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PROJECT PLANNING

Project planning consists 3 part
1. **management of project scope**
2. **Identifying project activities**
3. **Activities –sequencing, estimating duration and scheduling**

In part 1 we will discuss following:
- **Project initiation**
- **Defining project deliverables**
- **Scope planning**
- **Approval of POS**
- **Project definition statement**
- **Scope verification**
- **Scope change control**

Introductions

Scope is a brief and accurate description of the end-products or deliverables to be accepted from a project. It describes all the activities that have to be performed and identifies the resources that will be utilized for the successful completion of the project. Scope is also concerned with target outcomes, prospective customers, outputs, and the financial and human resources required for completing the project.

PROJECT INITIATION

Project are initiated only when an opportunity is reorganized or when some need arises. For example, a bank opens new branches in the countryside because of the growing demand for banking services in rural areas. A company starts a project for training its employees in 'total quality management' because of a business need. Construction farm start a project for a new type of structure because of a client's request. The election commission of India conduct election to meet a statutory requirement. In other word, projects are initiated because of specific requirement.

DEFINING PROJECT DELIVERABLES

The project management body of knowledge (PMBOK) define a project deliverable 'as any measurable, tangible, verifiable outcome, result or item that must be produced to complete a project or a part of project. A List of project deliverables is also called 'condition of satisfaction'

The list of project deliverables is developed in 4 steps. They are:

- Request
- Clarification
- response
- agreement

Request

In the first state, the client request the project manager to undertake a project as per his requirement

Clarification

The second step, the project manager explain what he has understood by the request made by the client. This is step is over only when the client feels that the project manager has understood the request made by him.

Response

In the third state, the project manager explains what he can do to fulfil the client's request. He informs the client of his capability, hi schedule, and fees for undertaking the project.

Agreement

Based on the project manager's response, both parties continue their discussions. If both parties are still willing to ahead with the project, they establish the project norms in this step.

Finally, both parties examineeach other's requestclosely to determine how the project should be executed. The final agreement is document in the "project overview statement".

SCOPE PLANNING

Scope planning involves development of scope statement. The project manager used tools like product analysis, cost /benefit analysis, and expert judgement to develop the scope of a project.

Product analysis is a technique for understanding the feature and function of a product list of techniques like 'value analysis' and 'quality function development' help the project manager gain more information regarding the project. By increasing his knowledge of the project's product, the project manager can define the scope of the project more precisely. A Cost/benefit analysis is necessary for studying the various tangible and intangible cost and benefits associated with the project. The project manager also consult expert to determine the scope of a project.

Scope of a project

The scope of a project can be divided into product scope and project scope product scope details all the function and features that are to be included in a product or service of a project. Project scope, however, detail the work to be done to deliver are required product with specific features. The tools and techniques for managing product scope vary with the nature of the project.

Drafting the project overview statement (POS)

The scope of a project is is documented in the "project overview statement". The project overview statement is also referred to as initial project definition, document of understanding, project scope statement for statement of work.

The project overview statement should be very specific. For example, "build a website like amazon.com," is not a scope statement because it does not provide guidance for building the site. A good scope statement would identify the goal of the project and describe how that goal can be achieved stop it should be express in a clear and precise manner so that all the project stakeholders understand what the project is all about. P o s should describe what the project is, why it is being taken up, and what value it brings to the farm. All future disease and regarding the execution of the project and allocation of necessary resource is based on the POS.

A project overview statement is not a static document. As the project progresses, it has to be revised or redefined. This is because overtime the situation may change and the POS should be documented accordingly. Depending on the circumstances, it can be modified or rewritten, taking into consideration the opinion of all the project stakeholders.The scope statements of large, technological projects often have to be modified because of the higher rate of technological changes. The POS should be e able to resolve any conflicts and misunderstanding that may arise among project members.

Parts of project overview statement
In general, the project overview statement consists of five parts;

1. Project problem /opportunity
2. project goal
3. project objectives
4. success criteria
5. assumption, risk and obstacles.

The POS first identifies the reason for undertaking the project, and then proceeds to identify the projects goal. the 'project goal' is further broken down into a number of project objectives. The POS also

mention the criteria for the success of the project and the various risk, obstacles involve in the execution of the project.

State the project problem /opportunity

The first part of a project overview statement States the problem or opportunities that the project is going to address. this statement need not to be defined rigidly. It should be written in such a way that all project stakeholders are able to understand it.

The gravity of the problem, or the business value of the opportunity stated in this part, will play a major role in getting the attention of the top management full stop some of the situations that give rise to the problems or opportunities is that forms the basis of POS are discussed below

Existing problem /opportunity area:the POS can address any of the problem that the farmer faces and offer afull or parcel solution to the problems. If there are any opportunities in the market, the POS should be explain how the farm can be take advantage of the situation.

Customer request: any of the request made by the farms internal or external customers can be mentioned in the the list of deliverable of a POS. The POS is thus a useful tool for forwarding customer request to top management.

Mandated requirement: A change in customer preferences all legal requirements may also make a farm take up a project. The POS describes how the farm is going to respond to this mandatory requirements.

Project goal

In the second part of the POS, the project goal is defined on the basis of the problem/ opportunity stated in the first part of the POS. A project should have a goal that can catch the attention of top management.

The project goal forms the purpose of the project and provides guidance to the entire project team. It helps everyone understand what the project is expected to accomplish. It is also a point of reference for clarifying questions that may arise about the scope of the project.The goal of the project should be stated clearly and precisely. Anyone who read it should be able to understand it without any additional explanation from the project manager. Technical jargon, if used, should be explained.

The goal statement should be specific and easy to remember. The firm should be in a position to implement every point mentioned in the statement. The goals statements to not mention any specific dates for starting or completing the project.

The goal statement should be 'SMART',

- where s represent specific (specific in addressing the purpose of the project)
- M represent measurable (measurable indicators of the project progress should be established)
- A represent assignable (assign label is a person to complete it)
- R represents realistic (States what can realistically be done with the available resources)
- T represent time relatedness (time required for completing the project)

Project objectives

The third parts of the POS define the objectives of the project stop and objective statement is more detailed version of the goal statement. These project objectives specified the exact boundaries of the project goal.

The project manager should ensure that the objective statement mention the following aspects of the project:

An Outcome: statement of what the project is going to achieve
A time period: the expected start and completion date
A measure: the parameters for measuring the project success.
An action plan: a plan for meeting the project's objectives.

Success criteria

The fourth part of the POS explains why the project is being taken up. it describes the business value of the project to the project farm and indicates when the project can be said to have successfully achieved its objectives. While preparing this part, the project manager should ensure that the the success criteria are quantifiable and measurable. The success criteria of a process can be: increase in revenue, increase in market capitalisation, etc. The success criteria should identify the exact benefits that the project can bring to the farm. Success criteria can also be presented in term of quantifiable statement like reduced turnaround time to service a customer, decreased error rates, etc.

Assumptions, risk and obstacles

The fifth section of the POS mentions all the organisational or environmental factors that may affect the outcome of the project. The project manager uses this section of the POS to alert senior management about the risk or obstacles that me influence the projects activities. These parts of the POS also mention the contingency plans to be prepared to reduce the impact of the above risks on the project.

Some aspects of projects that are risk prone are discussed below:

- **Technical aspects:** if the project farm does not have any experience in handling new technology, then the project manager should not choose technology related projects. Since it is difficult and manage technical process, non technical forms do not encourage search projects.
- **Environmental aspects:** to design a good POS, the project manager should understand the environment in which the project operates. Suppose the project sponsor suddenly leaves the project, the POS should solve this problem by recommending an alternative sponsor. It should also discuss how the right people can be acquired to work in crucial area of the project.
- **Interpersonal aspects:** good interpersonal relationships among process team members are essential for the success of any project. All interpersonal problems should be brought to the attention of top management.
- **Cultural aspect:** the POS should mention how the proposed project is suitable for the farm. If the project deliverable are completely different from what the farm is producing, then the project may not be accepted by the top management.
- **Casual relationship:** the solutions provided for correcting project problems depend on several assumptions. So, the project manager should mention the variables that are likely to affect the assumption made in the project.
  Attachment of POS
  Usually, project managers submit a POS that is only one page along. But top managers often request a more detailed POS that provides additional information about the business value of the project. Apart from the POS, top management usually request the project managers to

summit risk analysis and financial analysis reports. These reports help managers assess the economic value of the project.

Risk analysis

This report describes the various risk associated with proposed project activities, their probability of occurrence and there severity. Particularly, in highly technical project, the project managers should explain all the possible risks and their likely impact on the project results. Formal procedure should also be mentioned to effectively deal with these risks in the POS. This analysis also describes risk identification technique, risk qualification, and other risk control measures. The project managers also prepare a contingency plan for dealing with the risk. The top management of the farm analyses all this risks before accepting the project.

Financial analysis

The project manager also submits a financial analysis of the proposed project as an attachment to the POS. The following financial aspects of a project are analysed:

Feasibility analysis:

A feasibility analysis is conducted to ensure that the proposed project is financially viable. To do so, a project manager must;

1. Define the problem /opportunity clearly
2. define the scope of the project, what it includes and what it does not include
3. identify alternative solution for the problems
4. rank the alternative solutions
5. state the expected time and cost required
6. project the profit from the project
7. List the recommendations.

A thorough Examination of the solution and the various alternatives will help the project manager win the confidence of top management.

Return on investment:

The return on investment is the revenue likely to be generated over a life period of the project against the investment made into the project. Since return on investment is numerically expressed, it is easy for top management to identify the most profitable project.

Cost/ benefit analysis:

The cost benefit analysis explains the economic and social justification for the proposed project. But it is difficult to analyse project cost and benefits as some intangible benefit cannot be quantified.

Break even analysis

Through this analysis, the project manager determine when the project will arrive at a 'no profit -no loss situation'. Top management accept the project if the expected time for reaching a break- even situation is less than the 'threshold time' it has in mind.

APPROVAL OF POS

After preparing the POS, the project manager sends it to top management for approval. Top management exam means the proposed project to see if it adds any business value to the farm. The project manager can be ask some question by management regarding the content of the POS. for example, management may ask the project manager to expand or contract the scope of the project.

They can also question the validity of the financial analysis and ask the project manager to justify some of his statements. Depending on the explanation given by the project manager, management will decide if the project is worth undertaking. Approval of the POS indicates that

- Top management is interested in undertaking the project
- The client feels that the project has been understood and a satisfactory solution has been offered
- Top management feels that the project is well defined.
- Management may ask the project manager to identify the resources necessary for executing the project. Estimates of time and cost can be provided later by the project manager during the detailed planning stage.

Participants in the approval process

The project manager, project team members, project clients, top management of the farm and functional heads are the important participates in the project proposal process.

Project definition statement

The project definition statement (PDS) is similar to the POS, but the people who are involved in the preparation of the statement are different. When preparing the PDS, the project manager discuss with the the project team members, not the project client. However, the PDS has the same 5 parts structures as the POS: closest problem opportunity, project goal, project objectives, success criteria and assumption, risk and obstacles.

The PDS provide more detailed information about the project as it is used as a reference point by the project team for executing the process. The PDS keeps the entire project team moving in the right direction and also provides guidance to new project team members.

Unlike the POS, the PDS is circulated only among the members of the project in. As a result, technical jargon is used in the document. Scenes the POS does not the provide the level of detail required, PDS works as a more useful tool in project execution.

Scope verification

The project management body of knowledge (PMBOK) define scope verification as a process that formalized acceptance of the project scope by the project stakeholder. Here, the project manager reviews the fully or partially completed deliverable to ensure that they have been completed as per the specification. the document that describe the projects products or services are also reviewed by the project manager during scope verification phase.

The project manager also examines the test and project process and product to assess their conformity to project requirements. The project can formally be said to have started only after scope verification full stop the formal acceptance of a project and its deliverables is then distributed to the concerned party.

Scope change control

Scope change control is the process of controlling the changes in the project that ok occur at various stages of product life cycle full stop change control involves

- Managing the factors that scope changes to see that changes are advantageous to the project.

- Identifying the changes in the scope.
  Scope change control must be integrated with other control processes (time control, cost control, etc). Project manager use information collected from various documents to control scope changes. They are output of work breakdown structure WBS performance report and change request.

UNIT 2

IDENTIFYING PROJECT ACTIVITIES

Learning objective of this chapter
- **Activity definition**
- **Work breakdown structure (WBS)**
- **developing a WBS**
- **test for completeness of decomposition of activities**
- **approaches to defining deliverables in the WBC**
- **representing the WBS**

INTRODUCTION

Identify project activity is an important step in the project planning phase after the project scope statements has been defined. The work breakdown structure WBS is an useful tool for the project managers in identifying the project activities. It illustrate how is activities of the project contribute to the whole project in term of budget, schedule and performance. It also list the vendor/subcontractors associated with specific activities of the project software package like Microsoft project generate the wbs automatically.

ACTIVITY DEFINITION

An activity is an element of work performed during the course of a project. A project involves a number of interrelated activities. In general, activities share the following characteristic:

- Activities is of a definite duration
- Each activity use resources such as people, materials for facilities
- Each activity has a cost associated with it.

A project consists of a series of activities. and reactivity of the project has an activity that goes before it, and sometimes goats and activity that must be completed immediately before the start of another activity is called a predecessors activities. An activity that immediately succeeds underactivity and which cannot be started until the earlier one has been completed, is called a successor activity. Two activities which are taken up at the same time are called concurrent activities.

Activity definition involves identification of specific activities that must be performed in order to produce product deliverables.
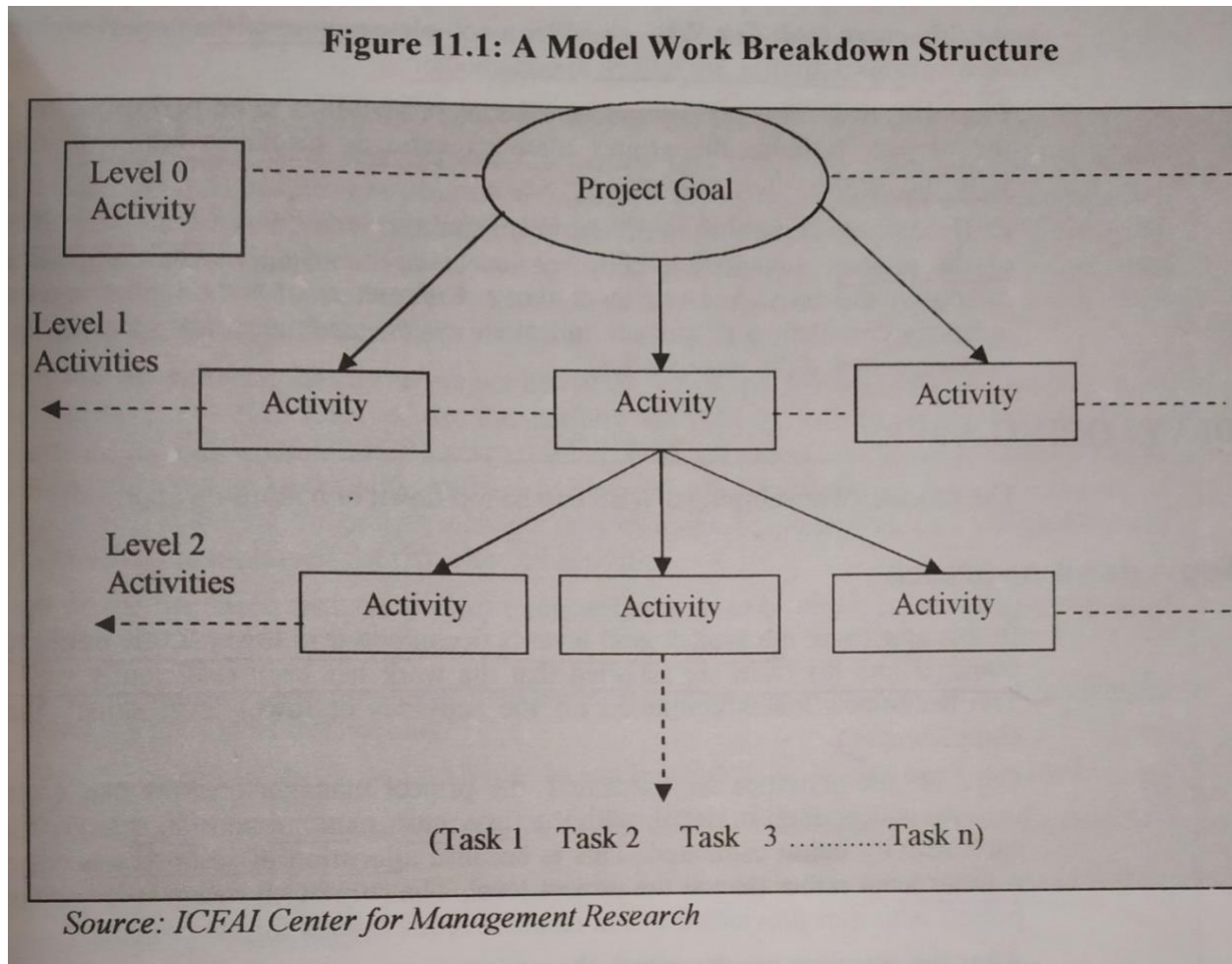
WORK BREAKDOWN STRUCTURE (WBS)

The project management body of knowledge PMBOK define work breakdown structure as a deliverable oriented grouping of project activities that organise and define the total scope of the project l. A deliverable is any miserable,tangible, verifiable outcome or result that must be produced to complete a project or part of a project.

The WBS helps the project manager to ensure:

- That the project includes all the activities needed

- That project includes no unnecessary activities

The breaking down of work into hierarchy of activitiesand task is called decomposition. The project goal statement is shown at the top of the WBS as a level zero activity. This level 0 activity is is decomposed into level 1 activities done completion of all level 1 activities means completion of level 0 activity. Similarly an activity at level n is said to be completed when its decomposed activities at level n + 1 are completed. The decomposition process make it easy for the project manager to estimate the duration of the activity, the resource required and the cost incurred. The decomposition is done to such an extent that each lower activity should satisfy the test of completeness.

Figure 11.1: A Model Work Breakdown Structure

Level 0 Activity — Project Goal

Level 1 Activities — Activity, Activity, Activity

Level 2 Activities — Activity, Activity, Activity

(Task 1 Task 2 Task 3 ....Task n)

Source: ICFAI Center for Management Research

Factors considered in developing a WBS

The project manager must keep in mind the following issues while designing a WBS:

- Every activity in the wbs should produce a single tangible deliverables
- Every activity at any level of the wbs is and aggregation of all its subordinate activities listed immediately below it
- Each activity should be unique and distinct from other activities of the project.
- The activity should be decomposed logically from higher level to lower levels.
- There should be some flexibility in the wbs development process,wbs might be updated when the project scope changes.

- The WPS must specify the important reporting point (example review meeting, monthly reports, test reports etc.) The activities should be compatible with organisational and accounting structures.

The uses of WBS are given below:

Thought process tool: The WBS improves the thought process of the project manager and his team by designing the entire project in a structured manner. it helps them to see how the project work can be defined and managed.

Architecture tool: The WBS provides a complete picture of the project and represents how various activities are related to one another.

Planning tool: The WBS provides the a series of activities to be performed to complete the project. It helps you the project manager estimate resources required and build a schedule for the whole project.

Project status reporting tool: The WBS can also be used as a tool to report the status of the project. Completion of lower level activity implies the completion of the the corresponding activity at one level above. Completion of some higher level activities indicates completion of project milestone events and these are reported to the top management and the project client.

DEVELOPING A WBS

The process of developing of wbs can be top -down and bottom- up approach.

Top -down approach

In this approach, the project gold label is decomposed to lower level until the project manager and his team are satisfied that the work has been sufficient well defined. The decomposition is continued till the activities of lower level satisfy the taste of completeness.

Once all the activities are identified, the project manager ensure that each project activity describe in detail, with the time, cost, material and labour requirements for each activity being estimated. this is because allocation of resources is easier at the the activity level rather than at the project level. the sum of all the resources allocated for all project activities provides the total resource requirements for the project.

After the activities are described, the project manager put them in sequence, so that a schedule can be drawn up for the entire project. The project manager analyses the dependencies among the various project activities to see how many of the activities can be taken up simultaneously. If sum of the activities can be carried out simultaneously it reduces the total project duration.

Bottom -up approach

Here, as in top down approach, the entire planning team prepares the first level breakdown. Then the team is divided into as many groups as there are level 1 activities. Each group makes a list of of all the activities that must be completed to complete one "level 1 activity". This is done by getting group

members to identify different activities and present this to the group. every activity that the group think is appropriate, is put down on a slip of paper. Once all the ideas are exhausted, related activities are are grouped together and the final list is submitted to the planning team. The planning team prepares the final work breakdown structure beira moving redundant activities and adding missing activities. The drawback in this approach is used that the activities are not defined properly.

TEST FOR COMPLETENESS OF DECOMPOSITION OF ACTIVITIES

Repairing an appropriate wbs is of critical importance in planning the project. The project manager should ensure that known unnecessary activities is is included in the wbs and that all the activities that are necessary to meet the ultimate project goals are included.

The decomposition of the project activity should be continue till all the lower level project activities fulfil the following condition

1. The activity must be measurable
2. It must have clearly defined start/end events
3. It must have a clear deliverables
4. The time /cost of the activity must be measurable
5. The duration of the activity must be in acceptable limits
6. The activity must be independent

If any activity does not satisfy all the six condition, it should be further decomposed.

APPROACHES TO DEFINING DELIVERABLES IN THE WBS

There are several approaches to defining the deliverables and building the wbs for a project. The three main type of approaches are:

1. Noun -type approaches
2. Verb -types approaches
3. Organisational approaches

Noun -type approaches

There are two types of noun type approaches use in developing a wbs. They are

- **Physical decomposition:** in this approach, the deliverables of the project work are define in term of physical components that make up the deliverable. For example, in a project for manufacturing a lathe machine, the project will involve the manufacture a physical component like gears, gear belts, motors machine base, fixtures, supporting blocks, shafts, cutting tools and dimension scales. All this component adds to be produced to make the end product and the WBS will represent manufacture of all the above physical components.
- **Functional decomposition:** in the functional noun type approach, the same cutting machine project is built on the functional requirement of the machine like manufacturing of gear system, conveyor system, motor system, work peace rotating system and dimension checking system. The WBS list functions to be performed to produce the end product.

The verb type approach defines the project deliverables in terms of the actions to be perform to produce them. There are two type of verb type approaches:

- Design- build- test- implement approach: assume a project that has to produce and innovative cutting machine. Here, all the features are to be added to the current cutting machine are designed, built, tested and implemented.
- Objective approach: the project manager reports completion of project activity on the basis of attainment of some project objectives. The objective approach is similar to the design-build-test- implementation approach and is used when progress reports are to be prepared at various stages of the project. Clear cut objectives are sets for each activity and the progress in meeting this objectives is measured. But setting objectives and measuring their completion level is difficult

Organisational approaches define project deliverables in terms of organisational units. Geographical, departmental, and business functional approaches are the important organisational approaches.

Geographical approach

If the the closet is dispersed geographically, then the project work is partitioned geographically.

Departmental approach

In the departmental approach, the project work is first divided department wise. Any other approach can be used later in each department. Complex project undertaken by a single farm usually follow the departmental approach at the earlier stages. Resource allocation become simpler this way, at each department will take care of the work assigned to it.
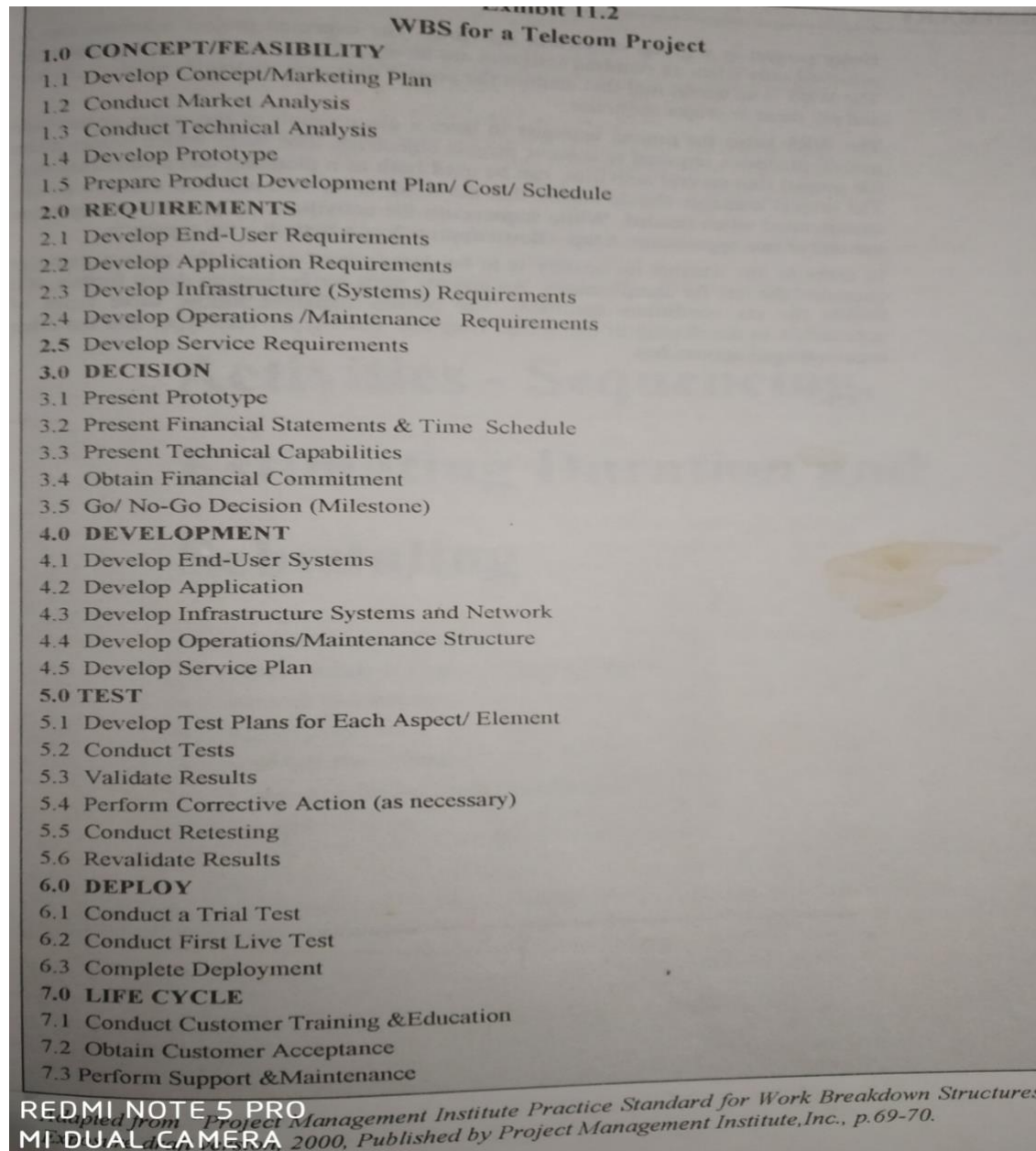
Business functional approach

According to this approach, the project work is divided based on business functional areas. The project work is divided into several business processes and an appropriate approach is followed for each process later. This approach has uses that of departmental approach, but the difficulty in this process lie in integrating all the deliverables from various processes.

REPRESENTING THE WORK BREAKDOWN STRUCTURE (WBS)

Work breakdown structure can be represented in different ways. what ever the structured type, the project goal that States the States the purpose of the project has to be written at the top. Then it is divided into various activities, called level 1 activities. The activities that do not satisfy the test for completeness are further divided into several activities again and D are called level 2 activities. The process is continued all the activities satisfy 6 criteria for completion com describe earlier.

Whatever is the type used for representation, the main issue in representing the WBS is to know whether the work required to achieve the desired outcome and meet the project objectives has been

captured in enough detail to identify the resources, assign the responsibilities, and the activities in sequence.

Exhibit 11.2
WBS for a Telecom Project

1.0 CONCEPT/FEASIBILITY
1.1 Develop Concept/Marketing Plan
1.2 Conduct Market Analysis
1.3 Conduct Technical Analysis
1.4 Develop Prototype
1.5 Prepare Product Development Plan/ Cost/ Schedule

2.0 REQUIREMENTS
2.1 Develop End-User Requirements
2.2 Develop Application Requirements
2.3 Develop Infrastructure (Systems) Requirements
2.4 Develop Operations /Maintenance Requirements
2.5 Develop Service Requirements

3.0 DECISION
3.1 Present Prototype
3.2 Present Financial Statements & Time Schedule
3.3 Present Technical Capabilities
3.4 Obtain Financial Commitment
3.5 Go/ No-Go Decision (Milestone)

4.0 DEVELOPMENT
4.1 Develop End-User Systems
4.2 Develop Application
4.3 Develop Infrastructure Systems and Network
4.4 Develop Operations/Maintenance Structure
4.5 Develop Service Plan

5.0 TEST
5.1 Develop Test Plans for Each Aspect/ Element
5.2 Conduct Tests
5.3 Validate Results
5.4 Perform Corrective Action (as necessary)
5.5 Conduct Retesting
5.6 Revalidate Results

6.0 DEPLOY
6.1 Conduct a Trial Test
6.2 Conduct First Live Test
6.3 Complete Deployment

7.0 LIFE CYCLE
7.1 Conduct Customer Training &Education
7.2 Obtain Customer Acceptance
7.3 Perform Support &Maintenance

Adapted from *Project Management Institute Practice Standard for Work Breakdown Structures* 2000, Published by Project Management Institute,Inc., p.69-70.

UNIT 3

ACTIVITIES-SEQUENCING, ESTIMATING DURATION AND SCHEDULING

Learning objective of this chapter
- **Fundamentals of project network diagram**
- **Activity sequencing**
- **Activity duration**
- **Schedule development**
- **Techniques for schedule development**
- **Schedule control**

After the project activities are identified they are represented in a project network diagram. The project manager sequences the project activities, estimates the duration and then schedules the activities. The project manager sequences the project activities by understanding the dependencies among them. He prepared the duration estimate of each project activity with the help of duration estimates from other projects historical information, expert advice, etc.

The project manager schedules the project activities to estimate the start and finish dates of each project activity, to arrive at the duration of the project. He can take help from two important technique to schedule the project:

- Program evaluation and review technique (PERT)
- Critical path method (CPM)

FUNDAMENTALS OF PROJECT NETWORK DIAGRAMS

According to the project management body of knowledge PMBOK, a project network diagram is a a schematic representation of the project activities and the logical relationship (dependencies) among them. The diagram helps the project manager in sequencing, scheduling and controlling the project. The diagram represents all the project activities, the sequence in which they have to be performed, the duration of each activity, the interdependencies among various activities and the criticality (significance) of each activity.

The project network diagram helps the project manager in project planning by detailing the project activities, estimating the required resources, and displaying the interrelationship among activities. The diagram helps to determine the start and end dates of each activity during scheduling an it also provides insights into possible trade off while controlling the project.

A good project network diagram should answer the following question:

- What is the estimated completion time of a project?
- How does a delay in an activity affect the expected completion time?
- How can be expected completion time of a project be reduced, if additional resources are available?

The project network diagram is represented by a series of activities and nodes. An activity is a specific task or operation required to do a project. it is depicted by an arrow. A node (also called an event), is a time oriented reference point that signifies the start or end of an activity. it is represented by a circle.

The difference between an activity and a node is that the activity represent the passage of time and the notes are points in time that denote the starting for ending of a specific activity. In the diagram activity a is represented with I and j as the starting and ending nodes. The activity can also be written as I-j. Event I is called the tail event hand event j is called the head event.

Dummy activity: an activity of zero duration that is used to represent the logical relationship in the network diagram is called a dummy activity. Dummy Activities do not consume any resources,
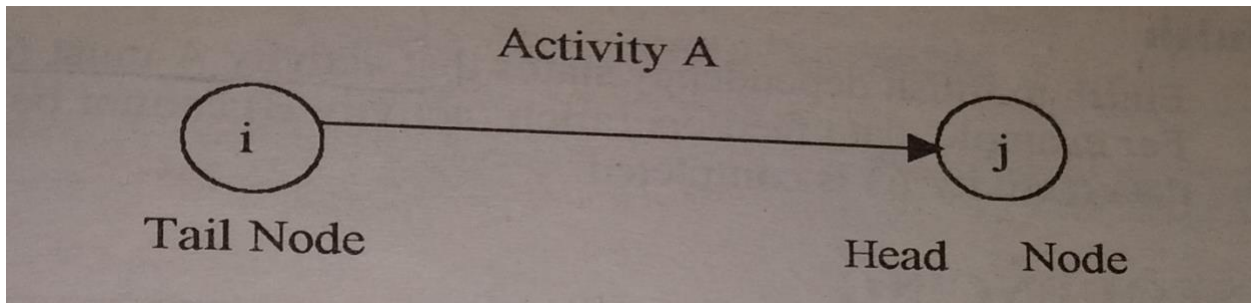
but are used to maintain the proper process relationship between the activities that are not connected by the nodes. It is represented by a dash line headed by an arrow.
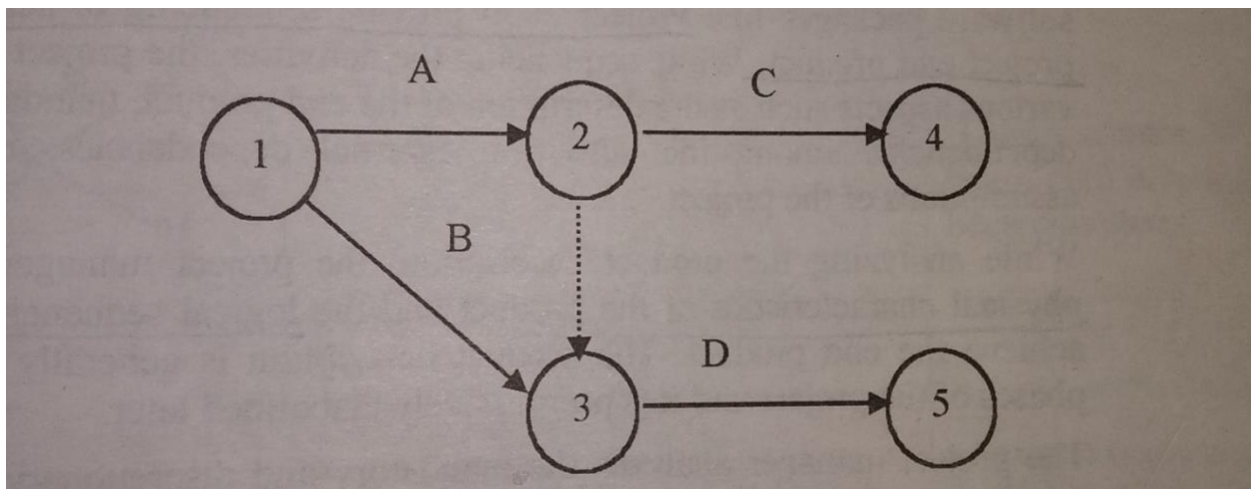
For example, in a project, A and B are concurrent activities. Activity C is dependent on A and activity D is dependent on both A and B. Then the project manager uses are dummy activity X to represent the relationship between activity A and activity D.

Dependencies in the project network diagram

Dependency is a relationship that exists between a pair of activities full stop there are four types of activity dependencies that describe the relationship between any pair of activities. They are : finish to start , start to start , start to finish and finish to finish.

Finish to start dependency states that activity A must be completed before activity B can begin. If activity A is obtaining raw material and activity B is inspecting the raw material, then activity B can be performed only after the completion of activity A. Therefore, the dependency is finished to start.

Start to start

Start to start dependency state that activity B can be started only if activity A has begun. This can be explained with the help of the previous example- that is the inspection activity can be started and continue once the raw materials start coming. Subsequently both activities go on in parallel.

Start to finish

Start to finish dependency Steel that activity B must start before activity A finish. For example, if a firm wants to develop a new information system to replace the existing one, the farm has to confirm that the new system is well operating. When the new system starts to work (activity A), the existing system can be discontinue (activity B).

Finish to finish

Finish to finish dependency state that activity A must finish before activity B finishes. For example, data feed operation (activity B) cannot be finished until the collection of data (activity A) is completed.

ACTIVITY SEQUENCING

Once the project activities are identified using the work breakdown structure, the project manager prepares and activity list of the project. He puts All the activities down in a logical sequence to arrive at the project end product.While sequencing the activities, the project manager has to study respected such as the description of the end product, mandatory and discretionary dependencies among the activities, external dependencies, other constants and assumption of the project.

While analysing the product description, the project manager has to consider the physical characteristic of the product and the logical sequencing of the activity to achieve the end product. The product description is generally less determined in early phase of the project and it is progressive we celebrated later.

The project manager analysis the mandatory and discretionary dependencies among the various project activities. Mandatory dependencies are those that are inherent in the nature of project. Clear the dependency between activities is certain. For example, new machinery is erected only when the layout has been finalized. Therefore the dependencies of the project that are defined by the project team. This dependency is also called as 'preferred logic'.

Methods of activity sequencing

The project manager considers all the above issues to sequence the project activities the project manager sequences all the present activities in an appropriate manner and represent them in the project network diagram. Some of the methods of activity sequencing are given below.

Arrow diagram method (ADM)

This method comedy network diagram is constructed using a arrow to represent the activities and connecting them at notes to show the dependencies. This method uses finish to start dependencies only to explain the logicalrelationships. This is also called Activity- on –Arrow (AOA) method.

Precedencediagram method (PDM)

In this method, network diagram is constructed using nodes to represent the activities and connecting them with arrows to represent the dependencies. This method used all four types of dependencies. This method is also called as Activity-on-Node (AON) method.

Conditional diagramming methods

The project manager also uses conditional diagramming method like GERT (graphical evaluation and review technique) And system dynamics that represent non sequential activities like loops (where activities are repeated again and again)or conditional branches (example a update is required only when errors are found in the inspection). PDM and ADM can not represent looks and conditional branches.

Figure 12.1: ADM Vs. PDM
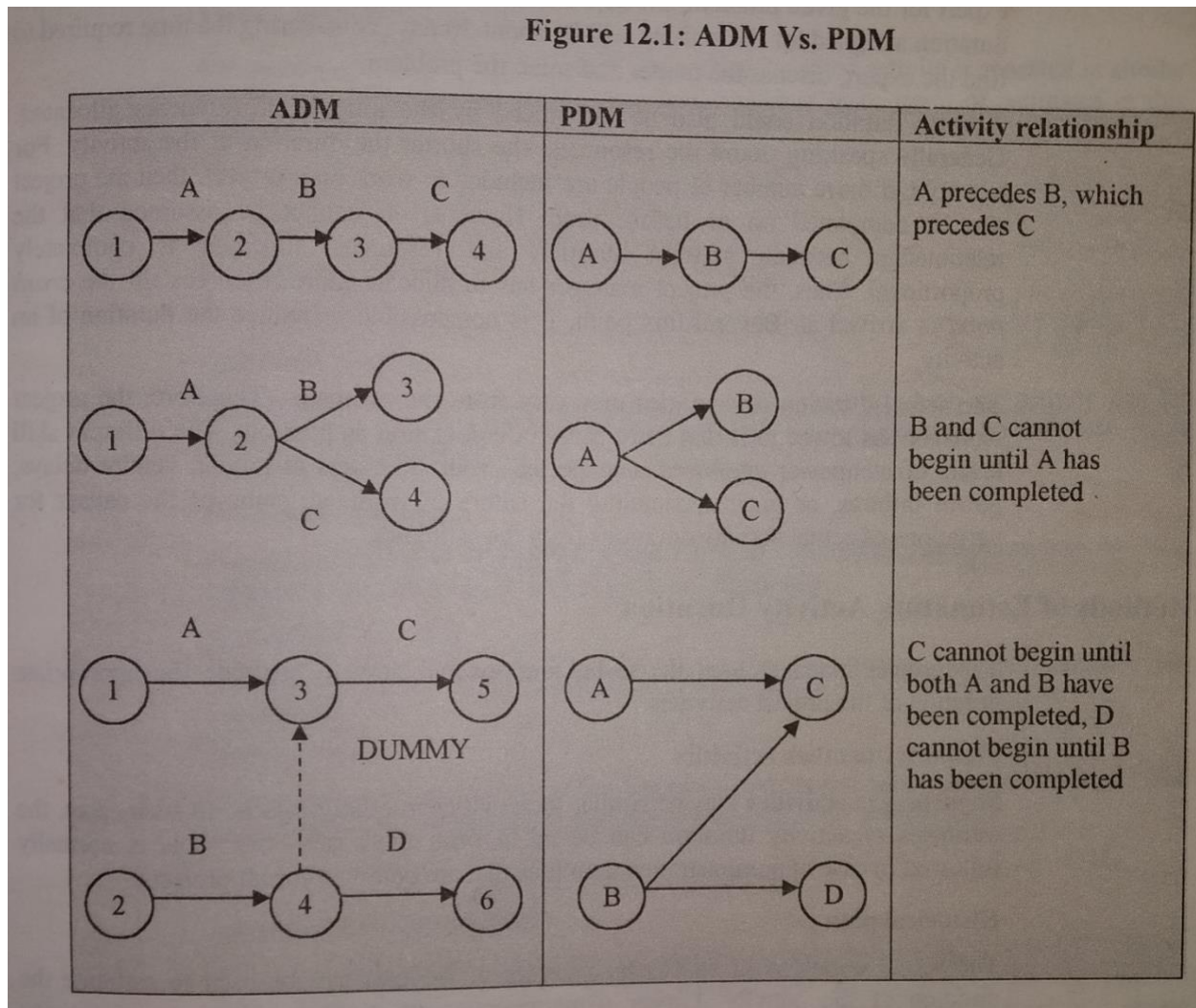
ACTIVITY DURATION

After the project activities are sequenced, the project manager estimate the duration of each activity to calculate the duration of the entire project. The duration of activities is the time period required to complete the activity. As it is not possible for a person to work continuously, the project manager may

include sometime allowance while estimating activity duration. He assigns these allowances based on his experience, the difficulty involved in the activity, the ability of the workman to execute it, etc. It is assumed that an average performer completes an activity in the estimated duration with his normal performance.

The actual duration of activities may vary from the estimates. therefore, the project manager has to see to it that there is as little division as possible. The different skill level of manpower employed, unexpected events like acts of nature, vendor delays, power failures, or misunderstandings the nature of work are some of the causes for variation of actual activity duration from the estimates.

Methods of estimating activity duration
The project manager uses the techniques given below to estimate the appropriate duration of the project activities.

Similarity to other activities
Some project activities may be similar to activities in other projects. In such case, the estimates of activity duration can be taken from those activities. This is normally followed in case of administration activities that are common for projects.

Historical data
The actual durations of successful projects in the past can be used to estimate the duration of the activity. Larger firms maintain an extensive database of activity duration history that records the estimating windows time, actual time, reason for time overrun (if there was one), characteristics of the activity, the skill level of the people, etc. When firms wish to assign duration estimation, they refer to historical data and find the duration estimate an actual time.

Expert advice
In case of highly technical activities, the project manager can consult a technical expert the activity duration. He can also consider the advice of vendors and other non-completing firms to assign the duration estimates.

Delphi method
In this method, the project manager forms a group of people and ask them to estimate the duration of an activity, after describing the natural and characteristics of the activity. The estimates of each participant are then collected.those participants whose estimation are very high or very low are asked to explain the reason for their estimates.

The project manager then discuss with all the group members to know why there estimates are higher or lower estimates of the other participants. He then ask the participants to write the new estimate of duration after the discussion full stop this process continue until the entire group arrives at a particular estimate. In general, this method is followed when expert advice is not available.

Three-point method

The duration of an activity may vary even when the same activity is repeated in similar condition. Therefore the project manager considered three types of estimate in this method they are:
- optimistic time

- pessimistic time
- most likely time

Optimistic time t0

Optimistic time is the minimum amount of time within which an activity can be completed full stop it is possible to complete an activity within the optimistic time only when the external environment is extremely favorable.

Pessimistic Time tp

Pessimistic time is the maximum amount of time required to complete an activity. This happen, when the external environment is unfavorable.

Most likely time tm

It is the time that is the best guess for an activity completion- neither optimistic nor pessimistic.

Expected time

the project manager arrives at the expected time based on the above estimates full stop the project manager calculate the estimate of duration of an activities as,

t=(t0 + 4tm + tp) / 6
Wide band Delphi method

A combination of Delphi method and the three point method is referred to as the wide band Delphi method. In this method, the members are asked to give an optimistic time, a pessimistic time, and the most probable time, instant of a single estimate. then the project manager follow the Delphi method and determine the duration estimate.

Schedule development
Schedule development is concerned with determine realistic start and finish time for project activities. It aims to maths project resources like machinery, material and labour with project activities overtime. Scheduling eliminates production problem, facilitates timely procurement of raw materials, and institute project complication on time.otherwise, it may lead to release in project activity, loss of inventory and cost overrun.

The project manager should be aware of the resources and the quantity of this resources needed at every stage of the project. He has to prepare a resource pool description that contains detail of all the project resources and their allocation to project activities.

The project manager prepares to type of calendar; project calendars and resource calendars to schedule the project. Project calendars emphasize the completion time of the project activities. Suppose it is estimated that the the project is to be completed in 7200 hours in normal working condition. Then schedules are prepared based on the time estimated. The project manager assume that 60% of the

project is accomplished, if 4320 hours are spent on the project. Most of the projects are scheduled based on project calendars.

Resource calendars schedule the project on the basis of the resources used. The focus here is on scheduling and utilizing specific resources effectively. For example, a construction project requires 1200 bags of cement. If 360 bags have been used, the project manager can assume that 30% of the work has been done. Here, the project manager concentrates on whether the specific resources are being used effectively or not. Project calendars are concerned with how various project resources are consumed over a period of time. Resource calendars deal with how a specific resource or specific category of resources is spent over a period of time.

TECHNIQUES FOR SCHEDULE DEVELOPMENT

The project manager can use some of the following method for schedule development;

- Critical Path Method (CMP)
- Program Evaluation and Review Technique (PERT)
- Graphical Evaluation and Review Technique

These methods are used:

- To estimate the completion time of the project
- To find out if the project is behind, ahead of or on schedule.
- To compare the actual resources spent which the planned resources at any stage of the project.
- To study activities that are critical for project completion and activities that can be delayed without delaying project completion.

   The project network diagram is used in schedule development.

PERT (Program Evaluation and Review Technique)

PERT (Program Evaluation and Review Technique) is a graphical scheduling tools to show the project's timeline. It was first developed by the United States Navy for the Polaris submarine missile program in the 1950s. Through the use of PERT the Project was finished 2 years in advance and this showed the importance of this scheduling technique. Afterwards it kept on being used in other fields thanks to its excellent productiveness. PERT started being used in the army industries, governmental institutions and private industries. Only during the 60s this technique became public and started spreading in various fields. Through PERT is possible to keep under control the project's activities using the visual representation that keeps in mind the interdependencies among the activities that are necessary to the conclusion of the project. This tool doesn't schedule the activities (as Gantt diagram) because the activities are considered with unlimited availability. In this context activities have only independencies and this means that some of them can only come after the completion of others. PERT is one tool that saves up in average 20% of the duration of the project as well as its cost.

The PERT diagram is formed by:

- **Activities**: they represent the tasks to be completed. They should include a description and the expected duration. The key activities that are essential for the project and that can be considered as intermediate finish line are named milestone.
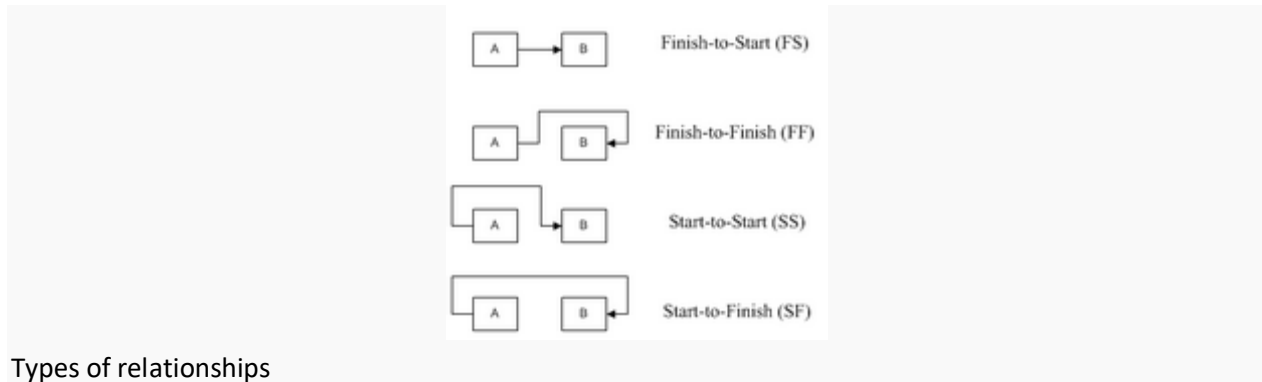
Types of relationships

- **Connections (or constraints)**: they show the existing relation between the activities that can be FINISH-START, FINISH-FINISH, START-START and START-FINISH.

  - FINISH-TO-START: the start of the successor task depends upon the completion of the processor's work.
  - FINISH-TO-FINISH: the completion of the next task depends upon the completion of the predecessor's task.
  - START-TO-START: the start of the successor task depends upon the initiation of the processor's work.
  - START-TO-FINISH: the completion of the next task depends upon the start of the predecessor's task.

- **Preset Date**: Some activities can have a significant impact on the critical path and their deadline becomes a sort of constraint. For this reason some of them have a prefixed date and cannot be run before that date or not after that date and so on.
- **Calendar**: PERT diagram needs to specify working ways, weekend days, holidays and so on to calculate in the exact timetable.
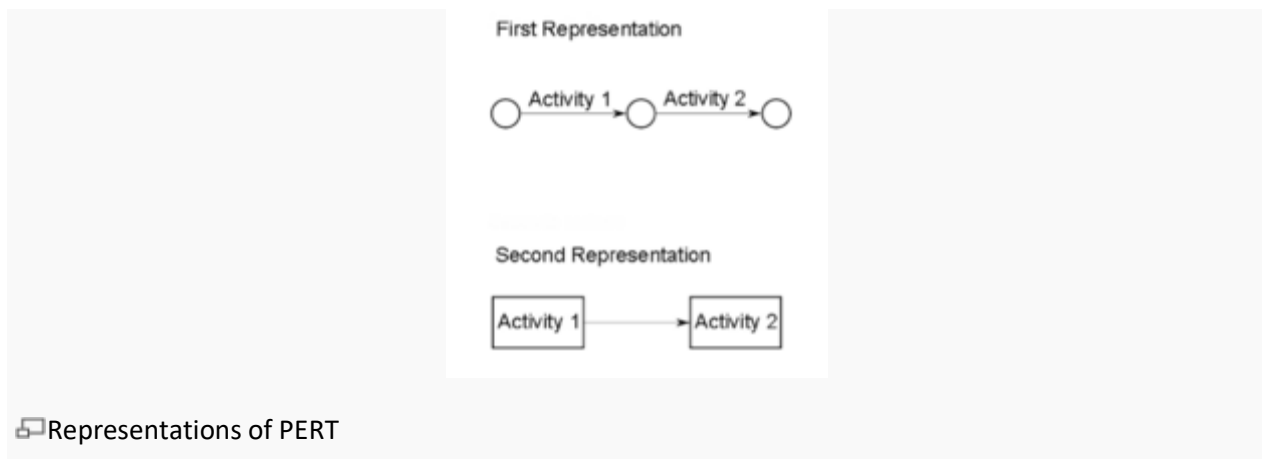
Representations of PERT

The first method AOA (activity on arrow) represents the activities through arrows and the starting event and the end event are represented by the nodes. This was the first representation of PERT and it shows exactly the network but it's difficult to use because it implies the use of "fake" activities to be able to show all the links between the various activities.

The second method AON (activity on node) to represent PERT uses rectangles to show the activities and the constraints between the activities are shown by arrows. This system is easier and is called "Precedence representation". Through this representation is possible to show all the constraints without adding extra "fake" activities.

In PERT diagram is fundamental to calculate the times for each activity that are going to be calculated through two steps, one onward and the other one backward. After is known the network between the activities and their duration, the PERT diagram can be started. The times that are going to be calculated are: The early start time (ES) The early finish time (EF) The late start time (LS) The late finish time (LF)

Time estimations

So far in PERT was used a fixed time for each activities. In reality it is more realistic to have three different time estimations such as optimistic time (O), Medium time (M) and Pessimistic Time (P). Through this it is possible to calculate the **expected time (TE)** for each activity.

$$TE = \frac{O + 4M + P}{6}$$

$$Variance = \frac{(P-O)^2}{36}$$

$$StandardDeviation = \sqrt{Variance}$$
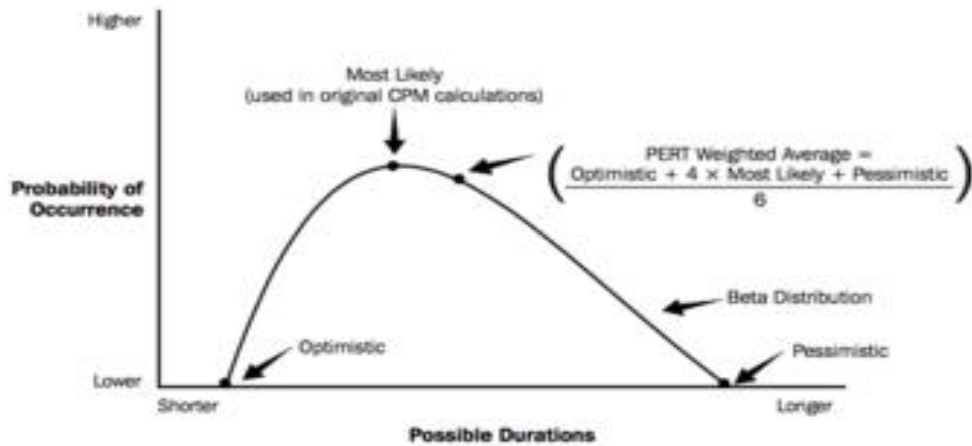
BETA distribution in PERT

The best way to represent PERT is the BETA distribution, seen on, that is a smooth curve. It uses three parameters that in this context are Optimistic time, Medium time and Pessimistic time. The peak on top of the graph is the most accurate estimation of the duration of the project. Calculating the Time Estimation (TE) for the various activities is an interesting way to have a more precise idea of the credible duration of the project. In addition to this, it is interesting to calculate the **variance** of each task. Through the variance it's possible to calculate the **standard deviation** (square root of the variance) to identify how much the project could be postponed or anticipated according to the esteem.

Activity	Optimal Time (weeks)	Medium Time (weeks)	Pessimistic Time (weeks)	Estimated Time (weeks)	Variance (weeks)
A	1	2	3	2	0.11
B	2	3	4	3	0.11
C	1	2	3	2	0.11
D	2	4	6	4	0.44
E	1	4	7	4	1
F	1	2	9	3	1.78

G	3	4	11	5	1.78
H	1	2	3	2	0.11

If for example the Critical Path is A-C-E-G-H it can be calculated its cumulative variance.

$$Variance(ACEGH) = 0.11 + 0.11 + 1 + 1.78 + 0.11 = 3.11$$

$$StandardDeviation(ACEGH) = \sqrt{3.11} = +/-1.78 weeks$$

This means that the project could finish earlier or later than the expected day. The delay or the advance should stay within 1.78 weeks according to the esteem.

Step by step to construct a PERT Diagram

STEP 1 – Arranging the activities

Arranging the network of the various activities and entering the Activity Name and Duration.

STEP 2 – Going onward (from the start to the end)

Calculate the Early Start (ES) and Early Finish (EF) of every activity. The last activity, through its EF, will show the total duration of the project. The first activity will have 0 as ES and EF as its duration. The next activity will have ES as the previous activity's EF. In case one activities has more than one previous activity who's dependent with, its ES is the latest EF. It makes sense because this activity cannot start before the previous ones are finished.

STEP 3 – Going backward (from the end to the start)

This step is fundamental to see if there's some possible slacks without delaying the whole project and which is the critical path. The last activity has LF=EF and LS=ES. The previous activity have LF as the next activity LS. In case an activity has more than one following activities the LF has to be taken is the worst (higher). LS is then calculated as LF – duration.

STEP 4 – Calculating the slack

Once all the ES,EF,LS,LF are completed it could be calculated the Slack. Slack = LS – ES = LF – EF In case the slack is more than 0 it means that that activity can be delayed the amount of time of the slack

without delaying the whole project. If the slack is equal to zero it means that that's a critical activity that if is delayed the whole project will be done after the deadline.

CPM (Critical Path Method)

The CPM was created in 1957 from the DuPunt Company to have a specific scheduling tool able to improve the planning and the development of projects. It's a technique that is used to identify, within a network of activities, the activities that are critical for the completion of the project. In other words **the critical activities are the ones that if delayed, they delay the whole project.**

CRITICAL ACTIVITY has SLACK=O

The goal of the CPM is to optimize the tradeoff between time (project length) and costs. It identifies the point where the costs are minimal according to the optimal time. This technique was used in the chemical factory of Louisville, Kentucky, and the time was reduced by 37%. This big success of CPM started spreading this technique in various field and in the whole economic world.

To create a CPM diagram the following elements are needed:

- List of the activities that are needed to complete the project
- Duration of each activity
- Dependencies between the activities.

As it can be noticed the same elements are needed to create PERT. For this reason most of the time, both PERT and CPM are created simultaneously. Indeed most of the time the use of both tools is called PERT/CPM.

Trade off between costs and time
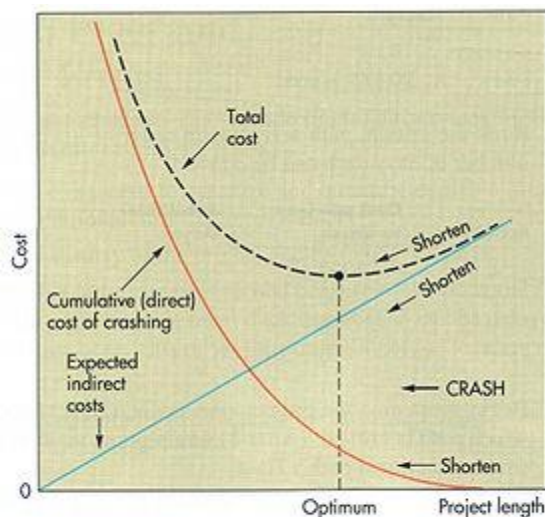
* Crashing activities reduce indirect project costs and increase direct costs; the optimum amount of crashing results in minimizing the sum of these two types of costs.

Tradeoff Costs-Time

Figure shows the tradeoff graph between costs and time. If the project has to be completed in a really short time the total cost (dotted line) is extremely high whereas if there is more time to finish the project the cost decreases (see dotted line). On the other hand if the project delays and for example it finished afterwards the deadline there are going to be penalties. Indeed the total cost line increases again. The dotted line is the sum of direct costs and indirect costs.

TOTAL COST = DIRECT COSTS + INDIRECT COSTS

Direct costs are all the expenses for the activities directly connected to the project. Some examples of direct costs are:

- Employees and workers salaries that work within the project
- Materials
- Outsourcing activities
- Software
- Machineries

Indirect costs are the expensed for the activities that sustain the project and are essential for its development. Some examples of indirect costs are:

- Salaries of the administration employees
- Salary of Top Management
- Costs of commercial activities

To sum up CPM is extremely important to understand the strong link between costs and time. Through this tool is possible to prevent extra crashing costs due to delays and to estimate the most realistic length of a project.

The estimated time length of the project (as showed above) is: estimated deadline +/- Standard Deviation of the Critical Path.

Differences between PERT and CPM

	PROS	CONS
PERT	- Smart tool for projects with high number of activities, data and dependencies. - It shows dependencies between the activities.	- Longer time to develop - Not readable from everyone. (experts only) - It facilitates the identification of the critical path and makes it visible. - The lack of a timeframe makes it harder to show the development status.

CPM	▪ Identifying critical activities is fundamental to be aware of possible delays. TIME=MONEY. This tool is really useful for planners to forecast the length of the project taking into account that critical activities could delay it. ▪ It makes dependencies visible.	▪ For large projects it's difficult to handle the dependencies and calculating the slack. In this case it is possible to use software that calculates everything. ▪ It does not account for resource and resource allocation.

GRAPHICAL EVALUATION AND REVIEW TECHNIQUE (GERT)

Graphical Evaluation and Review Technique is similar to PERT, except that it allows multiple project activities by the way of looping and branching project activities. Support an activity fails due to some unavoidable reasons, and then the project manager has to look for alternative ways to obtain the end result.

Similarly, some of the activities may not be carried out at all, some may be partially carried out and some that may be repeated. PERT cannot show alternative plans in a single network diagram. GERT overcomes this problems at it shows alternative ways to continue the project.

Duration compression techniques

When the project manager finds that the expected completion time of the project is more than the desired time, he attempt to reduce the project duration using some duration compression techniques like crashing, fast tracking, etc.

Crashing
Crashing refers to decreasing the total project duration after analyzing a number of alternatives to determine how to get the maximum duration compression for the least resources, subcontracting some activities, using more labor, etc. The project manager considered the time-cost trade offs for the critical activities of the project as they play a major role in the deciding the project completion time.

Some people argue that crashing may decrease the quality of a project. As all project activities cannot be completed just by adding more resources, the project manager should ensure that the quality of the project end product does not suffer as a result of crashing. Activities like planning and inspection are not crashing, in general, because they have an effect on the quality of the project output.

- A critical activity of the project.
- An activity of longer duration.
- An activity that has low per unit cash cost.
- An activity that does not cause any quality problems, if crashed
- An activity that is labor intensive.

The crashing procedure is explained below:

- Identify the sequence of activities and prepare a network diagram. Each activity should list the details of normal cost, normal time, crash cost and crash time.
- Compute the critical path of the project network.
- Calculate the crashing cost for all project activities using the formula,

(Crash course – Normal cost)
(Normal time – Crash time)

- Rank all the project activities in the ascending order of their crashing cost.
- Cash a critical activity that has the least crashing cost and calculate the new cost by adding the cost of crashing to the normal cost.
- When the critical path duration is reduced by crashing, other paths may also become critical. These are called parallel critical paths. So the project duration can be reduced by crashing the activities of activities in the parallel critical paths simultaneously.
- The crashing process is continued till further crashing is not possible or it does not result in the reduction of product duration.
- For different project duration, the total cost is found. The optimal project duration is found by the project duration corresponding to the minimal total cost.

Illustration

The normal costs and cash cost, and the normal times and crash times of all project activities in a particular project are given below. Assume that indirect costs of the project are Rs.40 per week. Find out the optimum project duration and the minimum project costs of the project.

Activity	Immediate Predecessor	Normal		Crash	
		Cost	Time	Cost	Time
1--2	--	1500	8	2000	6.
1--4	--	2000	10	3000	7
2--3	1--2	1100	6	1500	4
2--5	1--2	900	8	1500	5
4--6	1-4 and 2-3	300	12	400	8
5--6	2--5	500	5	800	4

The per unit crash cost (also called crash slope) for each activity is calculated as, Crash slope = (Crash cost – Normal cost) ÷ (Normal time – Crash time)

The per unit crash cost (also called crash slope) for each activity is calculated as, Crash slope = (Crash cost – Normal cost) ÷ (Normal time – Crash time)

The network diagram normal costs is shown in figure. Here, activity 3-4 is a dummy activity. The crash time for each activity is represented in brackets.

Activity	Crashing cost per week
1--2	250
1--4	333.3
2--3	200
2--5	200
4--6	25
5--6	300

The critical path of the object is 1-2-3-4-6 and the normal duration of the project 26 weeks. The normal cost of the project Rs. 7100. While crashing the activities, the one with the least crashing cost per week is selected first. Here, the activity 4-6 has the least crashing cost (Rs.25 per week). Therefore, it is

Figure 12.4: Network Diagram
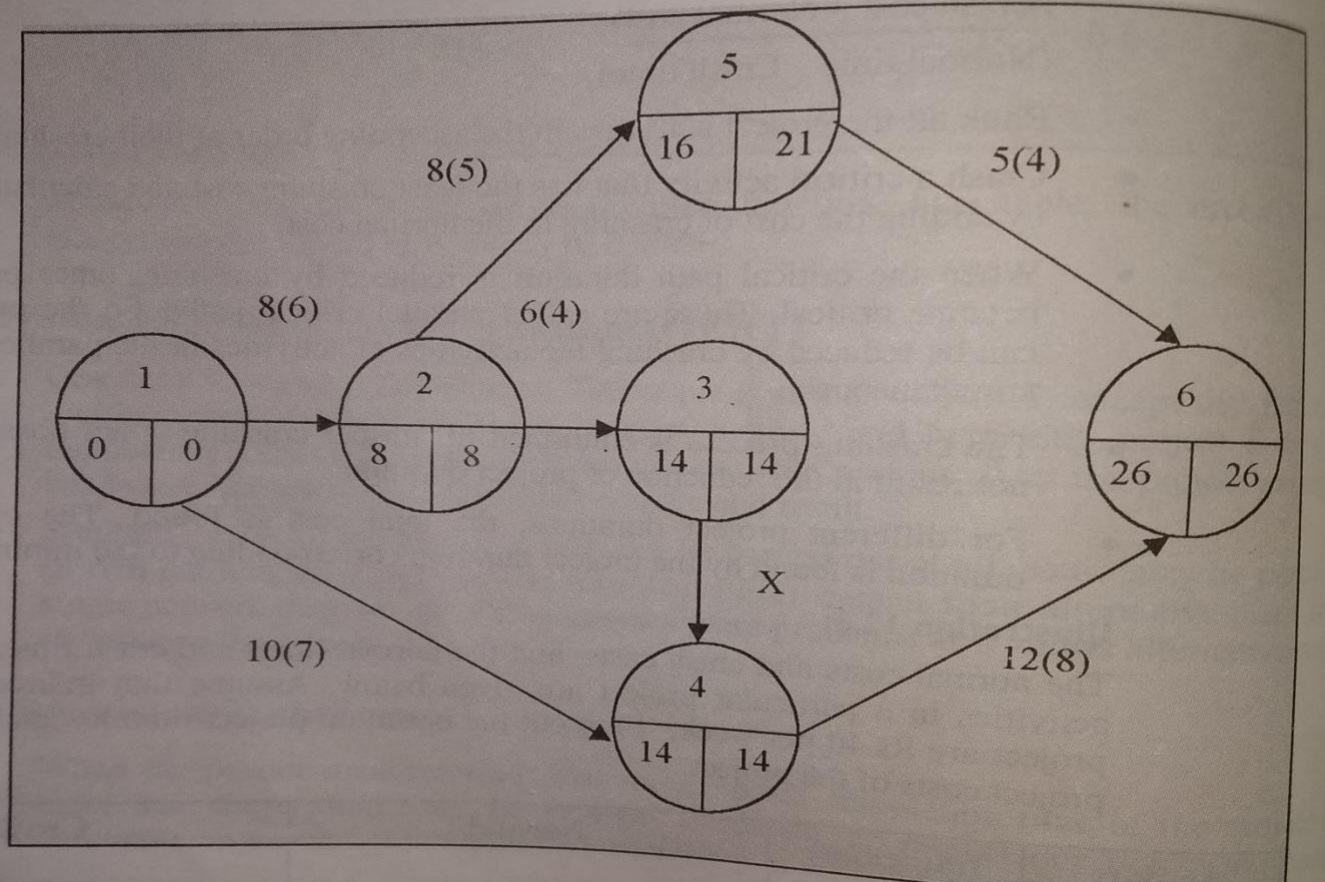
crashed first by 4 weeks, which means the project can be completed in 22 weeks. This increases project cost by Rs.100.

Next, activities 2-3 and 2-5 have minimum crashing cost per week (Rs.200). Now we crash the activity 2-3 as it is a critical activity. It can be crashed by 2 weeks. Even it is crashed by 2 weeks, the total project duration decreases by only 1 week (since the critical path of the project changes from 1-2-3-4-6 to 1-2-5-6).

Therefore, we crash the activity 2-3 by only 1 week. Then the expected project duration become 21 weeks and the project cost increases by Rs. 300 (Rs.100 + Rs.200).

Then we crash activity 1-2 by 2 weeks since it is the activity having next minimum cost (Rs.250). So the project duration becomes 19 weeks and the project cost increases by Rs.800 (Rs.300 + (Rs.250 × 2)). Finally, we crash the activities 2-3 and 2-5 simultaneously to reduce the project duration by 1 week. Here, the project incurs an additional cost of Rs.1200 (Rs.800 + Rs.200 + Rs.200). At this stage, all activities of the project has become critical activities and so the process of crashing is halted.

The following table provides all the steps mentioned above.

Crashing activity	Crashing time (Weeks)	New project duration (weeks)	Increased cost
4—6	4	22	100
2--3	1	21	300
1--2	2	19	800
2--5	1	18	1200

Since there exists an indirect cost of Rs.40 per week, the optimum cost of a project is calculated from the table below given.

Project Duration	Direct Costs	Indirect Costs	Total Costs
26	7100	1040	8140
22	7200	880	8080
21	7400	840	8240
19	7900	760	8660
18	8300	720	9020

Therefore, the optimum object duration is 22 weeks, when the total cost incurred is minimum, i.e. Rs. 8080.

Fast tracking

In this technique, the project manager attempts to reduce the project duration by doing activities in parallel. Suppose activity B can be started only after the completion of activity A in normal conditions. But the project manager can start boat activities at the same time, modifications to activity be as per the change in activity A. This ultimately reduces the duration of the entire project.

For example, software code is normally written only after the design is approved. But both the activities are started at the same time and the final code is written only after the software design in approved by the top management. But this technique required modifications, reworking, etc.

Resource Leveling

CPM and PERT techniques assume that the project has unlimited resources, and they can be assigned for project activities. However, in reality, project resources are usually limited. Sometimes activities may be delayed because of the non-availability of resources.

So, the project manager sequences the project keeping in mind the availability of resources, which forces him to recalculate the activity schedules. Normally, the project manager assigns the available resources to the critical activities first as they play a major role in determining the total completion time of a project.

SCHEDULE CONTROL

The project manager has to ensure that all the project activities are being carried out as per the schedule. Schedule control studies all the factors that affect project schedules. Schedule control determines the schedule changes and managers to complete them within the desired duration. Based on the changes, the project manager updates the project schedule.

The project manager has to consider the project schedule, performance reports, and requests while controlling the schedule. The project schedule represents the planned start and expected finish dates for each project activity. It provides a basis for the project manager to measure the schedule performance. Performance reports provide information about schedule performance and point out whether the activities are proceeding as per the planned schedule or not. The project manager initiates control to complete all the activities within the desired time. He considered the change request maybe the project stakeholder, which maybe verbal or written. These change requests maybe for extension or acceleration of project schedule.

The project manager uses technique like schedule change control system, and performance measurement in controlling the project schedule. the schedule change control system describe the procedure by which project schedules can be modified. The method include redrawing the project network diagram, and understanding the proposed changes. Performance measurement system assess the completion of the project activity in the normal duration. Calculate the magnitude of various and that may occur for each project activity.

Benefits of using scheduling techniques in Project Management

Project, Program, Portfolio

Scheduling techniques in Project Management are fundamental to deliver projects on time. Delays or failures do not only affect the project by itself but affect the structure where the Project Management belongs to. To have a clear idea of the differences between Project, Program and Portfolio, their definitions according PMI® are given.

- ▪ **Project**: *"A temporary endeavor undertaken to create a unique product, service or result."*[3]

- **Program**: "A group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually. Programs may include elements of related work outside of the scope of discrete projects in the program."[3]
- **Portfolio**: "A collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The projects or programs of the portfolio may not necessarily be interdependent or directly related."[3]

These three categories are interconnected and if one of these collapses, the others are going to be affected. If the life cycle of a project extends, it will alter both program and portfolio schedule.

Benefits on the project level
Managing efficiently and effectively a project means taking advantage of scheduling tools and techniques to use resources optimally. Even if different projects aren't linked one each other, their outcome is mostly the input of programs. Projects are the foundations of both programs and portfolios and for this reason they retain a big responsibility. Their delays or resources allocation affects the whole complex system. It's fundamental to use scheduling techniques to reduces as much as possible their impact on a bigger scale.

Benefits on the program level
A program is, by its definition, a bundle of projects that run simultaneously. Managing various projects at the same time isn't an easy job, an for this reason scheduling techniques are always used to control the development of the program. Within a program it's really useful to use scheduling techniques to visualize which projects are running well and sometimes better than the expected while others have delays and difficulties to proceed. Through the use of scheduling techniques it's possible to move resources between among various project to optimize their development.

Benefits on the portfolio level

At this point it's fundamental to bear in mind that usually portfolios keep running during the whole life of the company. They usually don't have a deadline but in some cases there are temporary ones who have to be scheduled and delivered on time. These type of portfolio runs only in a specific lapse of time. The fashion industry, for example, each season has one portfolio that is going to end the following months.

Deadlines and time limits are the most important constraints that affect the reputation of a company. Delivering on time project, product or services means being reliable and experienced. Delays or failure can always happen but through detailed scheduling techniques it's possible to prevent and manage them. Promising to customers the delivery of the project at a specific date and then not being able to commit it is synonymous of unreliability and lack of scheduling tools. Consequences will be penalties, loss of customers as well as incomes.

To sum up, the previous scheduling techniques are the most used and applied in Project Management. They are the base for a successful development of the project.

Reference:-

1. Project management, a text book of ICFAI UNIVERSITY
2. Scheduling techniques in project management, *Developed by Jessica Linda Ruina*

Question:-

1. Explain the techniques for schedule development.
2. Describe activity sequencing and its methods.
3. What do you understand by activity duration? Explain the method of estimating activity duration?
4. Define work breakdown structure. Explain the factor considered in developing a WBS.
5. What do you understand by scope planning? Explain development of scope statement?