UNIT 2

Work more precise the "joint" or the "council" (3 in to 12 elements) for an "administration in project management" is the amount of effort applied to produce a deliverable or to accomplish a task (a terminal element) or a group of related tasks defined at the same level in the WBS.

WORK CONTENT

Successful **project management** depends, to a significant extent, on the **manager's** ability to effectively specify the **work** contents of the **project** in terms of its activities and deliverables. One of the principal tools for planning and controlling the **work** contents of a **project** is the **work** breakdown structure (WBS).

TIME ESTIMATION METHOD

Two key features of a project are on-time and on-budget delivery. The project manager can only fulfill these objectives if the estimates leading to the project schedule and budget are accurate. Methods for estimating project times and costs focus on simplifying the process and breaking it down into little steps. Such methods allow project managers to estimate the cost and duration of small tasks more reliably. Estimates of many small tasks will be both high and low, and some will cancel out, reducing the overall error.

Time estimation method, i.e, production of time simultaneously with the performance of a second task, or reproduction of time immediately upon termination of a task whose duration has to be measured.

Accurate time estimation is a skill essential for good project management. It is important to get time estimates right for two main reasons:

1. Time estimates drive the setting of deadlines for delivery and planning of projects, and hence will impact on other people assessment of your reliability and competence as a project manager.

2. Time estimates often determine the pricing of contracts and hence the profitability of the contract/project in commercial terms.

Often people underestimate the amount of time needed to implement projects. This is true particularly when the project manager is not familiar with the task to be carried out. Unexpected events or unscheduled high priority work may not be taken into account. Project managers also often simply fail to allow for the full complexity or potential errors and stuff ups, involved with a project.

Step 1: Understand the Project Outcome

First you need to fully understand what it is you need to achieve. (Refer to my article; Project Management - Begin with the end in mind). Review the project/task in detail so that there are no "unknowns." Some difficult-to-understand, tricky problems that take the greatest amount of time to solve. The best way to review the job is to just list all component tasks in full detail.

Step 2: Estimate Time

When you have a detailed list of all the tasks that you must achieve to complete the project then you can begin to estimate how long each will take.

Make sure that you also allow time for project management administration, detailed project, liaison with outside bodies resources and authorities, meetings, quality assurance developing supporting documentation or procedures necessary, and training.

Finally, allow time for all the expected and unexpected disruptions and delays to work that will inevitably happen.

PROJECT COST ESTIMATION AND BUDGETING

Budgeting and cost control comprise the **estimation** of **costs**, the setting of an agreed **budget**, and **management** of actual and forecast **costs** against that **budget**. A **budget** identifies the planned expenditure for a **project**, programme or portfolio. ... Initial **cost estimates** can be comparative or parametric.

COST ESTIMATION

One of the first tasks when managing a project is the cost estimate. A cost estimate must be accurate, transparent and reliable. These factors are particularly important for a small business because its resources are limited. Using standard techniques lets you see the details of the cost calculations. Such techniques give accurate results, and their reliability is high as long as the inputs used for the calculations are exact. When you calculate project costs using effective cost-estimating techniques, you will be able to assign corresponding resources and develop schedules to manage the project successfully.

Resource Costing

A common technique for cost estimating is to list the resources you need for the project and to total their costs. Typical resources include equipment, material, services and labor. You can get costs for equipment, material and services by consulting price lists or by going out for bids for the larger pieces. Labor costs are hourly, and you can base the total costs on

estimates from similar projects or ask for bids to carry out the work. Small businesses use resource costing for larger or more complicated projects.

Unit Costs

Small or simple projects can be evaluated using a cost-per-unit that is characteristic of the project. The characteristic unit is a measure of the size of the project that is indicative for the particular project. It might be a cubic foot, a square foot or a work station. Typical applications are for building costs, paving, renovating or for standard systems such as data processing. Costs are a dollar amount per unit. To get the total cost, you decide how large the building or surface is or how many people will be working on the data. Multiply that by the unit cost to get the total. You can get typical unit costs from prospective suppliers or from industry associations.

Historical Costing

One of the most transparent ways of estimating the cost of a project is to base it on previous work. If your company has completed a similar project recently, all the required costing information is available from the project files. If you don't have such a project, other work your company has done in the past can help determine the cost of similar work on the new project. If a local business that is not a competitor has completed a similar project, it might be willing to help. Where available, historical data often gives the most accurate prediction of future costs.

BUDGETING

Cost budgeting is a tool to estimate the costs or necessary efforts for projects, work packages or activities in project management. Cost budgeting includes the estimation of costs, setting a fixed budget, and managing and controlling the actual costs (compared to the estimated ones). The costs then have to be allocated to the activities or work packages in a project. A carefully implemented schedule and resource plan enables a more precise cost budgeting.

The budget for a project is simply the combined costs of the individual activities or work packages that the project must accomplish. The budget is represented by the approved cost baseline.

Why the Project Budget is Important?

There are two key reasons the budget of your project is important...

First, the approved budget is what drives **project funding**. It will tell stakeholders how much money is needed and when it is needed. Your ability to get people, equipment, and materials when they are needed are dependent on the funding provided as a result of your budget.

The second reason budgeting is important for your project is because it provides the basis for **project cost control**. By measuring the project's actual cost against the approved budget,

you can determine if the project is progressing according to the plan or if corrective action is needed. This is accomplished using a cost baseline.

There are six points of information that one will need to prepare the budget:

- Activity Cost Estimates
- Basis of Estimates
- Scope Baseline
- Project Schedule
- Resource Calendars
- Contracts

Activity cost estimates are the individual cost estimates for each activity or work package that your project will complete. For each activity, the cost estimate generally includes direct labor, materials, equipment, services, facilities, and information technology.

The **basis of estimates** documents supporting details about the activity cost estimates. For example, how the estimates were made, assumptions and constraints, and the confidence level of each estimate.

The **scope baseline** will let you know if there are any funding constraints that may be mandated by your organization, contracts, or other groups such as government agencies.

The **project schedule** will be used to determine the cost budget over time. For a specified calendar period, you can combine the activity costs that are planned for that period to determine the time-phased budget.

Resource calendars will let you know which resources are assigned to the project and when they are assigned. Using each rates for each resource and combining with the project schedule you can then determine resource costs over time.

Contracts for products or services will be used to determine their costs and can then be included to the project budget.

Once you have the above information, then it is simply a matter of summing up the costs to determine the budget for your project.

Cost Estimate vs Budget

The cost estimates are simply the costs associated with the work packages or activities within the project schedule. Depending on the work package or activity, the cost estimate may be determined using parametric, three-point, or analogous estimating techniques. It is important for all cost estimates to include any assumptions that were made, where did the estimate originate, who provided the information, level of confidence, etc. Whereas The budget is

built using the cost estimates and the project schedule. The budget provides a view of how much the project is estimated to cost both from a total and a periodic perspective. This budget feeds the cost performance baseline which is then used as critical ingredient in performing earned value analysis and other cost management variance analysis techniques.

The project budget must be in alignment with the organization's funding limits in order to ensure the funding is available and has been appropriated.

PROJECT RISK MANAGEMENT

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.

Managers can plan their strategy based on four steps of risk management which prevails in an organization. Following are the steps to manage risks effectively in an organization:

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

Risk Identification

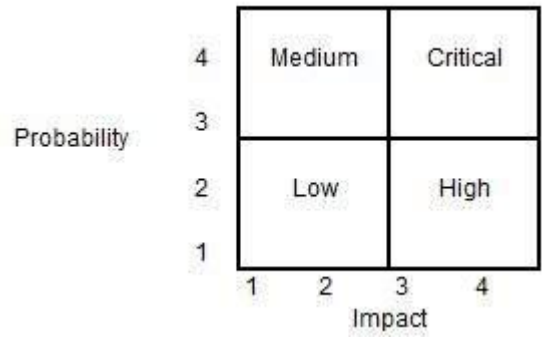
Managers face many difficulties when it comes to identifying and naming the risks that occur when undertaking projects. These risks could be resolved through structured or unstructured brainstorming or strategies. It's important to understand that risks pertaining to the project can only be handled by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

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.

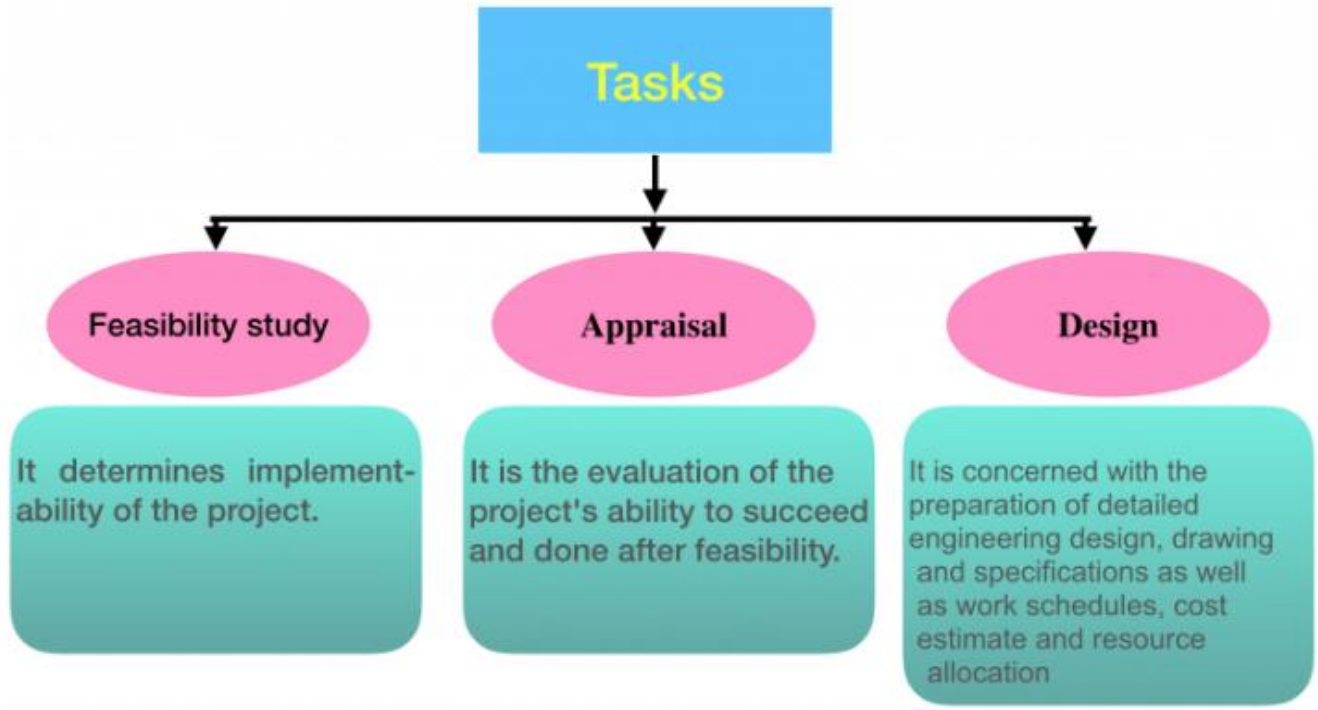
- The teams need to come up with a contingency plan whereby to strategically eliminate the risks involved or identified.
- Plan the risk management process. Each person involved in the project is assigned a risk in which he/she looks out for any triggers and then finds a suitable solution for it.

Project scheduling is a mechanism to communicate what tasks need to get done and which organizational resources will be allocated to complete those tasks in what timeframe. A project schedule is a document collecting all the work needed to deliver the project on time.

The project schedule is the tool that communicates what work needs to be performed, which resources of the organization will perform the work and the timeframes in which that work needs to be performed. The project schedule should reflect all of the work associated with delivering the project on time. Without a full and complete schedule, the project manager will be unable to communicate the complete effort, in terms of cost and resources, necessary to deliver the project.

Project Planning Process is concerned with the development of a project for investment. It identifies and addresses the task required for accomplishment of objectives.

Task involved in project planning are



Functions of Project Planning

- Determining the objectives of the project to be undertaken.
- Definition of work requirement.
- Estimating resource, funds, materials, machines and manpower requirements.
- Scheduling various stages and determining the time frame of overall work.
- Reducing risk and uncertainty.
- It provides the basis for co-coordinating the work among concerned; provide a basis for predicting & controlling time and cost.

Project scheduling and Planning Tools:

Project Managers can use a range of tools and techniques to develop, monitor and control project schedules. Increasingly, many of these can be applied digitally (using programs such as Excel, Microsoft Project and so on).

WORK BREAKDOWN STRUCTURE

Systematic and logical breakdown the project into its components and sub-components in hierarchical order is called work breakdown structure.

- It is constructed by dividing a project into major components, each of which is further sub-divided into smaller components.
- The process is continued till a breakdown accomplishes the manageable unit of works for which responsibility can be defined.

Work breakdown is the first and major step in planning and the execution of the project.

The level of smaller component should be such that each of which should be:

- Manageable so that responsibility can be assigned.
- Independent so that there is minimum dependence on other ongoing activities.
- Integrable so that total package can be seen, and
- Measurable so progress can be measured.

Levels of WBS:

- Total program
- Project

- Task (Activity)
- Sub tasks
- Work package
- The level of effort

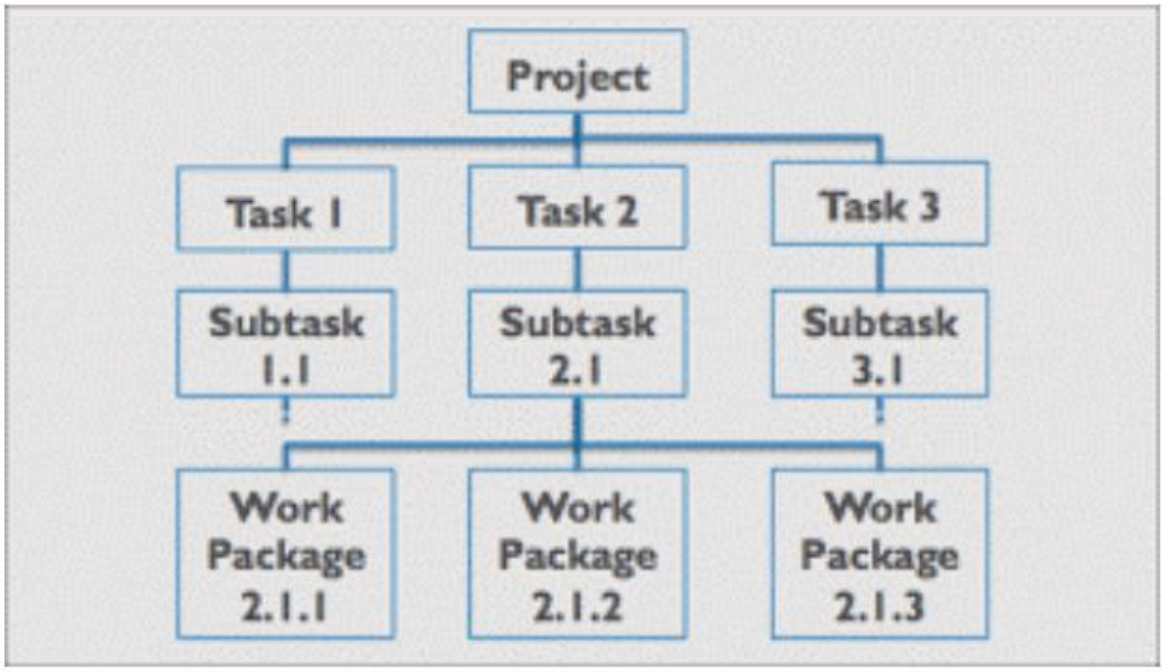
Characteristics of WBS:

- Top three levels of the WBS reflect integrated efforts and not department specific.
- The summation of all elements in one level must be the sum of all work in the next lower level.
- Each element of work should be assigned to one and only one level of effort.
- The WBS must be accompanished by a description of the scope of effort required.

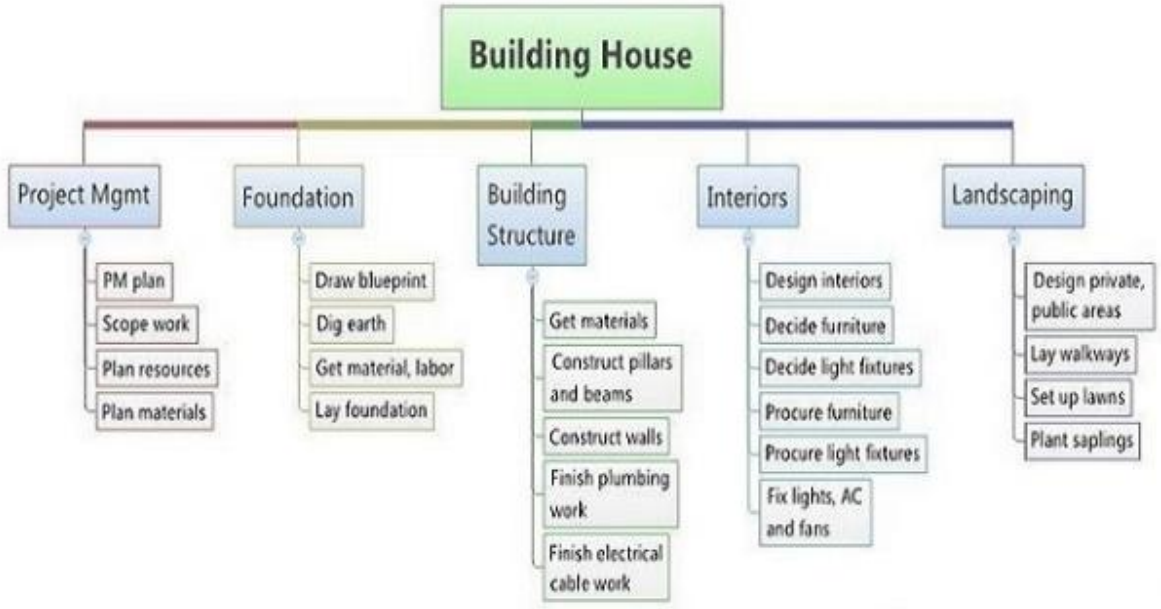
Advantages of WBS:

- Planning
- Cost estimate
- Schedules for different activities and the overall project can be established.
- Responsibility can assigned to each activity.
- Can be used to analyze the risk of each activity and project.
- Can be used in network analysis.

A typical WBS of a project



For example, Work breakdown structure of building construction



Linear Responsibility Chart (LRC)

A Linear Responsibility Chart (LRC) identifies team participant's clients, and/or line managers and the degree to which an activity is to be performed or a decision is to be made on the project. The LRC attempts to clarify the authority and working relationships in the project team. In a typical linear responsibility chart, rows (or columns) indicate activities, responsibilities, or functions required which can be all or just a few of the tasks in the work breakdown structure or elements or data and information within tasks of the WBS. Columns (or rows) identify positions, titles or people themselves. The symbols indicate the degrees of authority, responsibility or activity existing between the rows and columns.

BAR CHART (GANTT CHART)

- This is a horizontal bar chart plotted over time (e.g. days, weeks or months).
- Each activity is shown as a bar (its length based on a time estimate).
- Depending on task dependencies and resource availability, these bars may be sequential, or run in parallel.
- Each bar is plotted to start at the earlier possible start date.
- Bar charts are useful and used to detect the amount of resources needed for one particular project.
- Resource aggregation is done by adding resources vertically in the schedule.

- The purpose of this aggregation is to estimate the work production and establishing estimates for man-hour and equipment needed

Advantages:

- It is simple to understand.
- Easy to prepare, consume less resources.
- Easy to develop and implement, no training is required.
- It can be used to show progress.
- Appropriate for small projects.
- Can be used for resources schedule.
- It gives the clear pictorial model of the project.

Shortcomings:

- Difficult to construct Bar chart for the large and complex project due to limitations of the size of paper.
- The relationship between activities cannot be shown easily.
- Difficult to find critical path, critical activities, and floats etc.
- Difficulties in seeing immediately and exactly overall project duration if changes occur in any particular activity.
- It cannot be used as control device
- Long duration project may seem to be most important which may not be correct.
- Difficult to manipulate and make corrections i.e. updating means to redraw the entire chart again.

SCHEDULE NETWORK ANALYSIS

- The schedule network is a graphical display (from left to right across a page) of all logical interrelationships between elements of work — in chronological order.
- This order is from initial planning through to project closure.
- As the project progresses, regular analysis of this network diagram is a check to ensure that the project is proceeding ‘on track’.

Network Diagrams

- For a project involving a large number of activities, the project scheduling becomes very complex
- The use of the conventional method of scheduling like bar charts will not be effective in such case.
- Complex projects, if not correctly scheduled, will probably result in either under estimation or over estimation of the project implementation period.

Network diagrams are one of the modern tools of project management. There are two popular network based scheduling techniques.

- **Critical Path Method (CPM)**
    - Graphical network- based scheduling technique.
    - US Government agencies insisted on their use by contractors on major government projects.
- **Project Evaluation and Review Technique (PERT)**
    - In 1958 US Navy developed project management tool known as PERT for scheduling Polaris Missile Project.

CRITICAL PATH METHOD (CPM)

Unlike bar chart, it uses arrows to represent activities and length of arrows has no relation with activity duration. Start or end of an activity is called event and it is shown by circles with the special designation.

Terminology:

- Starting event is called tail event and ending event is called head event.
- Some event plays dual both the role of head and tail such events are called dual role events.
- Activity which must be completed before start of another activity is predecessor.
- Activity which starts after completion of an activity is its successor.

Critical path: The longest path in a CPM network is called critical path. There may be more than one critical path in a network.

Project duration: The time required to travel critical path is called project duration.

Critical activities: The activities lying on critical path are called critical activities.

Floats: Float means the available free time for an activity, which is useful for managers to manage the limited resources.

An activity has four types of floats.

Total Float (TF): It is the total free time for an activity i.e. maximum time by which completion of an activity can be delayed without affecting project completion time.

TF= (LF-ES)-t_{ij} = (LF- t_{ij}) - ES

= LS – ES

Free Float (FF): It is the spare time allowable for an activity so that the start time of succeeding activities are not affected. It is based on the possibility that all events occur at their earliest time.

FF = (EF -ES) – t_{ij} =EF – (ES+ t_{ij})

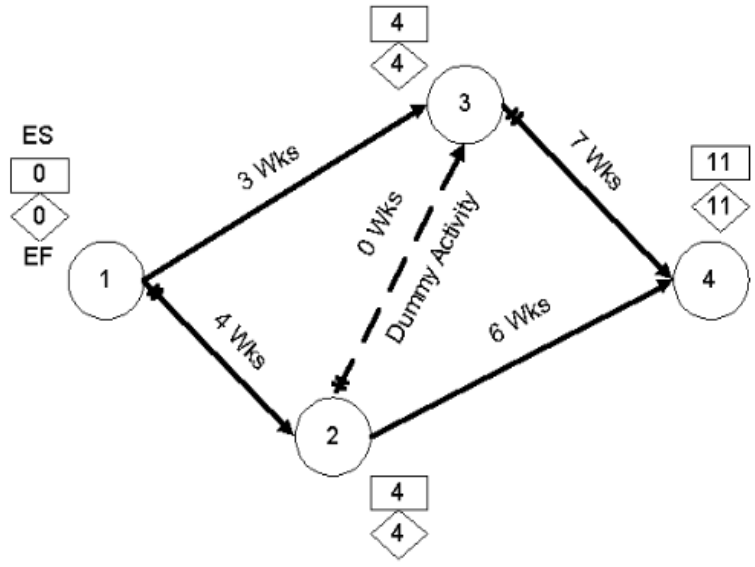
Independent Float (IF or Ind. Float): It is the maximum delay allowable for an activity so that the start time of succeeding activities are not affected. It may come negative but should be taken as zero.

IF = EF – LS – t_{ij}

Interfering Float (Int. Float): It is name given to head event slack. It is the difference between TF & FF.

Int. Float= TF – FF

CPM example:



There are three paths:

Paths	Duration(weeks)
1-2-3-4	4+0+7=11
1-2-4	4+6=10
1-3-4	3+7=10

Hence from above definition,

- Critical path= 1-2-3-4
- Project duration= 11 weeks(time duration along the critical path)
- Critical activities= 1,2,3,4

Event	Duration (Weeks)	Earliest Start Time	Earliest Finish Time	Latest Start Time	Latest Finish Time	Total Float
1-2	4	0	4	0	4	0
2-3	0	4	4	4	4	0
3-4	7	4	11	4	11	0
1-3	3	0	3	1	4	1
2-4	6	4	10	5	11	1

Advantages of Critical Path Method

- Makes dependencies visible.
- Organizes large and complex project.
- Enables the calculation of float of each activity.
- Encourages the project manager to reduce project duration.
- Increases visibility of the impact of schedule revisions.

- Provides opportunities to respond to the negative risk going over-schedule.

Shortcomings

- In large and complex projects, there will be thousands of activities and dependency relationships.
- This method doesn't account for resource and resource allocation.

PROJECT EVALUATION AND REVIEW TECHNIQUE (PERT)

Like CPM, PERT is also a network based planning tool developed by US Navy in 1958. It was used for scheduling Polaris Missile Project.

- But, unlike CPM, PERT is used for novel projects like research and development (R & D) where it is difficult to estimate activity duration accurately.
- CPM is used for projects with prior experience such as civil engineering works.
- It is a probabilistic approach for estimating project duration of an activity and event-oriented network diagram.
- PERT is preferred for those projects in which correct time determination for various activities cannot be made.

PERT uses three-time estimate for each activity with a view to overcoming uncertainty in time estimates.

Optimistic time estimate (t_0):

- It is minimum time i.e. the shortest possible time required to complete the activity in ideal conditions.

Pessimistic time estimate (t_p):

- Maximum time required to complete the activity in the worst condition.

Most probable time estimate (t_m):

- Time required to complete the activity in normal circumstances.

From these three time estimates, we calculate average time i.e. expected time (te) using the following formula.

$t_e = (t_0 + 4\,t_m + t_p)/6$

PERT assumes optimistic time and pessimistic time are equally likely to occur while the most likely time is four times more likely to occur than the other.

Similarly, standard deviation (σ) is calculated using,

S.D. (σ) = $(t_p - t_0) / 6$ and

Variance (σ^2) = $[(t_p - t_0) / 6]^2$

Difference between CPM and PERT

CPM	PERT
Deterministic tool, with only single estimate of duration	Probabilistic tool used with three estimates of duration
Activity oriented	Event oriented
CPM considers less uncertainty	PERT considers more uncertainty
Suited for routine projects requiring accurate time and cost estimates	Suitable for R&D related projects where the project is performed for the first time and the estimate of duration are uncertain
CPM can control both time and cost	This tool is basically a tool for planning and control of time
Easy to maintain	Costly to maintain