planned.

Legal Risk

Legal risk can be unpredictable and may arise from legal and regulatory duties. These include contract risks, litigation brought against the business or organization, and internal legal issues.

Market Risk

Market risk includes risks posed from competition, commodity markets, interest rates, foreign exchange, and liquidity and credit risks. This project risk is more unpredictable and difficult to plan for, but there are ways in which project managers can protect their business.

Governance Risk

Governance risk is connected to the performance of the board and management in regard to the community, ethics, company reputation, and community stewardship. This risk should be easier to mitigate because it depends largely on the behavior of executives in business. Of course, this risk is still real and should be taken seriously.

Strategic Risk

Strategic risk is another type of performance risk. Issues result from mistakes made when strategizing, such as picking project management software that doesn't work well for your project.

Framework for dealing with risk

Identify risks

The first step to getting a grasp on potential risks is to know what they are. In this step, you'll identify individual risks that might affect your project by making a list (or spreadsheet) of risks that might arise. Examples of common project risks include implementing a new technology program for the project, having a poorly defined project objective or deliverable, and not having adequate measures to protect the health and safety of project team members.

Use your own project management expertise and consult similar past projects to see what challenges you might expect. You'll also want to have stakeholders, team members, and subject matter experts generate ideas with you; they may have insight into the field that you've overlooked.

Analyze potential risk impact.

In the risk analysis stage, you'll explore the probability of each risk occurring, as well as the potential impact each risk will have on your project. You could begin putting this list of risks in a risk register, a chart that lays out each risk, followed by information like priority level and mitigation plans. You can record both qualitative and quantitative information.

Mitigate risks

Come up with a plan to mitigate each risk. We'll go into how you can treat risks in more detail below. Record these plans in your risk register as well.

Monitor risks

In the last step, set up a process to monitor each risk as your project begins. You can do this by assigning team members to keep an eye on specific risks and mitigate them. This ensures you'll have a constant sense of where the risks are and how likely they are to happen, so you'll be ready to tackle them if they occur.

Evaluating Risks to the schedule

Analysis of the project's schedule network can be used to identify risk factors associated with the project in the following ways:

- PERT
- Monte Carlo Simulation

PERT

PERT (Project Evaluation and Review Technique) was developed to take into account uncertainty of estimates of task durations. Instead of using a single estimate for the duration of each task, PERT requires three estimates - Optimistic Time, Most Likely Time, Pessimistic Time.

- Optimistic Time (to): The optimistic time is the shortest possible time in which the activity can be completed.
- Most Likely Time (tm): The most likely time is the normal amount of time the activity would take.
- Pessimistic Time (tp): The pessimistic time is the longest time the activity could take if everything goes wrong.

The main objective of PERT is to find out the completion time for a particular event and to determine what are the chances of completing a job and the risk of not completing a job in time. In the network analysis, it is assumed that the time values are deterministic or variations in time are insignificant. It is difficult to get a reliable time estimate because the technology is changing rapidly

Monte Carlo Simulation

As an alternative to the PERT technique, and to provide flexibility in specifying activity durations, Monte Carlo simulation techniques can be used to evaluate the risks of not achieving deadlines. The basis of this technique is to calculate activity times for a project network a large number of times, each time selecting activity times randomly from a set of estimates. The Monte Carlo method thus produces range of estimates with associated probabilities.

Thanks!

Any questions?

Unit-6:Software Quality Management

Total Quality Management (TQM)

Total Quality Management is a management approach that focuses on delivering products and services with the highest quality to maximize customer satisfaction and meet regulatory standards. Total quality management is an organization-wide effort for continuous improvement. That improvement can be defined as an employee's ability to provide on-demand products and services that are of value to their customers, even as their needs change

That's the "quality" in total quality management. The "total" indicates that the effort is one that touches every inch of every employee of an organization. As a methodology, however, total quality management has no widely agreed-upon approach. It does, though, draw from other tools and techniques, such as project quality control, quality assurance and testing, and others.

Total Quality Management Principles

- **Customer Focused:** The definition of quality lies with the customer, and all efforts to achieve success in the organization lead to customer satisfaction
- **Total Employee Involvement:** The effort is not isolated to one department of an organization. To be successful in its objective of customer satisfaction, there must be a common goal for all aspects of business and for each employee.
- **Process Oriented:** Process thinking is fundamental to total quality management; the internal steps a company takes directly result in the external output delivered to the customers.

- **Integrated System:** Basically, regardless of the size or complexity of the organization, all its distinct parts must work together.
- **Strategic and Systemic Approach:** Using strategic planning to create a strategic plan that integrates quality as a core component of the company is a way to structure total quality management into an organization's mission.
- **Continual Improvement:** The mantra for total quality improvement is customer satisfaction, but that is not a one-shot goal: the act of improving quality for the customer is a process without an end.
- **Fact-Based Decision Making:** In order to know if an organization is meeting its objectives, there must be data on performance, and those metrics must be collected and analyzed with accuracy and without prejudice. (For more

- **Communications:** It’s impossible to maintain a successful TQM approach without an effective communication plan. Communication plans make sure that every department is aware of what they and others are responsible for, so they can coordinate operations to achieve their common goal.

SIX SIGMA

Six Sigma is a methodology used to improve the output quality in a process. It does this by first identifying, and then removing, the causes of defects. This is achieved via a set of quality management methods that feature both empirical and statistical approaches. A staff member with Six Sigma expertise is also usually hired to monitor the process.

The Six Sigma management method philosophy focuses on better understanding of customer requirements, improving business systems throughout the organization, and enhancing the organization's financial performance. It is used to improve the organization's products, services and processes across various disciplines, including production, product development, marketing, sales, finance, and administration. It is achieved through understanding the underlying processes, and reducing or eliminating defects and waste.

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- **Improve:** Test and implement solutions to the identified problems using creative solutions to eliminate root causes and prevent them from coming up again. This is done with various brainstorming techniques and other problem-solving methods. It's suggested that focusing on the simplest and easiest solution is best. Test those solutions, and figure out what risks are inherent. Then create an implementation plan, and execute improvements. A SIPOC diagram is often used in Six Sigma in order to perform this step.
- **Control:** To ensure that these improvements are sustainable, monitor them by creating a control plan. Be sure to update that plan as needed. You can develop a control chart to assess the stability of the improvements as the project moves forward.

Software Quality

Quality software refers to a software which is reasonably bug or defect free, is delivered in time and within the specified budget, meets the requirements and/or expectations, and is maintainable. In the software engineering context, software quality reflects both functional quality as well as structural quality.

The quality of software can be defined as the ability of the software to function as per user requirement. When it comes to software products it must satisfy all the functionalities written down in the SRS document. The modern read of high-quality associates with software many quality factors like the following:

- Portability:
  A software is claimed to be transportable, if it may be simply created to figure in several package environments, in several machines, with alternative code merchandise, etc.

- **Usability**:
  A software has smart usability if completely different classes of users (i.e. each knowledgeable and novice users) will simply invoke the functions of the merchandise.
- **Reusability:**
  A software has smart reusability if completely different modules of the merchandise will simply be reused to develop new merchandise.
- **Correctness:**
  A software is correct if completely different needs as laid out in the SRS document are properly enforced.
- **Maintainability:**
  A software is reparable, if errors may be simply corrected as and once they show up, new functions may be simply added to the merchandise, and therefore the functionalities of the merchandise may be simply changed, etc

Why is software quality assurance important?

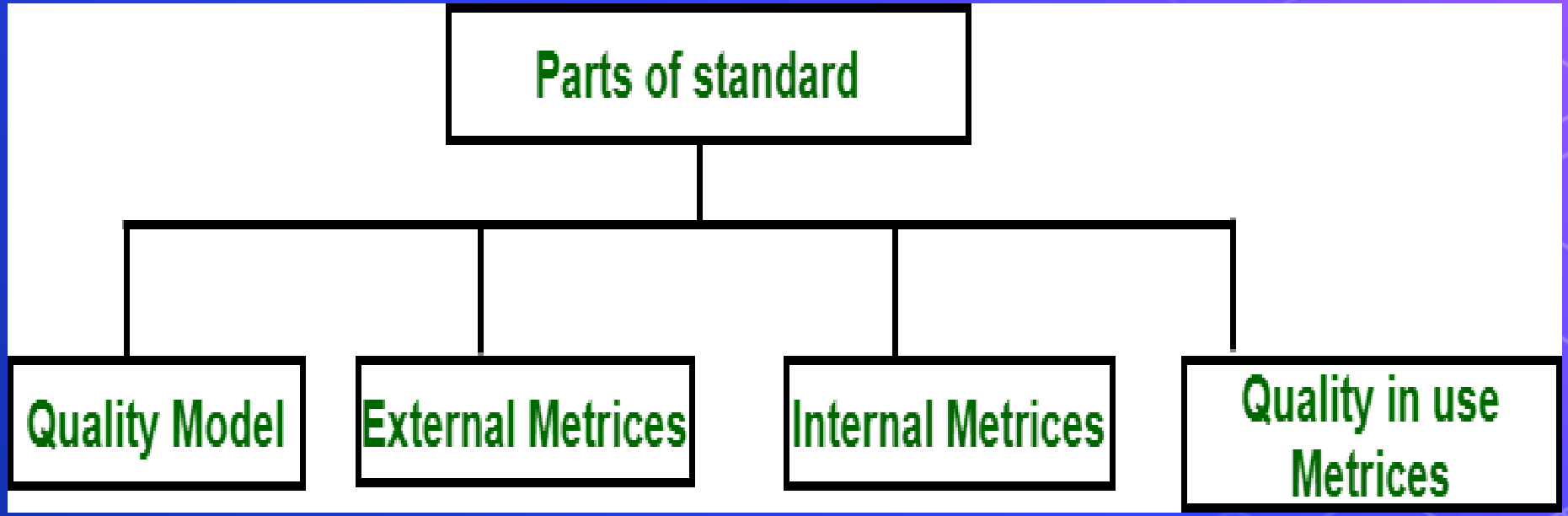
1. **Save time and money:** Software quality assurance ensures that the developers find bugs and errors at the early stages of software development. Therefore, they spend a lot less time and money fixing them.
2. **Stable and competitive software product. :**Software architects specifically vet each block in the software development process against industry standards.
   Granular testing for different requirements like reliability, functionality, usability, portability, etc., helps ensure that their product is high-quality.
3. **Ensures security. :**Software quality assurance helps organizations ensure that their application is efficient, secure, and trustworthy.
4. **Customer satisfaction:** Your software application has to fulfill all the needs to satisfy the customers. It has to work smoothly without any malfunctions. With software quality assurance processes in place, you can ensure that your product delivers everything that your audience expects.

ISO 9126

ISO/IEC 9126 is an international standard proposed to make sure ‘quality of all software-intensive products’ which includes a system like safety-critical where in case of failure of software lives will be in jeopardy. ISO i.e. International Organization for standardization and IEC i.e. International Electrotechnical Commission have developed ISO/IEC 9126 standards for software engineering . Product Quality to provide an all-inclusive specification and evaluation model for the quality of the software product.

ISO 9126 is an international standard for the evaluation of software. The standard is divided into four parts which addresses, respectively, the following subjects: quality model; external metrics; internal metrics; and quality in use metrics.

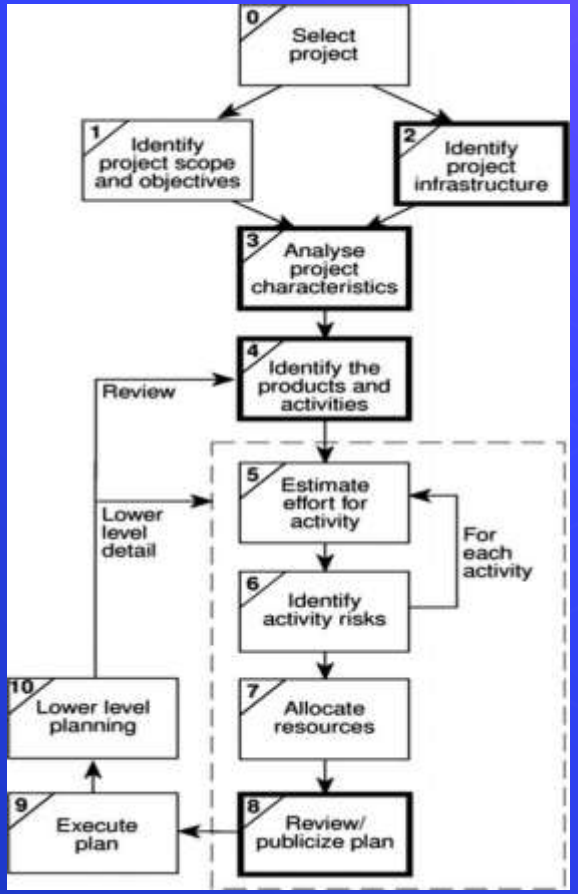
The standard is divided into 4 parts as depicted in the following figure :



Why is software quality assurance important?

1. Part-1 Software Engineering – Product Quality “Quality model” :
   It describes quality model framework which explains relationships between different approaches to quality as well as identifying quality characteristics and sub-characteristics of software products.
2. Part-2 Software Engineering – Product Quality “External Metrices” :
   It’s use is to describes external metrices that are used to measure characteristics and sub-characteristics which are identifies in part 1.
3. Part-3 Software Engineering – Product Quality “Internal Metrices” :
   It’s use is to describes internal metrices that are used to measure characteristics and sub-characteristics which are identifies in part 1.
4. Part-3 Software Engineering – Product Quality “Quality in use metrices” :
   It’s use is to identify metrices which are used to measure effects of combined quality characteristics for user.

Place of software quality in software planning



Thanks!

Any questions?

Unit-7:Software Configuration Management

What is Software Configuration Management?

In Software Engineering, Software Configuration Management(SCM) is a process to systematically manage, organize, and control the changes in the documents, codes, and other entities during the Software Development Life Cycle. The primary goal is to increase productivity with minimal mistakes. SCM is part of cross-disciplinary field of configuration management and it can accurately determine who made which revision.

Software Configuration Management (SCM) is a part of Software Project management to provide a better process to handling, organizing and controlling the changes in requirements, codes, teams and other elements in the software project development life cycle. The SCM primarily deals with version selection, tracking the changes and version control of software projects with high productivity and minimize the error or risk factor.

Why do we need Configuration management?

The primary reasons for Implementing Technical Software Configuration Management System are:

- There are multiple people working on software which is continually updating
- It may be a case where multiple version, branches, authors are involved in a software config project, and the team is geographically distributed and works concurrently
- Changes in user requirement, policy, budget, schedule need to be accommodated.
- Software should able to run on various machines and Operating Systems
- Helps to develop coordination among stakeholders
- SCM process is also beneficial to control the costs involved in making changes to a system

SCM Baseline

A baseline is milestone and reference point in software development that is marked by completion or delivery of one or more software configuration items and formal approval of set of predefined products is obtained through formal technical review. Baseline is shared project database. It is task of Software Configuration Management (SCM) that is used to maintain integrity of set of products.

Main aim of baseline is to reduce and control vulnerability i.e. Weakness of projects that can easily affect project and leads to changes that are uncontrollable. This can be achieved by fixing and changing configuration items (various key deliverables) in the development life cycle of product at some critical points. Each element that is associated with baseline needed to be kept under formal change control.

Baseline Process :

- Elements need to be documented in proper way and reviewed to find if there is an issue of design model. If any error or defect is found, then these errors and defects are corrected and fixed.
- All parts of model are being reviewed properly and all problems found are being fixed and approved.
- Design base model is now Baseline.
- Any further changes in the program architecture that is actually documented in the design model can be allowed to be done only after each has been evaluated and approved.

Baseline Components :

A typical baseline includes following components :

1. **Functional Baseline –**
   Operation Document, System requirements.
2. **Allocated Baseline –**
   High-level document, Preliminary Design, Interface control documents.
3. **Design Baseline –**
   Detailed design documents.
4. **Product Baseline –**
   Source and executable code units, final system specifications, user and maintenance manuals, Hardware and software specifications,
5. **Operational Baseline –**
   Source and executable code units, final system specifications, user and maintenance manuals, acceptance test plans, test procedures, site integration test cases and data sets and test reports
6. **Acceptance Test –**
   Source and executable code units, integration test plans, test procedures, test

Baseline Components :

1. **Integration Test –**
   Source and executable code units, unit test plans, test procedures, test cases, and data sets and test reports
2. **Unit Test –**
   Source and executable code modules

SCM Repository

In computer software engineering, software configuration management (SCM) is any kind of practice that tracks and provides control over changes to source code. Software developers sometimes use revision control software to maintain documentation and configuration files as well as source code. Revision control may also track changes to configuration files.

As teams design, develop and deploy software, it is common for multiple versions of the same software to be deployed in different sites and for the software's developers to be working simultaneously on updates. Bugs or features of the software are often only present in certain versions (because of the fixing of some problems and the introduction of others as the program develops).

Versioning and version control

Version control is a way to manage and document changes developers make to software code. Version control system (VCS) are also known as source control management (SCM), so the terminology is interchangeable.

The idea behind the SCM methodology is to prevent and resolve conflicts among developers' codes. Instead of using a file locking approach, version control system allows contributors to work simultaneously, applying changes on any part of the source codes and even concurrent access. Consequently, contributors can perform parallel changes smoothly.

Git Cheat Sheet

Git: configurations

```
$ git config --global user.name "FirstName LastName"
$ git config --global user.email "your-email@email-provider.com"
$ git config --global color.ui true
$ git config --list
```

Git: starting a repository

```
$ git init
$ git status
```

Git: staging files

```
$ git add <file-name>
$ git add <file-name> <another-file-name> <yet-another-file-name>
$ git add .
$ git add --all
$ git add -A
$ git rm --cached <file-name>
$ git reset <file-name>
```

Git: committing to a repository

```
$ git commit -m "Add three files"
$ git reset --soft HEAD^
$ git commit --amend -m <enter your message>
```

Git: pulling and pushing from and to repositories

```
$ git remote add origin <link>
$ git push -u origin master
$ git clone <clone>
$ git pull
```

Thanks!

Any questions?